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GEOLOGICAL SURVEY

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L. H. Pammel

THE WEED FLORA
OF IOWA

GEORGE F. KAY, State Geologist
JAMES H. LEES, Assistant State Geologist

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LETTER OF TRANSMITTAL

Iowa Geological Survey.

To Governor George W. Clarke and Members of the Geological Board:

GENTLEMEN: I submit, herewith, a bulletin on The Weed Flora of Iowa and recommend that it be published for distribution among the people of the state.

The thanks of the whole state are due Dr. L. H. Pammel of the Iowa State College of Agriculture and Mechanic Arts for the preparation of a comprehensive and thorough report, representing many years of careful and painstaking scientific work, on a subject that is most intimately related to agriculture, the industry that far exceeds in importance all other industries of our great state.

The Survey wishes to express its thanks to Dean Curtis, Director of the Iowa Agricultural Experiment Station, for his co-operation, and for his kindness in permitting the Survey to include in the bulletin on weeds results of investigations which were carried forward by Doctor Pammel while connected with the Experiment Station.

The Iowa Geological Survey had the honor, about ten years ago, to publish a complete monograph by Doctor Pammel on the Grasses of Iowa. This publication proved to be of great value, and it is with the fullest confidence that the bulletin on The Weed Flora of Iowa will be of equal if not of greater service to the agricultural and related interests of the state that it is now presented for publication as Bulletin 4 of the Iowa Geological Survey.

I have the honor to be,

Yours very sincerely,

GEORGE F. KAY,
State Geologist.

THE WEED FLORA OF IOWA

By L. H. PAMMEL

WITH THE COLLABORATION OF

CHARLOTTE M. KING J. N. MARTIN J. C. CUNNINGHAM
ADA HAYDEN and HARRIETTE S. KELLOGG

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PREFACE

Weeds do an enormous damage to the crops of Iowa. A conservative estimate places the injury at $25,000,000 annually. This loss could be largely avoided if we had more concise information on the subject, and if we could conserve the matchless resources of our soil by keeping the weeds down, the farmers would be greatly benefited in a financial way. It would seem appropriate, therefore, to publish a volume of the Weed Flora of the state at this time.

The need of a volume dealing with Iowa weeds as a feature of the flora of the state has long been felt by the public schools. Many papers have been published by the Iowa Agricultural Experiment Station, but these papers are mostly out of print. This work is much more comprehensive than anything heretofore published in this state. The title indicates that it is not a weed book, but rather a weed flora. Much stress has been laid on the geographical distribution of weeds. It is a contribution to the local flora of the United States.

The chapter on the geographical distribution of weeds will be found of special interest to the phytogeographer. I desire to express my thanks to Dr. M. L. Fernald, Messrs. R. I. Cratty, F. W. Paige, O. M. Olson, J. P. Anderson and Prof. B. Shimek for assistance in giving the geographical distribution of Iowa weeds. The chapter on the microscopic structure of weed seeds brings together in English much on the subject which has hitherto been inaccessible to the student not familiar with German or French literature. The chapter on morphology will greatly help the student to understand the changes occurring in the development of the flower and the formation of the seed. The chapter on the use of weeds in medicine will be of interest to those who occasionally make use of wild plants for medicinal porposes. The chapter on seeds describes a large number of weed seeds; this will be found of value to those engaged in a study of seeds.

The chapter on various weed laws gives a summary of laws in various states in the Mississippi Valley. In compiling these laws I have been aided by Mr. Small of the Iowa State Library, Mr. Moore of Wisconsin, Mr. Michel of South Dakota, Dr. Howard of Missouri and H. L. Bolley of North Dakota.

In the preparation of this Weed Flora, I have been greatly assisted by Professor J. N. Martin, who has written the chapter on morphology of the plant; Miss Ada Hayden, who has written the chapter on dissemination; Professor J. C. Cunningham, who has written the chapter on roots and underground organs; Miss Charlotte M. King, who is the joint author of the chapters on gross characters and microscopic structure of seeds. Miss King is also responsible for many of the excellent drawings. The chapter on medicinal weeds was prepared by Miss Kellogg. I am greatly indebted to her for painstaking editorial work and for preparing the bibliography and the index. In the matter of bibliography, it has seemed best to divide the subject into various sections so that the student may easily find the desired literature. The bibliography is not complete but enough papers are given to enable the student to find the important literature. I am indebted to Dr. Clark, of the Canadian Seed Laboratory, for the privilege of using some of the admirable illustrations of the Canadian work on weeds, also to Dr. Ernest Bessey for illustrations from Beal's Weeds of Michigan, and the classical Hillman seed figures in the Michigan bulletin, and to the Nevada Station for the use of the Hillman cuts. Some of the Hillman and a few other figures have been taken from the government publications. I am also indebted to various publishers for figures which have been taken from several textbooks of botany, as the Bergen & Davis book published by Ginn & Co.; several botanical works like Thomé's published in German, and to the Connecticut Experiment Station. A few figures have been taken from the Botanical Gazette. Credit is given under each figure. The photographs were made by F. E. Colburn, photographer at the Iowa Agricultural Experiment Station, G. T. Hart and C. R. Quade. The clerical work of the volume was performed by Miss Bertha Herr and my daughter, Miss Harriet. Mr. Burlingmair assisted in a study of weeds in different fields. To Mr. James H. Lees for his assistance in proof reading and editorial work I am also indebted. To all I wish to express my sincere thanks.

The reader will find it advisable to have several of the recent treatises on weeds. Mention may be made of my work "Weeds of the Farm and Garden," a general treatise of three hundred pages with numerous illustrations; the work of Fletcher and Clark of Canada; Bolley's "North Dakota Weeds;" Blatchley's "Indiana Weed Book;" W. J. Beal's "The Weeds of Michigan." A list of these publications and where they may be obtained will be found in the bibliography.

Ames, Iowa, December 18, 1912.

L. H. PAMMEL.

Page 754 Rosenberg, 1882 should be 1782.

Page 837 Patrick, P. E., should be Patrick, G. E.

Page 838 Blankenship should be Blankinship.

Page 842 L. T. Henderson should be L. F. Henderson.

Page 858 Panton, J. H. Weeds of Ontario should be listed on page 845.

Page 861 T. L. Williams should be T. A. Williams.

CHAPTER I.

DESCRIPTIVE MANUAL

L. H. PAMMEL

CHAPTER I.

KEY FOR FAMILIES.

I. Plants without true flowers; not producing seeds...*Pteridophyta.*
Stems jointed, rushlike..........................*Equisetaceae.*

I. Plants with true flowers, stamens, and pistils and producing seeds.
Spermatophyta.

II. Ovules not borne in a closed ovary (Pine, Spruce)..........
Gymnospermae.

II. Ovules borne in a closed ovary (Rose, Willow, Corn, etc.)....
Angiospermae.

III. Stems endogenous without central pith; no annual rings; parts of the flower usually in threes; single cotyledon...
Monocotyledoneae.

1. Grasslike plants 2.
   2. Flowers enclosed by chaff-like scales.
      Stems hollow; sheaths of leaves split...*Gramineae.*
      Stems solid; sheaths of leaves not split.*Cyperaceae.*
   2. Flowers not inclosed by chaff-like scales..*Juncaceae.*
1. Plants not grasslike; flowers with a perianth of 6 pieces; stamens 6..........................*Liliaceae.*

III. Stem formed of bark, wood, and pith, exogenous; leaves netted-veined; embryo with a pair of cotyledons.........
Dicotyledoneae.

1. Corolla absent
   2. Plants fleshy or scurfy..............*Chenopodiaceae.*
   2. Plants not fleshy or scurfy 3.
      3. Ovary free 4.
         4. Flowers unisexual.
            Ovary 1-celled ....*Urticaceae.*
            Ovary 3-celled ....*Euphorbiaceae.*
         4. Flowers perfect.
            Calyx and bracts greenish and scarious......
            Amaranthaceae.
            Calyx generally corolla-like.
            1. Fruit a 1-seeded achene.....*Polygonaceae.*
            1. Fruit a 5-12 seeded berry...*Phytolaccaceae.*
      3. Ovary inferior ....*Nyctaginaceae.*
1. Calyx and corolla present.
   2. Corolla of separate petals 3.
      3. Plants fleshy, flowers yellow........*Portulacaceae.*

3. Plants not fleshy 4.
   4. Pistil single 5.
      5. Flowers regular.
         Stamens numerous, free...*Ranunculaceae.*
         Stamens numerous; sepals and petals present, inserted on calyx...........*Rosaceae.*
         Stamens 10; fruit a legume...*Leguminosae.*
   4. Pistil compound 6.
      6. Ovary free.
         Ovary 1-celled ....*Caryophyllaceae.*
         Ovary more than 1-celled 7.
         7. Ovaries united into a ring...*Malvaccae.*
         7. Ovaries not united into a ring 8.
            8. Leaves simple.
               With punctate dots; stamens numerous ....*Hypericaceae.*
               Leaves not with punctate dots; stamens 6..................*Cruciferae.*
               Leaves compound, pinnately 3-foliate. *Anacardiaceae.*
               Leaflets 3, obcordate.....*Oxalidaceae.*
               Leaflets 5-7 pairs.....*Zygophyllaceae.*
               Leaflets 3, viscid or fetid herbs..... *Capparidaceae.*
      6. Ovary adherent; flowers in umbels..... *Umbelliferae.*
      6. Flowers not in umbels.......*Onagraceae.*

1. Calyx and corolla present, petals more or less united.
   2. Flowers regular 3.
      3. Plants with milky juice.
         Stamens united ....*Asclepiadaceae.*
         Stamens distinct ....*Apocynaceae.*
      3. Plants without milky juice.
         4. Plants twining ....*Convolvulaceae.*
         4. Plants not twining 5.
            5. Stamens 5 or more 6.
               6. Style 2-cleft; flowers not in heads; fruit 2-4 seedlike nutlets..........*Boraginaceae.*
                  Fruit many seeded pod...*Hydrophyllaceae.*
                  Flowers in heads; anthers in ring or tube about the style.........*Compositae.*
               6. Style 1; fruit many seeded.....*Solanaceae.*
            5. Stamens fewer than corolla lobes
               Caulescent, flowers blue ....*Verbenaceae*
               Acaulescent, flowers greenish.*Plantaginaceae*
   2 Flowers irregular.
      Stems 4-angled; ovary deeply 4-lobed......*Labiatae.*
      Stems not 4-angled; ovary 2-celled..*Scrophulariaceae.*

PTERIDOPHYTA, FERNS AND THEIR ALLIES.

This group of plants, sometimes called vascular cryptogams, is represented in our flora by the maidenhair fern, brake, spleenwort, shield fern, etc. The Boston fern is frequently cultivated.

FIG. 1. Common Horsetail (*Equisetum arvense*). Roadsides, fields, common everywhere in Iowa.
(Photographed by Colburn.)

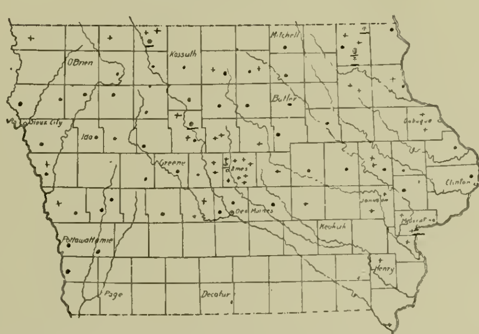


FIG. 1-A. Distribution of Common Horsetail.

EQUISETACEAE, HORSETAIL FAMILY.

This small family of rushlike plants contains a few species only and but one that is weedy.

Common Horsetail (*Equisetum arvense L.*).

Description.—A rushlike perennial with running rootstocks and annual stems; branches in whorls; fertile and sterile plants, the fertile appearing early in spring with a terminal cone, yellowish in color, bearing the spore cases (sporangia) underneath a scale; spores provided with hygroscopic bands; sterile frond with whorled branches.

Distribution.—Widely distributed in North America, common in sandy moist fields, on railroad embankments; common in Story, Boone, Carroll, Crawford, Harrison, Woodbury, Clinton, Dubuque, Lee, Page, Polk, Cerro Gordo, Emmet, Webster, Marshall, Johnson, Winneshiek and Allamakee counties

Extermination.—This is a most persistent perennial; only by giving frequent shallow cultivation after small grain is removed during the summer can the weed be kept in check.

SPERMATOPHYTA, FLOWERING PLANTS.

The seed plants have stamens and pistils and reproduce by seeds. Represented by the pine, spruce, hemlock, wheat, rye, corn, rose, maple, ash, aster, goldenrod, squash, etc.

GYMNOSPERMAE, GYMNOSPERMS.

The seeds are not inclosed in an ovary. Trees or shrubs generally with needlelike or scalelike leaves; represented in Iowa by the red cedar, white pine, etc. None are weedy.

ANGIOSPERMAE, ANGIOSPERMS.

Ovules borne in a closed ovary. Represented by a large number of our native and cultivated plants, like wheat, corn, lily, rose, clover, tomato, etc.

MONOCOTYLEDONEAE, MONOCOTS.

Plants with endogenous stem, the woody fibers in bundles distributed through the pith. Annual ring absent. Flowers generally on the plan of 3; embryo with a single cotyledon. Corn, lily, onion, asparagus, blue grass, switch grass are representatives.

GRAMINEAE, GRASS FAMILY.

This large family is of great economic importance, since it contains many of our food plants, including the well known cereals,

FIG. 2. Johnson Grass (*Sorghum halepense*); *a*, sessile spikelets. A most troublesoume weed.
(Lamson-Scribner, U. S. Dept. Agr.)

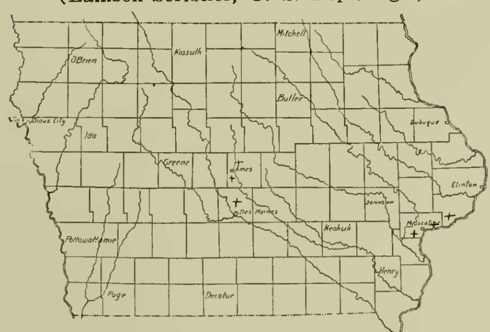


FIG. 2-A. Distribution of Johnson Grass. Reported recently from southwestern Iowa.

rye, wheat, oats, barley, corn, kaffir corn and millet, besides such forage grasses as blue grass, timothy, brome grass, foxtail, and a few ornamental plants, like pampas grass, ribbon grass, etc.

Johnson Grass (*Sorghum halepense* (L.) Pers.).

Description.—A stout perennial, with smooth, erect, simple culms, 3-5 feet high, and strong, creeping root-stocks; leaves elongated, ¼-¾in. wide, acute; ligule ciliate, and on the back where leaf-blade joins the sheath there is more or less pubescence; panicle open, 6-12 in. long, the whorled branches naked below, the 3-5-flowered racemes clustered towards their extremities; pedicels of the staminate (rarely neutral) spikelets pilose with stout hairs; sessile spikelet broadly lanceolate, acute, 2-3 lines long, pale green or violet, becoming dark or nearly black at maturity; callus small, obtuse, shortly and sparsely barbate; first glume coriaceous, sparingly pubescent on the flattened back, 5-7-nerved; second glume similar and equaling the first, convex below, subcarinate above, acute, the hyaline inflexed margins ciliate; third glume a little shorter than the outer ones, membranous, faintly 2-nerved, the infolded margins ciliate; fourth glume broadly oval, obtuse, nearly ½ shorter than the second, 2-lobed or bidentate at the apex, ciliate awned; awn 5-8 lines long; palea a little shorter than the glumes, nerveless, ciliate. Introduced and cultivated in many southern states for hay; in many places it has become a dangerous weed, difficult to exterminate.

Distribution.—The weed is common in the south, often a most troublesome weed. It has been reported as persisting in the vicinity of Hamburg, Fremont county.

Extermination.—Use the same methods as for quack grass. This may become a most troublesome weed.

Finger Grass (*Digitaria sanguinalis* (L.) Scop.).

Description.—A much branched, leafy annual, 1-3 ft. high, spreading on the ground, with erect, smooth, spreading culms, frequently rooting at the lower joints, joints sometimes smooth, though more frequently bearded with deflexed hairs; sheaths loose, generally pilose, hairy, ciliate on the margins, with a membranaceous ligule; leaves 2-4 in. long with rough margins, occasionally pilose at the base; flowers produced in digitate spikes, hence the common name finger grass; spikelets less than ⅛ in. long in pairs, 1 nearly sessile, the other with a stalk, each flower consisting of 2 sterile

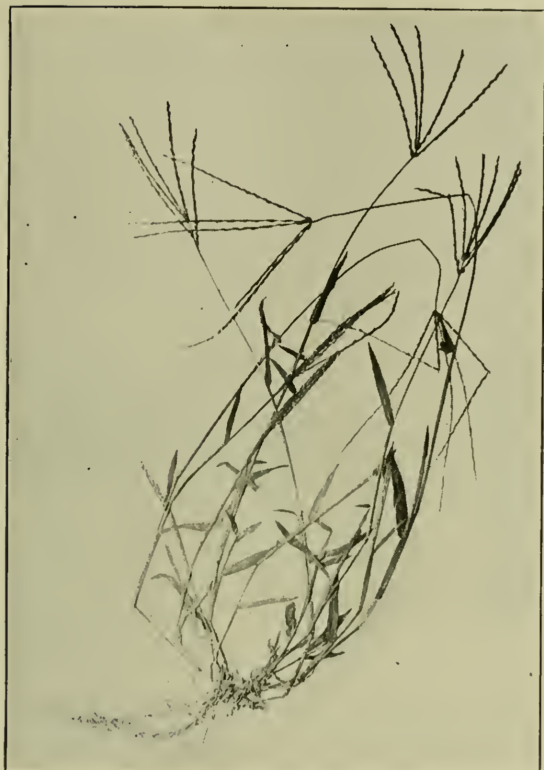


FIG. 3. Common Crab Grass (*Digitaria sanguinalis*). Common in fields, gardens, meadows. Rooting at the joints.
(Photographed by Colburn.)

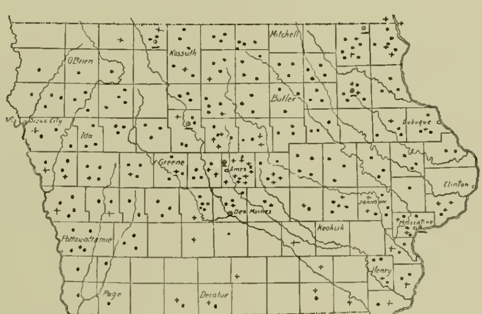


FIG. 3-A. Distribution of Common Crab Grass.

glumes and the flower proper; the first glume very small, the secong about ½-⅔ as long as the spikelet, usually hairy on the margin, the third glume somewhat longer than the fourth, which is 5-

nerved and usually silky-villous along the marginal nerves, fourth glume smooth and acute; fruit minute, pitted and cross-striated, light straw color except where the sterile glumes remain attached, which are gray in color and minutely hairy.

Distribution.—This European grass is cosmopolitan; abundant in the eastern and southern states and in California; common in all parts of Iowa, more particularly in gardens, corn fields, and streets.

Extermination.—This grass is much more difficult to remove than the foxtails because it roots so readily at the joints. Thorough cultivation will remove the weed. Do not allow it to go to seed.

Chemical Composition.—Common crab grass (*Digitaria sanguinalis*) has been used as a forage plant in many parts of the United States and many chemical analyses have been made. Analyses are reported from Mississippi, Tennessee and Iowa. The Iowa analysis reported by Weems is as follows:

NATURAL CONDITION

Sample	Water	Fat	Protein	Albuminoids	Crude Fiber	Ash	Nitrogen free extract
1	66.95	1.11	2.52	(1.98)	8.62	4.10	16.70

WATER FREE SUBSTANCE

Sample	Water	Fat	Protein	Albuminoids	Crude Fiber	Ash	Nitrogen free extract
1	----------	3.34	7.61	(5.98)	26.11	12.41	50.53

Smooth Crab Grass (*Digitaria humifusa* Pers.).

Description.—An annual 6 in.-2 ft. high, closely resembling *D. sanguinalis* in habit, but smooth throughout, excepting for a few hairs at the throat of the sheaths; spikelets 2-7, smaller than in *D. sanguinalis,* about 1 line in length; first glume very minute or obsolete; second and third glumes nearly equal in length, or the second a little shorter than the fourth, pubescent at the back.

Distribution.—Smooth crab grass is native to Europe but is now cosmopolitan; in eastern North America from New England to Texas and Mexico, Rocky mountains and Pacific coast; less common in Iowa than common crab grass; rapidly spreading in the state, more particularly in gardens; common in lawns and pastures.

Figure 4 Figure 4A

Fig. 4. Crab Grass (*Digitaria sanguinalis*). Common in cultivated fields.
Fig. 4-A. Smooth Crab Grass (*Digitaria humifusa*) ; *a*, leaf with sheath ; *b*, spikelet ; *c, d*, scales, stamens and pistils. Common in gardens and lawns.
(Drawn by C. M. King.)

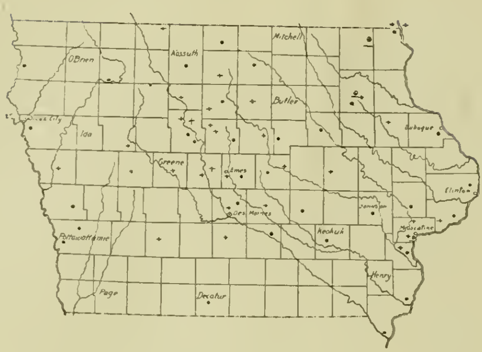


FIG. 4-B. Distribution of Smooth Crab Grass.

Extermination.—This weed is somewhat more difficult to exterminate than the foxtail, especially in lawns where it is common. Here it produces seed so close to the ground that the lawn mower will not catch this part of the plant. It may, however, be easily destroyed in fields which are cultivated. Stir the soil with a cultivator or hoe, exposing the roots to the sun.

Old Witch Grass (*Panicum capillare* L.).

Description.—An annual with usually coarse, branching stems, 1-3 feet long, with very hairy leaf-sheaths and capillary, widely spreading panicles, terminal on the culm or its branches; culm geniculate and branching near the base, rarely simple, generally pilose or pubescent below the bearded nodes; sheaths pilose to densely hirsute, with spreading hairs; ligule very short, densely ciliate; leaf-blade flat, lanceolate or linear, acute, usually thinly hairy on both sides, margins scabrous and ciliate near the base; hairs throughout spring from small papillæ, those on the leaf-blade being confined chiefly to the principal nerves; panicle diffuse, 3-12 in. long, the branches solitary in pairs, or rarely whorled, the ultimate branches and pedicels strongly hispid; spikelets 1 line long, ovate, acute, or abruptly acuminate-pointed, smooth; first glume clasping the base of the spikelet, obtuse or acute, 1-3-nerved, about ⅓ the length of the 5-7-nerved and nearly equal second and third glumes, the acute tips of which are sometimes minutely pubescent; flowering glume smooth and shining, elliptical, obtuse, or subacute, a little shorter than the larger outer glumes. Variable. July to October.

FIG. 5. Tickle Grass (*Panicum capillare*). Common in fields and gardens, etc. (Photographed by Hart.)

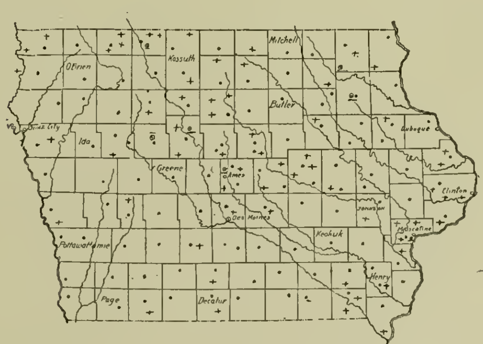


FIG. 5-A. Distribution of Tickle Grass.

Distribution.—Old witch grass is common throughout the state, frequently as a weed. It is variable, the form occurring in cultivated fields being stout and hispid; but when occurring in moist meadows and old lake beds it has slender and somewhat capillary branches. In Iowa it is quite common in Plymouth, Woodbury, Muscatine, Story, Emmet, Franklin, Clinton, Carroll, Crawford, Pottawattamie, Scott and other counties.

Extermination.—This annual grass is easily exterminated by cultivation. It seldom gives trouble in well cultivated corn fields. It might be well also, when the weed is abundant, to rotate with some leguminous crop.

Sprouting Crab Grass (*Panicum dichotomiflorum* Mx.).

Description.—A smooth, usually much-branched annual with stems 2-4 or 6 ft. tall, rather coarsely spreading or ascending (rarely erect); long, flat leaves and diffuse terminal and lateral panicles; sheaths smooth, lax, somewhat flattened; ligule ciliate; leaf-blade 6-12 or 24 in. long, 2-10 lines wide, acute, scabrous on the margins and sometimes also on the prominent nerves, rarely pilose on the upper surface; panicles pyramidal, 4 or 5-12 or 15 in. long, the primary and secondary branches spreading, scabrous; spikelets rather crowded upon short, appressed and scabrous pedicels, lanceolate-ovate; acute 1-1½ lines long, smooth, green or purplish; lowest glume embracing the base of the spikelet, usually obtuse and nerveless, rarely 1-3-nerved, ¼-⅓ as long as the nearly acute 5-7-nerved second and third glumes, the latter having sometimes a hyaline palea in its axil; floral glume elliptical, subacute, smooth and shining, a little shorter than the larger outer glumes; anthers saffron yellow.

Distribution.—Widely distributed in eastern North America, common in many parts of Iowa, as Ames, Des Moines, Sioux City, Council Bluffs, Davenport, Eddyville.

Extermination.—Prevent the formation of seed and give thorough cultivation.

FIG. 6. Sprouting Crab Grass (*Panicum dichotomiflorum*); *a, b, c,* spikelets; *d, e,* flowering glume. Widely distributed in the state.

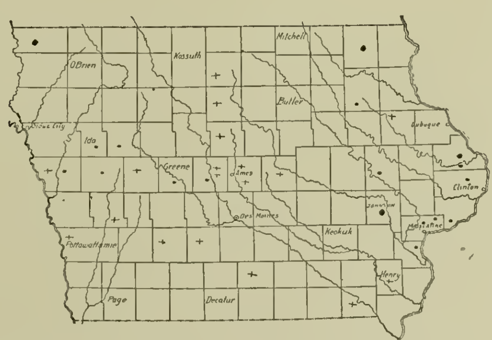


FIG. 6-A. Distribution of Sprouting Crab Grass.

Barnyard Grass (*Echinochloa crusgalli* (L.) Beauv.).

Description.—A coarse, ascending, leafy annual 1-5 ft. high, with wide leaves; spike 1-3 in. long, crowded in a dense panicle;

FIG. 7. Barnyard Grass (*Echinochloa crusgalli*). Fields, barnyards and roadsides.
(Photographed by Hart.)

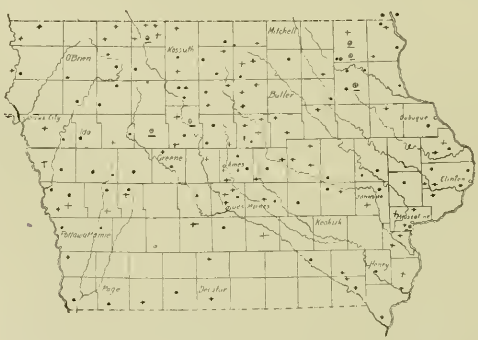


FIG. 7-A. Distribution of Barnyard Grass.

culms frequently branched near the base; sheaths loose, smooth or sometimes hispid; leaves broad and flat, 6 in.-1 ft. or more long; smooth or roughened, margin roughened; spikelets densely and irregularly crowded in several rows along one side of the spikelike branches of the panicle, 1½ lines long, outer glume or bract from ¼-½ the length of the spikelets, second and third glumes smooth, pubescent or hispid along the nerves, fourth glume smooth, awnless or short awn-pointed.

Distribution.—Barnyard grass is native to Iowa, also to other parts of North America, and is quite generally distributed, particularly in barnyards, on shores of lakes, streams and in gardens, but is most abundant in low places.

Extermination—By thorough cultivation and preventing the formation of seeds.

Chemical Composition.—Chemical analyses of this grass have been reported from Iowa, North Carolina, South Dakota and Mexico. Weems reports the following composition from Iowa material.

NATURAL CONDITION

Sample	Date	Height	Water	Fat	Protein	Albuminoids	Crude Fiber	Ash	Nitrogen free extract
1 ----------	--------	----------	76.34	.73	1.43	(1.35)	9.44	2.47	9.59

WATER FREE SUBSTANCE

Sample	Date	Height	Water	Fat	Protein	Albuminoids	Crude Fiber	Ash	Nitrogen free extract
1 ----------	--------	----------	----------	3.09	6.07	(5.73)	39.90	10.46	40.48

Pigeon Grass, Foxtail (*Setaria glauca* (L.) Beauv.).

Description—An erect annual 1-2½ ft. high; with flat leaves; bristly cylindrical spike, from 1-3 in. long; heads slender; bristles tawny yellow; small seeds conspicuously cross-striated and easily distinguished from the next species because of their larger size and by the cross-striation.

Distribution.—This weed is quite generally distributed in the United States, particularly in eastern states. It occurs everywhere in the state of Iowa, particularly in corn fields, where it comes up abundantly, after the corn is "laid by;" also in gardens and in pastures, especially in the fall.

Extermination.—It is not generally recognized, but it is probably true, that more money is spent in the extermination of foxtails than of any other class of weeds we have in the state of Iowa, yet they are all easily destroyed. One of the best and most effective methods of destroying the foxtail is by plowing the small grain field as soon as the grain is removed. If this is not done a large amount of seed is produced. After this plowing in the fall the field should be disked and harrowed in the spring and then planted to corn. The corn should be cultivated as frequently as possible, at least four or five times. This method should prove effective for the destruction of foxtail and pigeon grass.

Fig. 8. Pigeon Grass (*Setaria glauca*); *a*, spikelet showing the second glume, the upper portion of the flowering glume and bristles; *b*, spikelet showing the back of the first and third glumes.

(U. S. Dept. Agr.)

Chemical Composition.—Various analyses have been reported from Washington, D. C., Mississippi, South Dakota and Iowa. The following analyses are given by Dr. Weems:

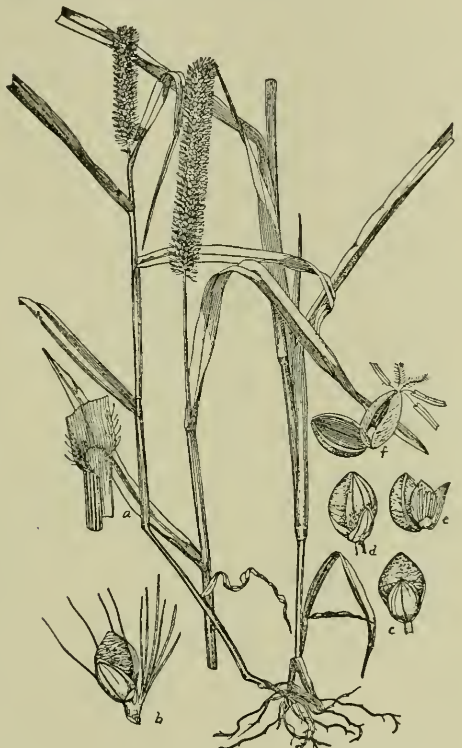


FIG. 8-B. Pigeon Grass (*Setaria glauca*); *a*, portion of leaf showing ligule; *b*, spikelet with bristles; *c*, spikelet; *d*, spikelet with first, second, and third glumes; *e*, spikelet showing flowering glume and sterile glume; *f*, flower opened showing stamens and pistil.

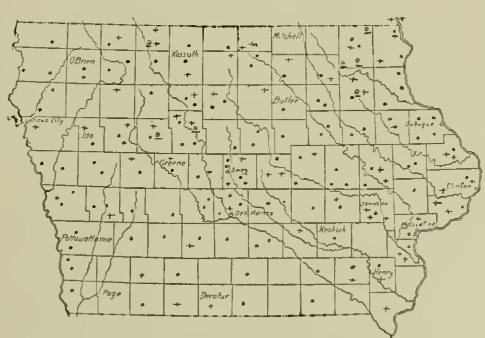


FIG. 8-A. Distribution of Pigeon Grass.

NATURAL CONDITION

Date	Water	Fat	Protein	Albu-minoids	Crude Fiber	Ash	Nitrogen free extract
9-11-1897	80.53	.50	2.05	(1.91)	6.86	2.92	7.14

WATER FREE SUBSTANCE

	----------	2.55	10.53	(9.85)	35.30	14.49	37.13

FRESH OR AIR DRY SUBSTANCE

	Water	Ash	Fat	Crude Fiber	Protein	Nitrogen free extract	Albu-minoids
S. D. (7)	8.17	13.40	1.88	31.25	10.53	34.77	6.94
Tenn. (2):							
Nearly ripe	3.20	7.75	3.80	31.77	5.00	47.48	--------
Washington, D. C. (3):							
Cut July 1, very young	74.20	2.80	.60	5.59	4.39	12.42	--------
Cut July 24, early bloom	68.40	2.29	.84	8.14	2.86	17.47	--------

WATER FREE SUBSTANCE

S. D. (1):							
Aug. 8, 1898	----------	14.59	2.05	34.03	11.47	37.86	--------
Tenn. (2)	----------	9.04	3.93	32.82	5.16	49.05	--------
Washington, D. C. (3):							
Cut July 1, very young	----------	10.80	2.30	21.70	17.00	48.10	--------
Cut July 24, early bloom	----------	7.30	2.70	25.80	9.00	55.30	--------
Mississippi	----------	16.74	2.71	35.04	9.20	34.31	--------

Green Foxtail (*Setaria viridis* (L.) Beauv.).

Description.—An erect annual from 1-3 ft. high; leaves 4-12 in. long, with rough margins; greenish, more or less compound cylindrical spikes from 1-5, or even in some cases 6 in. long; bristles few, much longer than the spikelets; spikelets ½ in. long, the chaff of second and third glumes as long as the minute chaff of the fourth glume, the latter being dotted and striate. A single head produces an enormous number of seeds.

Distribution.—This European grass is common in North America, especially eastward. It is found everywhere in the state, more particularly in corn fields, gardens, and in vacant places.

Extermination.—The same method of extermination should be used for this weed as for pigeon grass.

Chemical Composition.—Green foxtail grown in Pennsylvania and cut Aug. 11, 1880, analyzed as follows, according to the U. S. Dept. Agr. (Chem. Comp. Am. Grasses, 1884, p. 125) :*

FIG. 9. Green Foxtail (*Setaria viridis*). Common in corn fields, waste places. (After Clark and Fletcher.)

*Jenkins and Winton: Bull. Off. Exp. Sta. 11: 71.

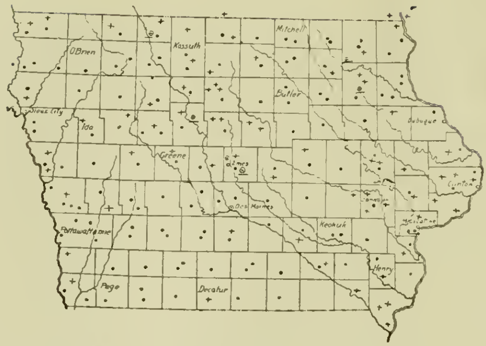


FIG. 9-A. Distribution of Green Foxtail.

FRESH AIR DRY MATERIAL

Water	Ash	Protein	Fiber	Nitrogen free extract	Fat
14.30	6.80	7.30	18.80	50.18	2.62

WATER FREE SUBSTANCE

	7.9	8.6	21.9	58.5	3.1

Bristly Foxtail (*Setaria verticillata* (L.) Beauv.).

Description.—An annual from 1-2½ ft. high with leaves from 2-7 in. long, somewhat narrower than in the preceding, from ¼-½ in. wide; sheaths smooth, rough on the margins and veins; spike cylindrical, from 1-4½ or 5 in. long, composed of short cylindrical clusters; bristles short, a little longer than the spike, single or in pairs, barbed downward; seeds small, greenish, ⅛ line long, minutely cross-striated and wrinkled.

Distribution.—This European grass is more common eastward and southeastward. It is of comparatively recent introduction into Iowa, being most abundant in the southeastern part, though also occurring at such points as Marshalltown, Ames, Sioux City and Council Bluffs. It is found in gardens and in the streets.

Extermination.—The foxtails are annuals and hence it ought to be an easy matter to destroy them. They produce an enormous amount of seed. Mr. G. M. Lummis estimated that a good sized plant of *Setaria viridis* had 2,500 to 5,000 seeds, and *Setaria glauca* 1,000 to 5,000; this being the progeny of a single seed.

FIG. 10. Bristly Foxtail (*Setaria verticillata*); *a*, spikelet showing bristle and glume; *b*, spikelet.
(U. S. Dept. Agr.)

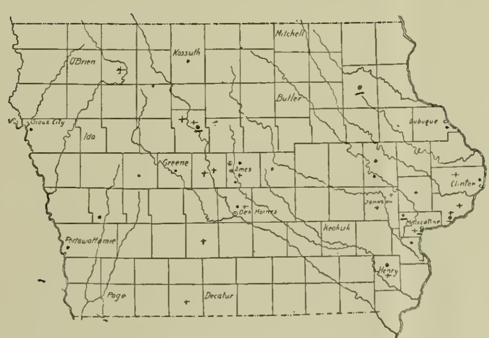


FIG. 10-A. Distribution of Bristly Foxtail.

Where these grasses are so abundant the ground becomes thickly covered. Dr. Beal of the Michigan Agricultural College has found that the seed retains its vitality for a considerable length of time. After six years twenty-one seeds out of fifty germinated. The seeds of all three species are much more tenacious when young than when older. The ground is covered so thickly that only a few of the plants are destroyed. Covering up with soil or exposing the roots to the sun is effective.

FIG. 11. A weedy cornfield: Foxtail, Smartweed, etc. Such a weedy field materially decreases the yield of corn. Notice how the weeds have crowded out the corn.

(Photographed by Pammel.)

Clark and Fletcher recommend as follows: "The only way to eradicate this weed is to mow it or hoe it out before it goes to seed. Anything which prevents it from going to seed for a number of years will eradicate it in time. Most ground, however, is so full of the seed that it takes a number of years of conscientious work to exterminate it.

FIG. 12. Foxtail and other weeds in back dooryard. Too many such places in Iowa.
(Photographed by Charlotte M. King.)

Sandbur (*Cenchrus tribuloides* L.).

Description.—Annual, with spreading or ascending, much-branched culms, rarely 1 ft. high, somewhat compressed; leaves flat or simply folded, about 6 in. long, acute, finely serrulate along the margins; sheaths generally much exceeding the internodes, hairy along the margins and at the throat; burs containing the spikelets, 6-20, nearly globose, covered with strong and more or less pubescent, barbed spines, which become very hard at maturity and readily fall off.

Distribution.—Common in eastern North America, sandy shores of lakes, streams, and sandy soil. In Iowa, common on Muscatine Island, railroad embankments, gravel knolls, and in Polk, Clinton, Muscatine, Scott, Woodbury, Linn, Jackson, Johnson, Dubuque, Webster and Black Hawk counties.

Extermination.—This weed is easily exterminated by cultivation. The roots are fibrous and exposure to the sun for a short time will destroy the weed.

FIG. 13. Sandbur (*Cenchrus tribuloides*). Common on sandy soils, gravel knolls, etc.
(Photographed by Hart.)

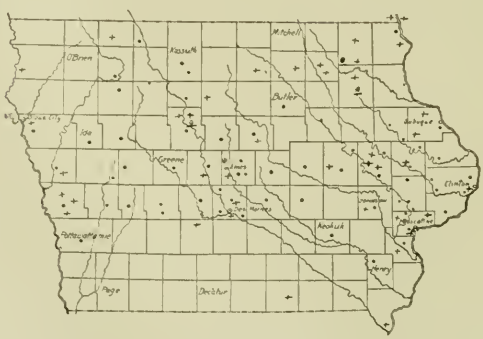


FIG. 13-A. Distribution of Sandbur.

Vanilla or Holy Grass (*Hierochloe borealis* Roem. and Schultes).

Description.—A perennial grass with creeping, fragrant rootstocks, ½ ft. high; panicle somewhat one-sided, 2-5 inches long;

FIG. 14. Holy Grass, Vanilla Grass (*Hierochloe borealis*). Common in northwestern and northern Iowa in low grounds. Creeping "roots" something like Quack Grass, but with the odor of vanilla.
(Photographed by Colburn.)

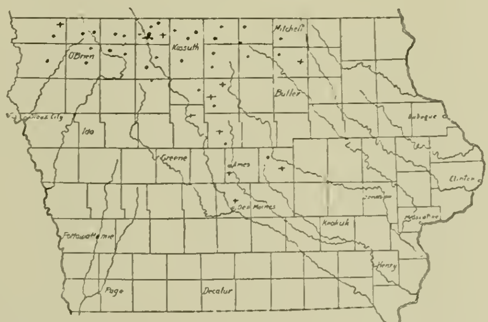


FIG. 14-A. Distribution of Holy Grass.

spikelets chestnut colored, 3-flowered; the 2 lower flowers staminate with 3 stamens; the upper flower perfect, short pedicelled, awnless, with 2 stamens.

Distribution.—Common in the north. Frequently a troublesome weed in Minnesota and northwest territory. Common only as a weed in a few of the northwestern counties of Iowa.

Extermination.—This weed can be exterminated by giving a shallow plowing after the crop has been removed and stirring the soil thus exposing the root-stocks to the action of the sun.

Poverty Grass (*Aristida dichotoma* Michx.).

Description.—A slender, tufted, branched annual from 12-24 inches tall; spikelets in narrow, striate, simple or compound spikes;

FIG. 15. Poverty Grass (*Aristida dichotoma*). Common in dry, sterile soil. *a*, lower or empty glumes of a spikelet; *b*, a floret showing awns, middle one coiled.

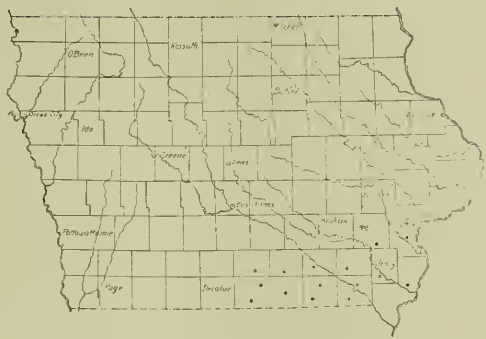


FIG. 15-A. Distribution of Poverty Grass.

empty glumes nearly equal, longer than the flowering glume, equaling the small lateral awns; the awns unequal, the long middle awn horizontal, but soon becoming reflexed.

Distribution.—Poverty grass is common in dry, sterile, or clay soil in southeastern Iowa.

Extermination.—The fibrous roots of the plant are easily killed by cultivation.

Long-awned Poverty Grass (*Aristida tuberculosa* Nutt.).

Description.—A rigid, much-branched perennial, 12-18 in. tall; panicles simple, 4-7 in. long; erect, rather distant branches, the lower in pairs of which one is short and few-flowered, the other elongated and many-flowered; empty glumes, nearly equal, awn-pointed, flowering glume, twisted above to division of awns; awns nearly equal, articulated with glume.

Distribution.—Common gravelly knolls and sandy soil, northern and eastern Iowa.

Extermination.—Succumbs readily to cultivation.

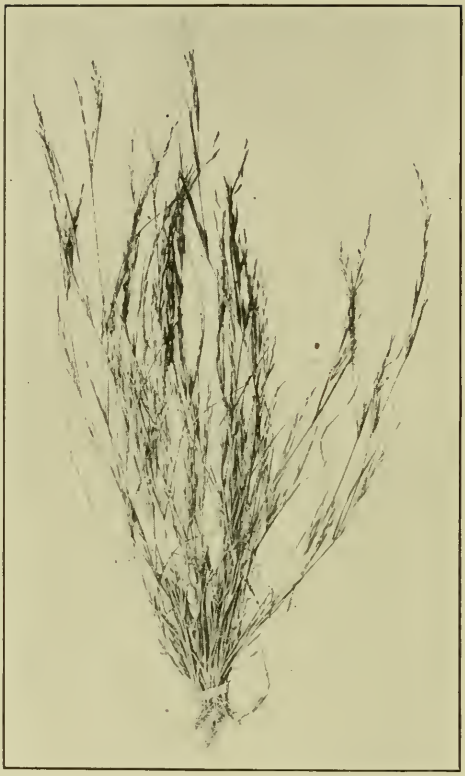


FIG. 15-B. Poverty Grass (*Aristida tuberculosa*). Common in gravelly and sandy fields.
(Photographed by Colburn.)

Nimble Will (*Muhlenbergia schreberi* J. F. Gmel.).

Description.—A low, ascending perennial with slender, much-branched, wiry culms, 1-2 ft. long; sheaths smooth, pilose at the throat; ligule very short; leaf-blade 1-2 lines wide, 1-4 in. long, scabrous on both sides; panicles 3-7 in. long, slender, branches erect, rather densely flowered; spikelets 1 line long, equaling or exceeding the pedicels; empty glumes minute, unequal, the lower sometimes obsolete; flowering glume narrowly lanceolate, pilose near the base, scabrous on the nerves above, terminating in a slender straight awn, 1-2 lines long; palea equaling the glume. Shaded thickets.

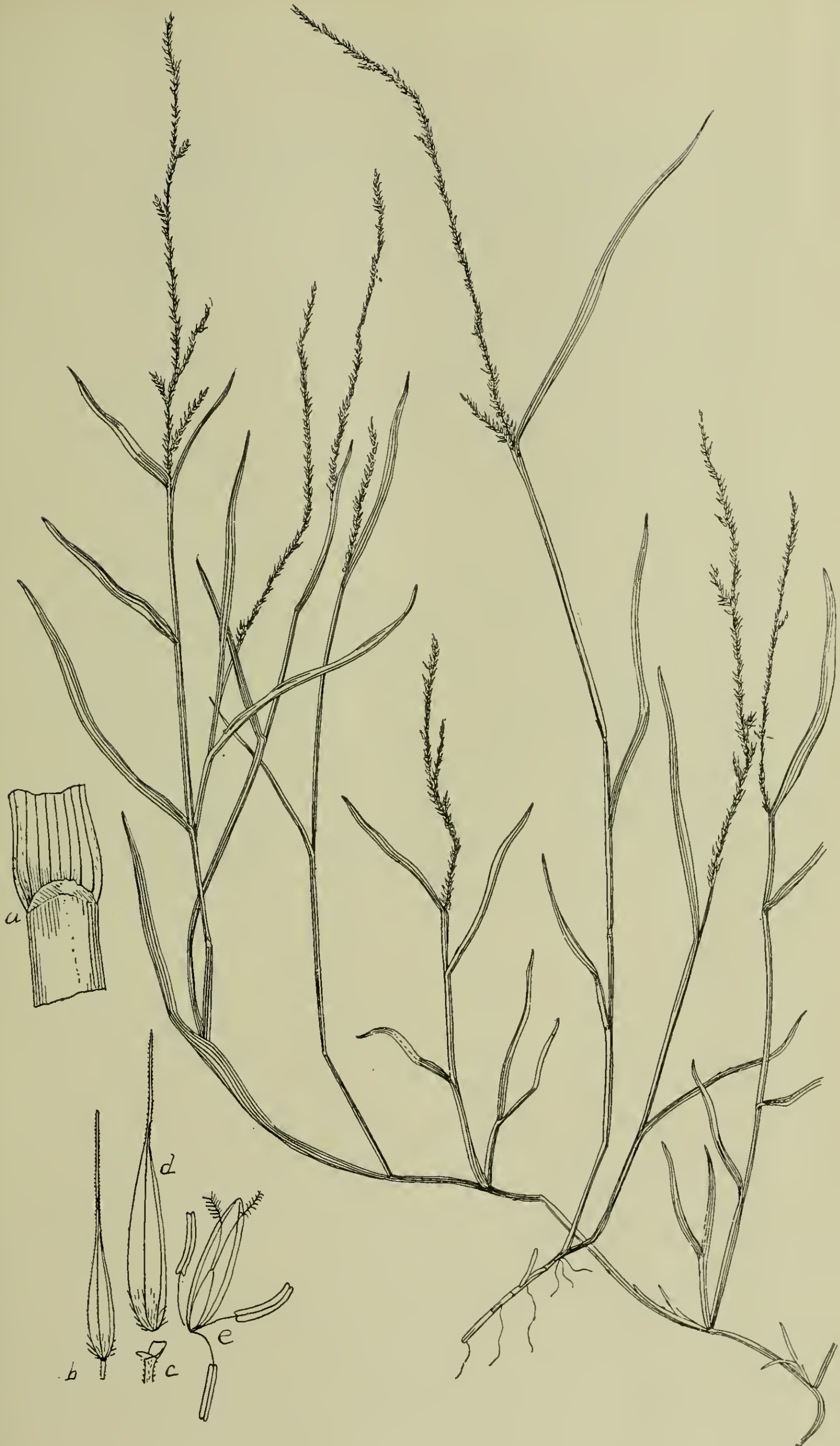


FIG. 16. Nimble Will (*Muhlenbergia schreberi*) ; *a*, sheath and base of leaf ; *b*, *d*, glumes ; *c*, lower part of rachilla ; *e*, flower. In southern Iowa. (Drawn by C. M. King.)

Distribution.—Nimble Will was originally confined to southeastern Iowa. It has spread northward along the Mississippi, where it is now abundant as far north as Dubuque. It occurs also in central Iowa in Story, Boone and Webster counties and is spreading. The grass is of little economic importance.

Extermination.—This weed is much more difficult to destroy than the other nimble weeds illustrated. The root-stocks spread more or less horizontally and are large and fibrous. Give a thorough cultivation, exposing the roots to the sun, and then follow with some leguminous crop. This weed is apt to be abundant in pastures. Here there is no other method of treatment than to get blue grass and white clover into the pasture.

Mexican Drop-seed Grass (*Muhlenbergia mexicana* (L.) Trin.).

Description.—An upright or ascending, usually much-branched perennial 1-3 ft. high, with a scaly, creeping root-stock; numerous flat leaves and contracted, densely-flowered panicles; sheaths longer or shorter than the internodes, smooth; ligule ½ line or less long; leaf-blades 1-3 lines wide, 2-7 inches long; spikelets about 1 line long on very short pedicels; empty glumes nearly equal, acuminate-pointed about the length of the floral glume (a little shorter or sometimes a little longer), scabrous on the keel; flowering glume lanceolate, acute or mucronate-pointed, 3-nerved, pilose near the base and on the callus; palea a little shorter than its glume, very acute.

Distribution.—Widely distributed in eastern North America, from Canada to Minnesota, South Dakota, Iowa, Nebraska and Missouri. Common everywhere in waste ground in Iowa, especially in Polk, Story, Pottawattamie, Webster, Crawford, Black Hawk, Calhoun, Clinton, Linn, Jasper, Lee and Dubuque counties.

Extermination.—The character of the "roots" is so different from that of the roots of quack grass and the other perennial weeds that it is not difficult to exterminate. The "roots" of this weed and the allied species are more or less clustered. In an experiment conducted to exterminate it we found that by giving a shallow plowing of four or five inches and harrowing to expose the "roots" to the sun, they were killed, no growth making its appearance during the rest of the season. Of course this is not effective during rainy weather.

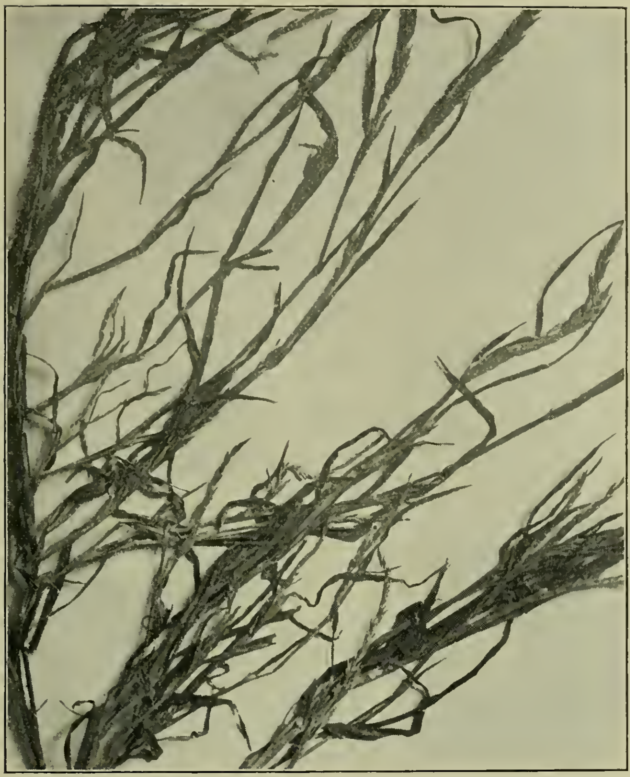


FIG. 17. Mexican Drop-seed Grass or Nimble Will (*Muhlenbergia mexicana*). Common in orchards, gardens and fields; sometimes called Orchard Grass, but incorrectly also called Turkey Grass because of the thickened clustered "roots."

(Photographed by Hart.)

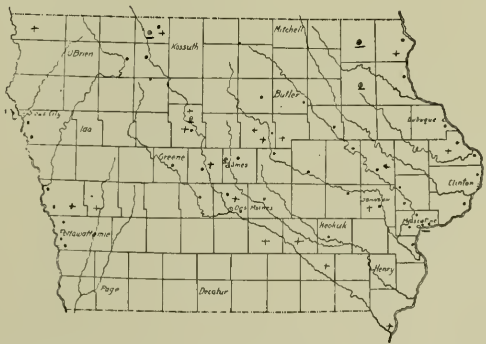


FIG. 17-A. Distribution of Mexican Drop-seed Grass.

Chemical Composition.—Mexican drop-seed grass has been chemically investigated by the Dakota, Tennessee and Iowa stations. The Iowa analyses were made at 7 different times between April 29 and July 20 with the following results. The water content varies greatly as does the protein content.

NATURAL CONDITION

Sample	Date	Height	Water	Fat	Protein	Albuminoids	Crude Fiber	Ash	Nitrogen free extract
1 ----------	4-29-1896	4-12	84.82	.88	3.51	(2.73)	3.70	2.04	5.05
2 ----------	5-14-1896	20-23	73.28	1.21	5.12	(3.78)	7.72	2.77	9.90
3 ----------	5-28-1896	26-29	82.95	.54	2.86	(1.96)	6.[illegible]3	1.95	5.27
4 ----------	6- 8-1896	36-38	77.46	.79	2.41	(2.14)	8.10	2.08	9.16
5 ----------	6-18-1896	38-39	73.37	.81	2.13	(2.10)	9.01	2.57	12.11
6 ----------	6-29-1896	39-40	58.77	1.49	3.22	(2.[illegible]0)	13.32	2.64	20.56
7 ----------	6-20-1896	48-49	81.98	.53	1.48	(1.09)	5.82	1.10	9.09

FIG. 18. Mexican Drop-seed Grass (*Muhlenbergia mexicana*); *a*, *b*, spikelets.

WATER FREE SUBSTANCE

Sample	Date	Height	Water	Fat	Protein	Albuminoids	Crude Fiber	Ash	Nitrogen free extract
1 ----------	------------	--------	--------	5.81	23.16	(17.00)	24.36	13.41	33.26
2 ----------	------------	--------	--------	4.52	19.17	(14.17)	28.90	10.38	37.03
3 ----------	------------	--------	-------	3.11	16.77	(11.46)	37.72	11.43	30.94
4 ----------	------------	--------	--------	3.49	10.70	(9.52)	35.94	9.27	40.60
5 ----------	------------	--------	--------	3.03	8.00	(7.88)	33.83	9.67	45.47
6 ----------	------------	--------	--------	3.62	7.81	(6.30)	32.31	6.40	49.86
7 ----------	------------	--------	--------	2.95	8.26	(6.11)	32.48	6.16	50.15

Marsh Muhlenberg (*Muhlenbergia racemosa* (Mx.) B. S. P.).

Description.—A rather stout, upright perennial, with very tough and densely scaly root-stocks, nearly simple culms, 2-3 ft. high, and densely flowered panicles, 2-4 in. long; spikelets 2-3 lines long, the long, acuminate-pointed outer glumes nearly equal and exceeding the very acute flowering glume, which is densely bearded at the base.

FIG. 19. Marsh Muhlenberg, Drop-seed Grass, Wild Timothy, and frequently called Orchard Grass (*Muhlenbergia racemosa*). Common in gardens, orchards, and especially in grain fields in low grounds.
(Photographed by Hart.)

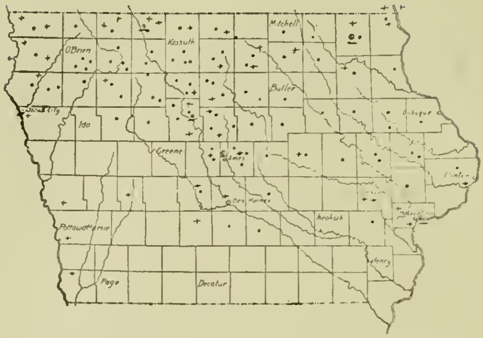


FIG. 19-A. Distribution of Marsh Muhlenberg.

FIG. 19-B. Marsh Muhlenberg (*Muhlenbergia racemosa*) ; *a*, spikelet with long acuminate-pointed outer glumes ; *b*, flowering glume, bearded.

Distribution.—Widely distributed in eastern North America, especially in meadows from Canada and New England, to New Jersey, west to the Rocky mountains, Iowa to Missouri.

Extermination.—The clustered root-stocks are easily destroyed by exposing to the sun. Use the same methods as those given for the Mexican drop-seed grass.

Sheathed Rush Grass (*Sporobolus vaginiflorus* (Torr.) Wood.).

Description.—A slender, caespitose annual, 1-3 ft. high, with narrow, short leaves, and simple, few-flowered, terminal and axillary, spikelike panicles which are about 1 in. long, and mostly enclosed in the somewhat inflated leaf-sheaths; spikelets 1-2 lines long.

FIG. 20. Drop-seed or Rush Grass (*Sporobolus vaginiflorus*). Common in sandy fields, lawns and gravelly soil.
(Photographed by Hart.)

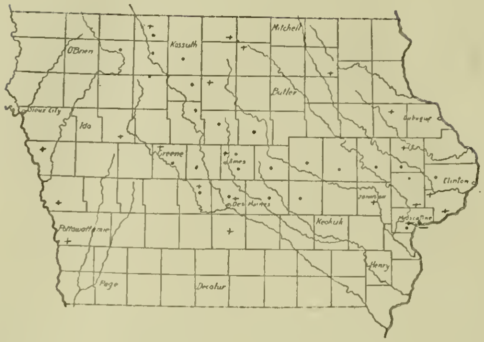


FIG. 20-A. Distribution of Sheathed Rush Grass.

Distribution.—Common in sterile fields and waste places from New England to Wisconsin, South Dakota, and Iowa, and southward. Especially common in pastures, lawns, and along roadsides in Iowa. Story, Polk, Boone, Clinton, Crawford, Carroll, Webster and Emmet counties.

Extermination.—This annual is easily exterminated by cultivation. The small fibrous roots succumb readily when exposed to the sun. Do not permit the plant to form seed.

Small Rush Grass (*Sporobolus neglectus* Nash).

Description.—Culms 6-12 in. high, erect, from a usually decumbent base, slender, often much-branched, smooth and glabrous; sheaths about half as long as the internodes, inflated; ligule very short; leaves 1 line wide or less at the base, smooth and glabrous beneath, scabrous and hairy near the base above, attenuate into a slender point, the lower elongated, the upper 1-3 in. long, setaceous; terminal panicle 1-2½ in. in length, usually more or less included in the upper sheath, striate; lateral panicles enclosed in the sheaths; spikelets about 1½ lines long, the outer scales acute, the lower one slightly shorter, third scale acute, glabrous, a little longer than the second, and about equaling the acute palet.

Distribution.—Occurs from New Brunswick to Virginia, Wisconsin, Iowa, South Dakota and Texas. In similar situations with the preceding species. Along beaten paths, pastures and roadsides.

FIG. 21. Drop-seed or Rush Grass (*Sporobolus neglectus*). Pastures, sandy fields.
(Photographed by Hart.)

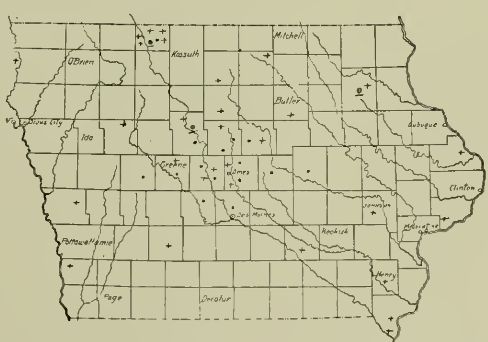


FIG. 21-A. Distribution of Small Rush Grass.

Extermination.—This weed should be treated in the same manner as the preceding species.

Wild Oats (*Avena fatua* L.).

Description.—An erect, glabrous annual, 3-5 ft. high, with flat leaves and spreading panicles of large, oatlike, nodding spikelets;

FIG. 22. Wild Oats (*Avena fatua*). In oat and grain fields, northeastern Iowa. (After Clark and Fletcher.)

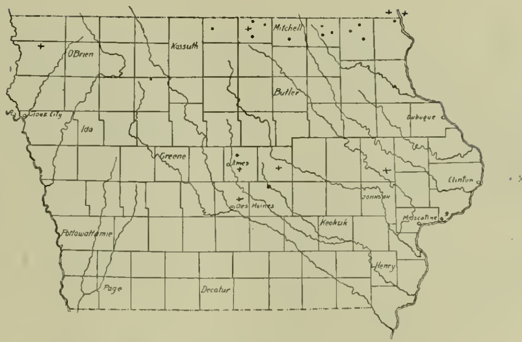


FIG. 22-A. Distribution of Wild Oats.

spikelets 2-4-flowered, with empty glumes ¾ to 1 in. long, and pubescent, flowering glumes 6-9 lines long, awns nearly twice as long as the spikelets.

Distribution.—Common in Canada, rare in eastern North America, abundant in the northwest, Wisconsin, Minnesota, Dakotas, Rocky mountains and Pacific coast. In a few counties in northern and northeastern Iowa.

Extermination.—Largely spread with oats seed. Use only clean oats seed. It succumbs readily to cultivation. Practice rotation of crops. Corn or some other cultivated crop should follow oats. The oats field should be brought into meadow. Clover and timothy are good rotations.

Crowfoot Grass, Wire Grass (*Eleusine indica* Gaertn.).

Description.—A coarse, tufted annual, with erect or spreading stems, 6-24 in. high, and digitate spikes; sheaths compressed and sparingly ciliate; leaf-blade long and narrow, both surfaces glabrous, or the upper scabrous and thinly hairy; spikes 5-7, 2-4 in. long, digitate at the apex of the culm, often with 1 or 2 lower down, widely spreading; spikelets closely imbricated, 1½-2 lines long, 3-6-flowered; glumes obtuse, the first small and 1-nerved; seeds rugose, enclosed within a thin, loose pericarp.

Distribution.—Naturalized from the Old World. In waste ground, streets, yards, from New England to Iowa, and common southward. In Iowa, in Marshall, Scott, Pottawattamie, and Clinton counties.

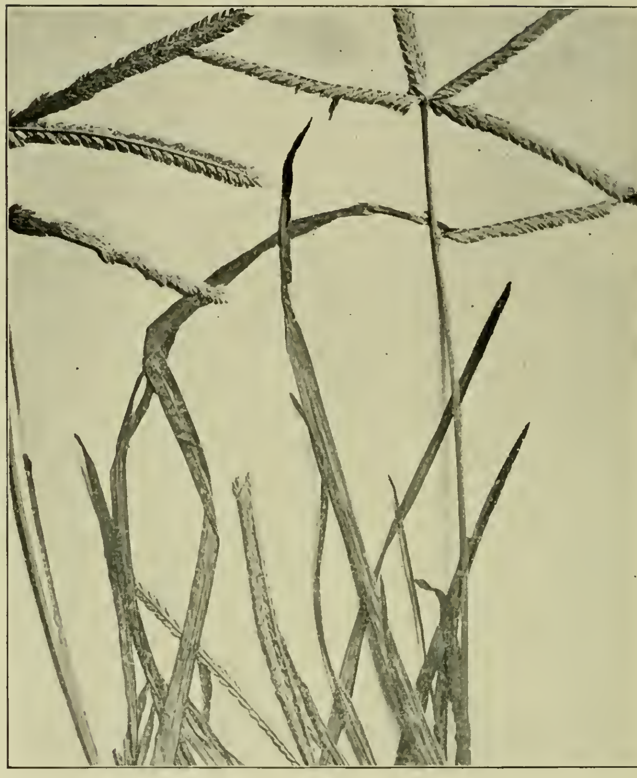


FIG. 23. Crowfoot Grass (*Eleusine indica*). Streets, roadsides, southern and southeastern Iowa.
(Photographed by Hart.)

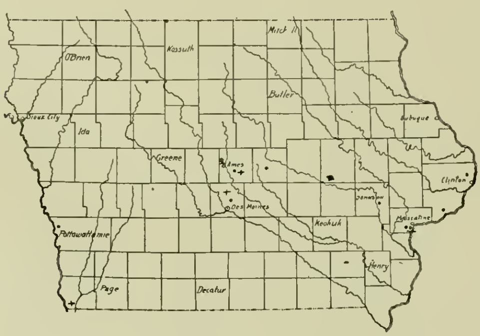


FIG. 23-A. Distribution of Crowfoot Grass.

Extermination.—Cultivation readily destroys the weed. When it appears in the lawn it must be pulled up or the grass cut closer to the ground.

Chemical Composition.—The chemical composition of Yard grass, Crowfoot, Crab grass, Wire grass (*Eleusine indica*): (Cut Aug. 11, 1880; grown in Pennsylvania) according to U. S. Dept. Agr., Chem. Comp. Am. Grasses, 1884, p. 125, is as follows:*

FRESH OR AIR DRY MATERIAL

Water	Ash	Protein	Fiber	Nitrogen free extract	Fat
14.30	19.81	10.14	19.63	43.33	2.79

WATER FREE SUBSTANCE

	11.5	11.8	22.9	50.5	3.3

Candy Grass (*Eragrostis major* Host).

Description.—A rather showy, much-branched annual, with erect or ascending stems, 6 inches-2 or 3 feet high; sheaths striate, smooth, hairy at the throat; ligule a fringe of short hairs; leaf-blade flat, 3-10 in. long, 1-3 lines wide, somewhat scabrous on the upper surface; panicle elliptical or oblong, the branches usually spreading, flowered, 2-8 lines long, 1½-2 lines broad, spikelets ovate to linear, 7-40 empty glumes nearly equal, ovate, obtuse, prominently nerved, and scabrous on the keel; palea ciliate on the keels.

Distribution.—*Eragrostis major* is a weedy grass in all parts of the state; introduced by the earliest settlers.

Extermination.—This weed is easily exterminated by cultivation. The best way to kill it is to cultivate corn in the soil and follow with small grain.

*Bull Off. Exp. Sta. 11; compiled by Jenkins and Winton.

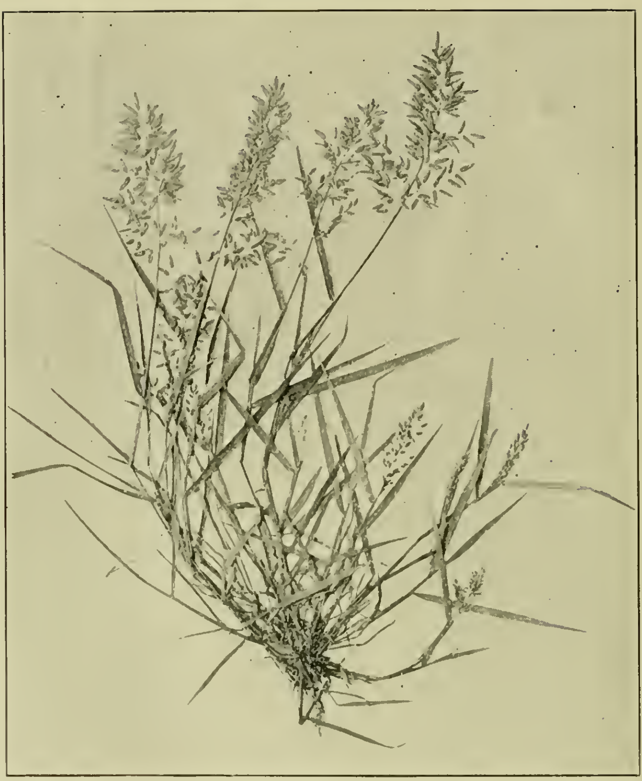


FIG. 24. Candy Grass, Stink Grass (*Eragrostis major*). Common in gardens, fields and roadsides.
(Photographed by Colburn.)

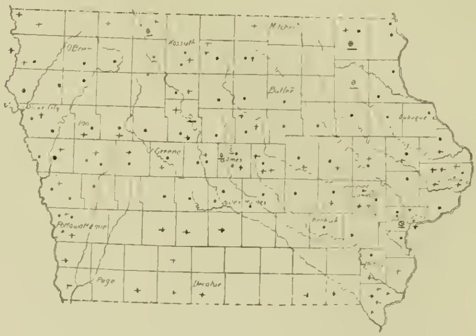


FIG. 24-A. Distribution of Candy Grass.

Southern Spear Grass (*Eragrostis pilosa* (L.) Beauv.).

Description.—An annual, 5-18 in. high, with erect or ascending stems diffusely branching near the base; sheaths pilose at the throat, otherwise smooth, leaf-blade 1-7 lines long, ½-1½ lines wide, conduplicate when dry; panicle oblong-lanceolate to pyramidal, 3-8 or 12 in. long, the widely spreading primary branches solitary, or 2-3 together, the axils not pilose; spikelets narrow-lanceolate, 2-4½ lines long, 3-15-flowered, appressed to the branches, nearly equaling or exceeding their capillary pedicels; empty glumes ovate, acute, scabrous on the keel, the longer one about ½ line in length; flowering glume broadly ovate, obtuse, distinctly 3-nerved, scabrous on the keel, about ¾ line long; palea scabrous on the keels; grain oblong.

FIG. 25. Spear Grass (*Eragrostis pilosa*). Roadsides, streets, fields, etc. (Photographed by Quade.)

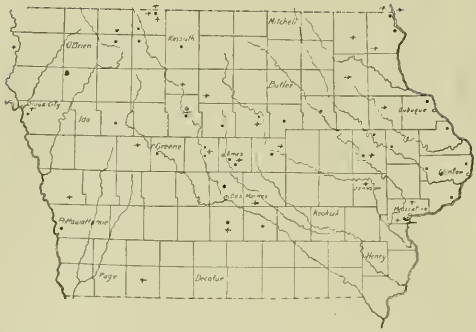


FIG. 25-A. Distribution of Spear Grass.

Distribution.—This grass is widely distributed in eastern North America in waste places, roadsides, and sometimes in fields, especially in sandy soil. New England to Wisconsin, Minnesota and southward.

Extermination.—Succumbs readily to cultivation.

Soft Chess (*Bromus hordeaceus* L.).

Description.—An erect, usually slender, pubescent annual, 1-3 ft. high, with flat leaves, and contracted panicles, 1-3 in. long; spikelets 3-8-flowered, ½-1 in. long, with pubescent glumes, the flowering ones 3½-4½ lines long, obtuse and awned; awns 3-4 lines long.

Distribution.—Frequent in waste places, roadsides, and fields, from Canada to Virginia and Rocky mountains. Most abundant of the brome grasses in Iowa, Story, Boone and Polk counties.

Extermination.—Succumbs readily to cultivation. Fields are largely sown from plants growing in waste places. Therefore, cut down the weed along roadsides and in waste places.

Chemical Composition.—Chemical analysis made at the experiment station at Ames by Dr. Weems shows the following results:

FIG. 26. Soft Chess, Annual Brome Grass (*Bromus hordeaceus*). Common in fields and waste places.
(Photographed by Colburn.)

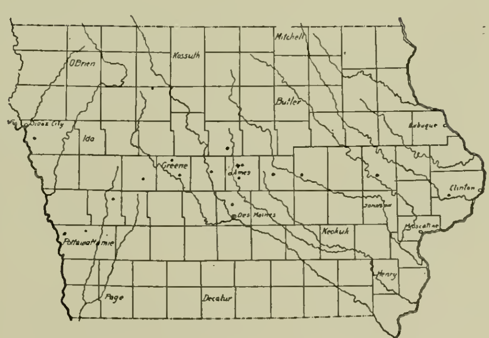


FIG. 26-A. Distribution of Soft Chess.

NATURAL CONDITION

Sample	Date	Height	Water	Fat	Protein	Albuminoids	Crude Fiber	Ash	Nitrogen free extract
1 ----------	4-24-1896	5.10	85.07	1.41	4.19	(3.23)	3.18	1.92	4.23
2 ----------	5- 4-1896	18-18	87.29	.94	2.14	(1.38)	3.38	1.83	4.45
3 ----------	5-11-1896	18-24	79.37	.85	2.62	(2.50)	5.47	2.19	9.50
4 ----------	5-20-1896	--------	80.63	.78	2.96	(2.10)	6.42	2.05	7.16
5 ----------	6- 1-1896	30.32	71.41	.85	3.52	(3.08)	10.01	2.54	11.67

WATER FREE SUBSTANCE

1 ----------	----------	--------	--------	9.46	28.05	(26.61)	21.31	12.89	28.26
2 ----------	----------	--------	--------	7.43	16.83	(14.80)	26.61	11.38	34.75
3 ----------	----------	--------	--------	4.10	12.71	(12.12)	26.54	10.64	46.01
4 ----------	----------	--------	--------	4.08	15.30	(10.88)	33.18	10.61	36.83
5 ----------	----------	--------	--------	2.95	12.30	(10.76)	35.01	8.91	40.83

This grass is very nutritious in its young condition. The protein varies from 2.14 per cent to 4.19 per cent, but there is a seeming variation with different plants found under different conditions.

Chess, Cheat (*Bromus secalinus* L.).

Description.—An erect annual, 2-3 ft. high; culms smooth or pubescent at the nodes; sheaths striate smooth, scabrous or sometimes pilose; ligule short, blunt; leaf-blade 6-12 in. long, rather broadly linear, smooth beneath, more or less rough and pilose on the upper surface; panicle 4-8 in. long, erect, the more or less compound branches, spreading, even in fruits; spikelets 6-10 lines long, oblong ovate, turgid, 6-12-flowered, pendulous in fruit, empty glumes oblong lanceolate, acute, the first 3-5, the second 7-nerved; flowering glumes ovate-oblong, obscurely 7-nerved, smooth or minutely downy along the margins and toward the apex, becoming nearly cylindrical in fruit; palea obtuse, strongly nerved; nerves toothed or fringed with distant bristles.

Distribution.—Common wherever wheat is cultivated and sometimes in waste places, from the Atlantic to the Pacific. At one time common in many parts of Iowa, but now occurring sparingly except where wheat is cultivated.

Extermination.—Use clean seed and sow in clean soil. The weed succumbs readily to cultivation.

Chemical Composition.—The common *Bromus secalinus* analyzed at the Iowa station by Weems shows the following analysis.

FIG. 27. Cheat or Chess (*Bromus secalinus*). In grain fields. (After Clark and Fletcher.)

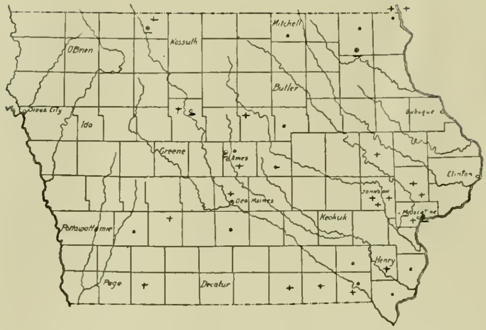


FIG. 27-A. Distribution of Cheat or Chess.

NATURAL CONDITION.

Sample	Date	Height	Water	Fat	Protein	Albuminoids	Crude Fiber	Ash	Nitrogen free extract
1.	5-20-1896	25-30	79.22	1.99	2.74	(1.96)	9.15	2.21	4.59
2.	6-15-1896	28-29	66.55	1.19	3.23	(2.49)	12.38	2.61	14.01

WATER FREE SUBSTANCE.

Sample	Date	Height	Water	Fat	Protein	Albuminoids	Crude Fiber	Ash	Nitrogen free extract
1.				9.59	13.17	(9.42)	44.04	10.63	22.57
2.				3.57	9.66	(7.44)	37.03	7.91	41.83

There is considerable nourishment in the nutritive substance when the plant is young, but when old it can not be considered very nutritious.

Downy Brome Grass (*Bromus tectorum* L.).

Description.—A slender, erect, leafy annual, 7-25 in. high, with narrow, softly pubescent leaves, and open, nodding panicles, 3-7½ in. long; spikelets 5-8-flowered, with unequal, acuminate-pointed, hirsute, empty glumes, and rough or hirsute flowering glumes, 4-6 lines long; awns 6-8 lines long.

Distribution.—Common in waste places, Rocky mountains and the Pacific coast, Atlantic states, Maine to Iowa. Not abundant in Iowa.

FIG. 28. Downy or Awned Brome Grass (*Bromus tectorum*). An annual grass in streets of our larger cities.
(Photographed by Quade.)

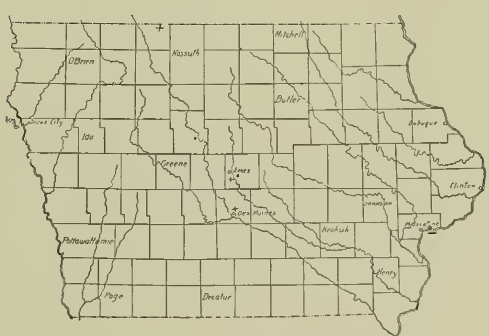


FIG. 28-A. Distribution of Downy Brome Grass.

Extermination.—Care should be used in destroying packing material. In the few localities in which this weed occurs in Iowa, it has come from packing material. It succumbs readily to cultivation.

Poison Darnel (*Lolium temulentum* L.).

Description.—An annual, with smooth, stout culm, 2-3 ft. high; sheaths scabrous; ligule short, spike 6-12 in. long; spikelets 5-7-flowered; empty glumes sharp pointed, as long as the spikelet, flowering glumes turgid, awned or awnless, shorter and broader than in *L. perenne.*

Distribution.—Introduced from Europe; naturalized in eastern North America and quite abundant on the Pacific coast; found in many counties in Iowa.

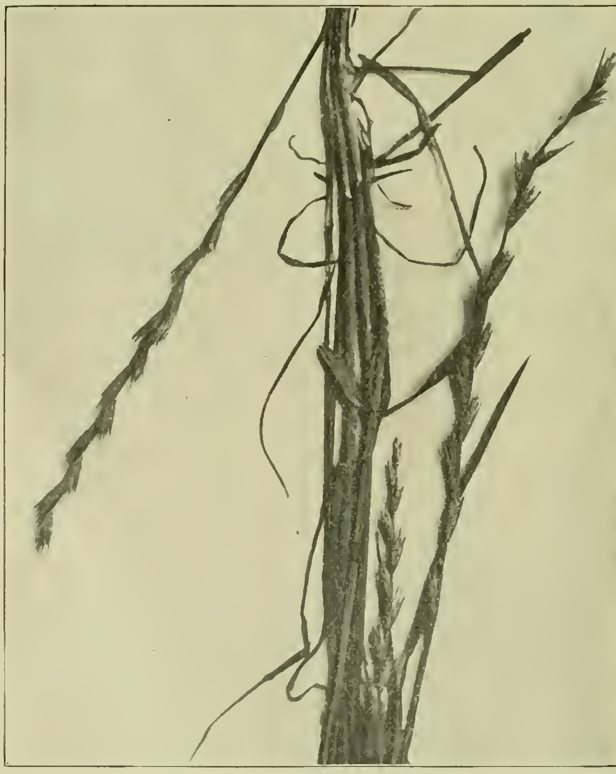


FIG. 29. Poison Darnel (*Lolium temulentum*). Common in oat and wheat fields in northern Iowa.
(Photographed by Hart.)

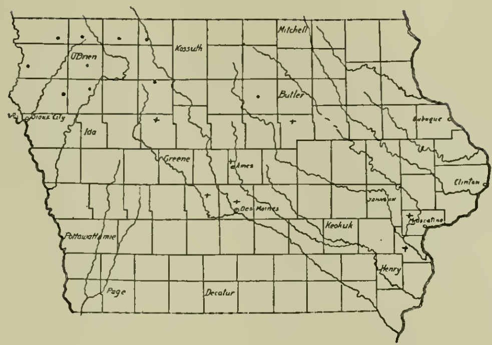


FIG. 29-A. Distribution of Poison Darnel.

Extermination.—Sow clean oats or wheat. The weed succumbs readily to cultivation.

Quack Grass (*Agropyron repens* Beauv.).

Description.—A perennial with a many-jointed, creeping rhizome (root-stock); culm from 18 in-4 ft. high, bearing numerous leaves from 5-12 in. long, and from 1/3-1/4 in. wide; margins rough, very smooth beneath, slightly hirsute above; spikes 6-12 in. long, erect; spikelets on opposite sides of a jointed and channeled rachis, pubescent on the margin, erect, 4-8-flowered; lower or sterile glumes acute or short-awned, prominently 5-7-nerved, flowering glumes smooth; palet acute or somewhat rounded, smooth or slightly pubescent.

The Western Wheat Grass (*Agropyron smithii* Rydb.) is closely related to quack grass. The plant is glaucous; leaves are rigid, bluish green in color, scabrous on the margin, edges rolling in; spikelets 7-13 flowered, in a thicker spike ("head") than quack grass; running root-stocks ("roots"). Common along railways and in northwestern Iowa. This plant is not considered a weed. It may be used to plant railway embankments.

The Slender Wheat Grass (*Agropyron tenerum* Vasey) produces a slender long head, greenish in color, running roots absent.

Distribution.—This grass is common and widely distributed from Manitoba, Minnesota, and western Iowa to Arkansas and Texas. In Iowa it has been found and reported in the following localities: Afton Junction, Ames, Armstrong, Iowa and Minnesota line nea Ceylon (Minnesota), Elmore, Hampton, Harcourt, Keokuk, Des

Moines, Mason City, Nora Springs, Ontario, Pilot Mound and in Hamilton county. It is especially common in the loess soil from

FIG. 30. Quack Grass, Quick Grass, Scutch Grass (*Agropyron repens*). Fields, waste places, around elevators, meadows, roadsides and pastures, especially northern Iowa.

(After Clark and Fletcher.)

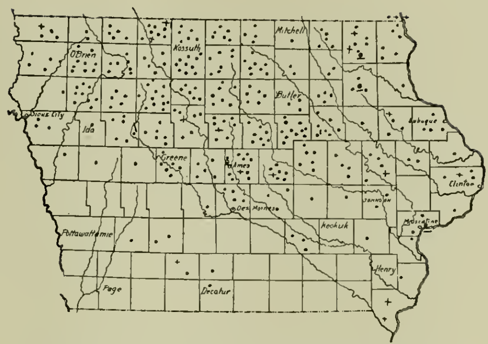


FIG. 30-A. Distribution of Quack Grass.

Carroll to Lyon county and eastward and northward and is found extensively along railroads. It is found in northern Iowa from Mississippi to Missouri rivers, probably in every county.

Extermination.—With reference to the extermination of quack grass, experiments made at Ames indicate that quack grass can be exterminated. When it covers considerable areas it may be necessary to summer fallow. The land should be plowed in August when the small grain crop has been removed. The first plowing should be shallow, not more than two or three inches deep. Then harrow with a common drag. This will expose a large number of the "roots". If the grass appears again, run over the field with a disc and drag. This should be continued for the remainder of the season. In the spring plow the soil six or seven inches; drag and expose the "roots". The field should be kept free from weeds of all descriptions during the entire growing season. It may be necessary to go over the field at least once a week to get all of the quack grass. *Where land brings as much per acre as in Iowa, no farmer can afford to leave his land fallow. The field should be given the same treatment in the fall and early spring as outlined above. Sow thickly with one of the following crops: Sorghum, Millet, Buckwheat, or Rye. These crops will not entirely kill the quack grass but will reduce its vitality to such an extent that what remains may be easily treated by plowing six or seven inches deep in the fall, following with a harrow. With sorghum very little quack grass will remain.* Experience has shown that quack grass is shallow-rooted and that the roots will not grow readily through the soil beyond a depth of six inches.

FIG. 30-B. Western Wheat Grass (*Agropyron smithii*). Common along railroads and in northwestern Iowa. The distribution of *A. smithii* is shown in fig. C and of Slender Wheat Grass (*A. tenerum*) in fig. D. *a,* empty glumes; *b,* flowering glumes with flowers.

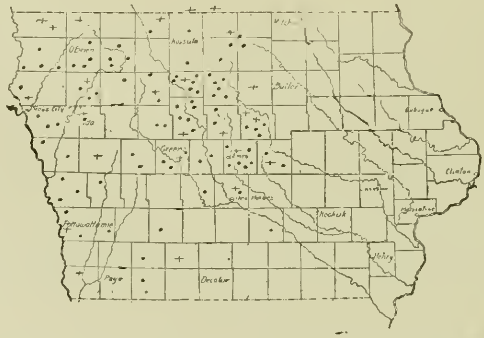


FIG. 30-C. Distribution of Western Wheat Grass.

The following suggestions for exterminating the weed are made by Fletcher and Clark: "Let the plant exhaust its substance in the production of a hay crop, which should be cut and removed as soon as the head is formed and before it is in bloom. Plow shallow and cultivate until the root-stocks have been brought to the surface by implements that can be forced, after repeated applications, to the full depth of the furrow. A disc is not satisfactory because the cuttings from the root-stocks are difficult to gather and they perpetuate

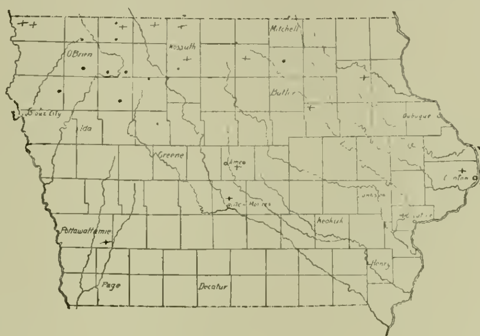


FIG. 30-D. Distribution of Slender Wheat Grass.

the growth, wherever transplanted. When brought to the surface the root-stocks should be gathered and burnt or removed. This should be done at once before the plant has had an opportunity to renew its growth. For Manitoba, S. A. Bedford recommends plowing up the couchgrass late in the spring and seeding at once to barley, three bushels to the acre."

Chemical Composition.—Various chemical analyses have been made of quack grass. The following were reported by Weems from material grown in Iowa.

NATURAL CONDITION

Sample	Date	Height	Water	Fat	Protein	Albuminoids	Crude Fiber	Ash	Nitrogen free extract
1.	4-18-1896	4- 8	73.96	1.15	5.13	(4.57)	6.13	3.14	10.49
2.	5- 6-1896	16.24	79.06	.81	4.41	(2.47)	5.66	3.11	6.95
3.	5-20-1896	20-30	79.56	1.51	4.64	(2.11)	4.96	2.09	7.24
4.	6- 1-1896	26.28	75.84	1.47	4.23	(2.04)	6.68	2.66	9.64
5.	6-15-1896	26-28	80.56	1.28	1.35	(1.32)	5.05	2.12	9.64

WATER FREE SUBSTANCE.

Sample	Date	Height	Water	Fat	Protein	Albuminoids	Crude Fiber	Ash	Nitrogen free extract
1.				4.41	19.70	(17.57)	23.55	12.08	40.26
2.				3.86	21.06	(11.80)	27.12	14.84	33.12
3.				7.37	22.71	(10.34)	24.28	10.24	35.40
4.				6.08	17.52	(8.44)	27.56	11.00	37.84
5.				6.59	6.96	(6.80)	25.97	10.93	49.55

It is not as valuable for pasturage as blue grass but it compares very favorably with timothy in regard to the amount of protein and nitrogen free extract it contains.

Squirrel-tail Grass (*Hordeum jubatum* L.).

Description.—An annual or winter annual from 6 in -2 ft. high, producing fibrous roots which form solid, compact bunches, leaves not unlike those of blue grass, but paler in color, from 2-4 in. long, margins scabrous; flowers in a dense spike from 2-4 in. long, pale green or purplish in color; spike consisting of a number of 1-flowered spikelets, 3 occurring at each joint, 1 being perfect, the other spikelets awl-shaped, rudimentary, and borne on short stalks, 1 sterile spikelet occurring on each side of the perfect flower, which bears a long awn; at each joint will be found 6 empty long-awned glumes spreading at maturity giving to the plant its bristly appearance; when mature, the spike breaks up into joints consisting of the rudimentary spikelets and a perfect flower, so that each joint has one "seed," the number of "seeds" in a spike varying from 35-60. A single cluster of plants may therefore produce from three hundred to two thousand mature "seeds". The plant has a wonderful capacity for "stooling". From a single plant as many as forty spikes may be produced, and the number no doubt often exceeds this.

Distribution.—Squirrel-tail grass, originally, was abundant in the vicinity of alkali lakes and along the borders of streams west of Missouri river. It also occurred sparingly on the North Atlantic coast; now, however, it is common across the continent. In Iowa it is abundant in all parts of the state not only in pastures but in meadows, fields and gardens.

Extermination.—Squirrel-tail or wild barley is a most pernicious weed along the roadsides and in pastures and meadows; pernicious because it not only prevents the growth of the better grasses but is injurious to live stock. As this weed is most common in the pasture, the best way to treat it is to mow the pasture before the grass has matured its seed. Since this weed is an annual, or winter annual, this would effectively dispose of the plant were it not for the fact that the seed is blown in from neighboring fields and roadsides. Cultivation will readily destroy the weed and where it is abundant in fields shallow cultivation followed by the disk and harrow should be effective.

Clark and Fletcher, in regard to exterminating this grass, which in Canada is known as Skunk-tail Grass, say: "There is no difficulty in eradicating this grass from any land which can be plowed,

FIG. 31. Squirrel-tail Grass or Wild Barley (*Hordeum jubatum*). Meadows, pastures and roadsides.
(After Clark and Fletcher.)

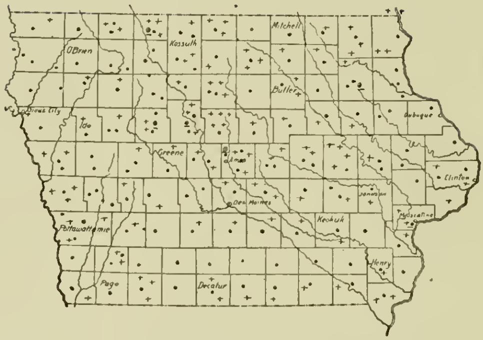


FIG. 31-A. Distribution of Squirrel-tail Grass.

as the usual method of breaking in June will destroy it. It gives most trouble in waste places where it ripens its seed, which is spread abroad in every direction by wind and water. It grows freely about the edges of hay sloughs on the prairie and is generally ripe before the hay is cut. The remedy in this case would be cutting before the seed is formed."

FIG. 32. Squirrel-tail Grass or Wild Barley (*Hordeum jubatum*). Widely distributed in Iowa pastures, roadsides, etc.
(Photographed by Charlotte M. King.)

Chemical Composition.—Analyses have been reported from Iowa and South Dakota. The following report is by Weems from Iowa.

NATURAL CONDITION.

Sample	Date	Height	Water	Fat	Protein	Albuminoids	Crude Fiber	Ash	Nitrogen free extract
1. --------------	5-20-1896	10.15	80.51	.97	4.33	(3.00)	7.13	2.19	4.87
2. --------------	5-26-1896	23.24	72.60	1.59	3.38	(2.36)	10.10	2.35	9.98
3. --------------	6- 5-1896	23.24	67.97	.94	3.74	(2.75)	12.47	2.70	12.18
4. --------------	6-17-1896	21.25	54.39	1.68	5.80	(3.76)	17.85	4.00	16.28

WATER FREE SUBSTANCE.

1. --------------	----------	---------	---------	4.97	22.21	(15.43)	36.59	11.24	24.99
2. --------------	----------	---------	---------	5.82	12.36	(8.62)	36.90	8.46	36.46
3. --------------	----------	---------	---------	2.94	11.78	(8.57)	38.92	8.43	37.93
4. --------------	----------	---------	---------	3.69	12.71	(8.24)	39.14	8.78	35.68

Little Barley (*Hordeum pusillum* Nutt.).

Description.—An annual, 4-10 in. high; culms more or less geniculate at the lower nodes; sheaths smooth, the uppermost often inflated and enclosing the base of the spike; leaf-blade 1-3 in. long, usually a little pubescent on the lower surface; spikes narrow, 1-3 in. long; empty glumes rigid, the 4 internal ones of each group dilated above the base, those of the central spikelet sublanceolate, all awn-pointed; outer glumes of the imperfect, lateral spikelets setaceous; flowering glume of the central spikelet awned; awn equaling those of the empty glumes; florets of the lateral spikelets awnless, or nearly so.

Distribution.—Common in Missouri and Illinois and becoming plentiful in southeastern Iowa; also in Marshall and Pottawattamie counties. Common on the plains.

Extermination.—This annual weed is easily destroyed by cultivation. Comes up abundantly in streets and along roadsides. The production of seed in such places makes it possible for farm land to be sown. The plants should be cut to prevent seeding of farms.

Chemical Composition.—According to the Wyoming Experiment Station the composition is as follows:*

*Bul. Wyo. Agr. Exp. Sta. 87; compiled by Henry G. Knight, Frank E. Hepner, Chemists; and Aven Nelson, Botanist.

FIG. 33. Little Barley (*Hordeum pusillum*). Roadsides, fields. Common in southern Iowa.
(Photographed by Colburn.)

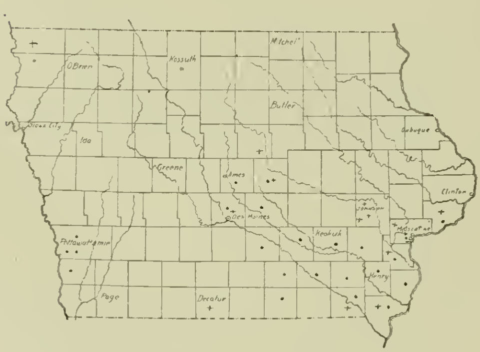


FIG. 33-A. Distribution of Little Barley.

	Natural Condition	Water Free Substance
Water	5.79	--------
Ash	9.25	9.82
Ether extract	1.77	1.88
Crude fiber	31.58	33.52
Crude protein	6.49	6.89
Nitrogen free extract	45.12	47.89

CYPERACEAE, SEDGE FAMILY.

This family contains few economic plants. The chufas is used as food for hogs. The papyrus of the ancients, and the so-called rushes of our ponds belong to this family. Many of the plants grow in low grounds.

Northern Nut Grass (*Cyperus esculentus* L.).

Description.—A grasslike plant growing from 1-2½ ft. high; with triangular stems, leafy at the base when young, later leaves terminating the stems; spikes of numerous spikelets with from 12-30 light chestnut or straw-colored flowers; scales of the spikelets rough-margined; achene longer than broad.

This perennial weed spreads extensively by its underground nut-like tubers. It is closely related to the Southern Nut Grass (*Cyperus rotundus* L.) and in the north entirely replaces it.

Distribution.—It is quite generally distributed in the state and occurs frequently in North America from New Brunswick to Texas; common especially in low spots. Being somewhat yellowish in appearance it is easily recognized.

Extermination.—This weed can be exterminated only by thorough cultivation. Running the harrow over the field when corn is young will not exterminate the weed. The little offshoots merely sprout again giving rise to many more plants. Running the cultivator through the field is more effective, but not sufficient. In badly infested fields it will be necessary to use the hoe.

JUNCACEAE, RUSH FAMILY.

These grasslike plants are related to the lilies. They generally grow in low grounds and are of little economic importance.

FIG. 34. Northern Nut Grass (*Cyperus esculentus*). Corn fields, especially low grounds. Young plants have a yellowish color. Weed spreads by the "roots."

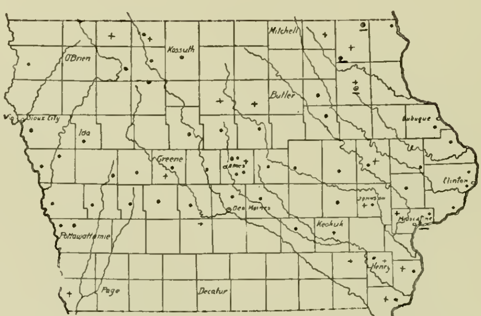


FIG. 34-A. Distribution of Northern Nut Grass.

Slender Rush (*Juncus tenuis* Willd.).

Description.—A leafy perennial, wiry stem, 9-18 in. high; leaves flat or channeled; flowers in panicles, the panicles shorter than the involucral leaves; flowers green, sepals lanceolate-acute, spreading in fruit; capsule green; seeds small, ribbed.

Distribution.—A cosmopolitan weed widely distributed in North America; common along beaten paths and fields, especially in pastures, in every part of Iowa.

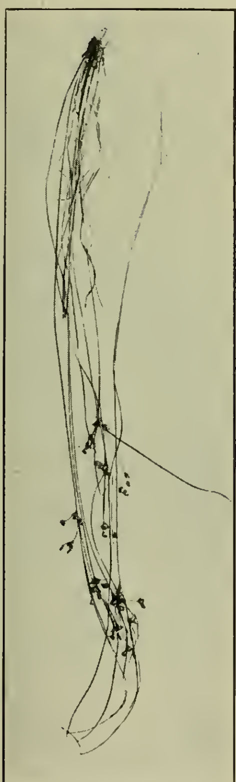


Figure 25

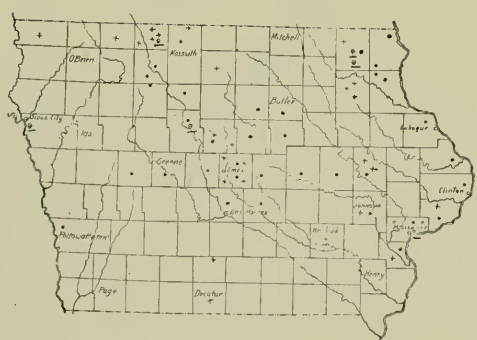


Figure 35A

FIG. 35. Wire Grass or Slender Rush (*Juncus tenuis*). Common in pastures along roadsides.
(Photographed by Colburn.)

FIG. 35-A. Distribution of Slender Rush.

Extermination.—This weed is not difficult to exterminate by cultivation. Where it occurs in pastures that cannot be cultivated, an effort should be made to start a leguminous plant like white clover which will kill out the rush to some extent.

LILIACEAE, LILY FAMILY.

This family contains a number of economic plants like onion, garlic, leek, chives, such cultivated ornamental plants as the lily, lily of the valley, and hyacinth and some poisonous plants as the colchicum and bunch flower.

Common Bunch Flower (*Melanthium virginicum* L.).

Description.—Tall, leafy-stemmed plants 3-5 ft. high; leaves linear, the lower sheathing, the upper similar and sessile; flowers in an ample panicle, fragrant; perianth of flat segments greenish yellow; styles persistent, capsule 3-celled; 8-10 seeds in each cavity.

Distribution.—In low meadows and prairies from New England to Iowa river basin, Minnesota, Texas and Florida. Common only in eastern central Iowa to the Missouri line.

FIG. 36. Bunch Flower (*Melanthium virginicum*) In meadows, eastern and southern Iowa. Poisonous.
(Photo Gardner.)

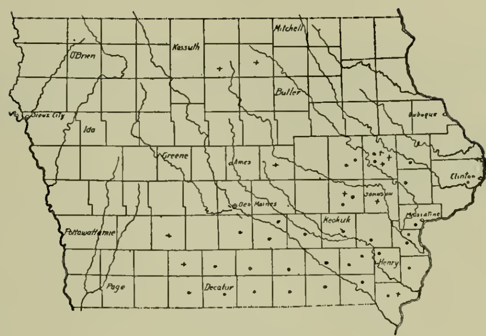


FIG. 36-A. Distribution of Bunch Flower.

Extermination.—This weed is common only in native meadows It is killed when these meadows are broken up and cultivated.

Wild Onion (*Allium canadense* L.).

Description.—A perennial herb, with small scapose bulb; bulb coat somewhat fibrous; flowers umbellate, umbels densely bulbiferous; perianth of 6 divisions which are narrowly lanceolate, as long as the 6 stamens or longer; capsule 3-celled, not crested; seeds black.

Distribution.—Common in moist meadows in many parts of Iowa: Boone, Story, Marshall and Polk counties; from New Brunswick to Wisconsin, Texas and Florida.

Extermination.—This weed is common in native meadows, seldom persists like the wild garlic (*Allium vineale*) of Europe in cultivated fields; thorough cultivation of the field with a plow and disk and cultivator will destroy the weed.

DICOTYLEDONEAE, DICOTS.

Stem formed of pith wood and bark; between the bark and wood, the cambium layer an annual ring of wood formed each year; leaves netted veined; flowers generally on the plan of five; embryo with a pair of cotyledons. Rose, pigweed, potato, bean, clover, Russian thistle, horse nettle, Canadian thistle belong to this division.

FIG. 37. Wild Onion (*Allium canadense*).
(Photographed by Charlotte M. King.)

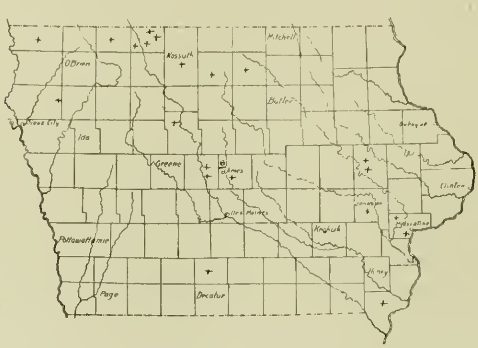


FIG. 37-A. Distribution of Wild Onion.

URTICACEAE, NETTLE FAMILY.

This family in the large sense contains such economic plants as the fig, india rubber tree, hemp, hop, and such trees as the hackberry and elm.

Nettle (*Urtica gracilis* Ait.).

Description.—A perennial, stinging herb from 2-6 ft. high; sparingly bristly; leaves ovate-lanceolate, sharply serrate, with long petioles, 3-5-nerved sparingly pubescent, petioles usually bristly; flowers inconspicuous, paniculate, dioecious or of staminate and pistilate flowers; achene compressed, inclosed by the persistent calyx. Hairs multicellular at base, urticating.

FIG. 38. Stinging Nettle (*Urtica gracilis*). Common along fences and in waste places. *a*, stinging hairs of plant.
(Photographed by Colburn. *a* drawn by Charlotte M. King.)

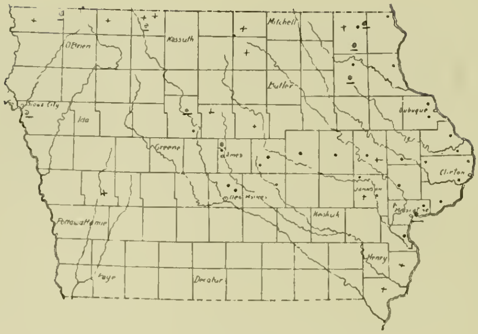


FIG. 38-A. Distribution of Nettle.

Distribution.—Eastern Canada to Wisconsin, Minnesota, central Canada and Louisiana; found along roadsides, borders of thickets and woods; occasionally in gardens and waste places especially in eastern and southern Iowa.

Extermination.—The perennial root stocks make this weed quite persistent and difficult to destroy, because the weed often occurs in inaccessible places along fence-rows; however, persistent cultivation will exterminate the weed.

*Chemical Composition.**

FRESH OR AIR DRY IATERIAL.

Water	Ash	Protein	Fibe	Nitrogen free extract	Fat
82.44	2.30	5.50	1.96	7.13	0.67

WATER FREE SUBSTANCE.

	13.1	31.4	11.2	40.5	----

Hemp (*Cannabis sativa* L.).

Description.—A rough, stout, dioecious annual, 3-10 ft. tall; inner bark of tough fibers; leaves digitate, of 5-7 linear-lanceolate, coarsely toothed leaflets, the upper alternate; flowers green; staminate, in compound racemes; pistillate, in erect spikes, each consisting of a calyx of a single sepal folded around the ovary and 2 filiform stigmas; fruit an achene; endosperm fleshy; embryo curved.

*Compiled by Jenkins and Winton: Bull. Off. Exp. Sta. 11.

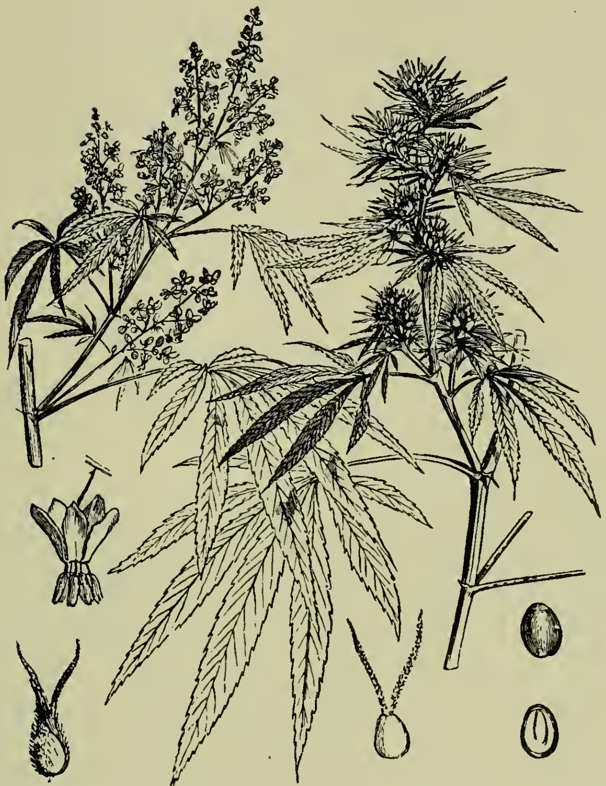


FIG. 38-B. Hemp (*Cannabis sativa*).

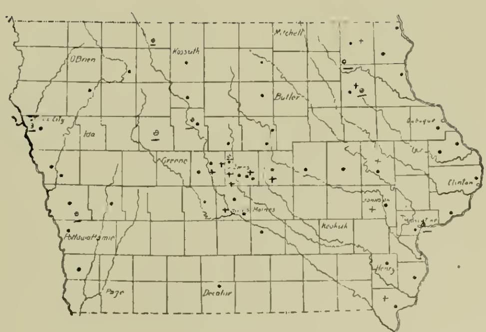


FIG. 38-C. Distribution of Hemp.

Distribution.—Waste places, New Brunswick south to North Carolina and west to Minnesota, Kansas, and Rocky mountains. Widely distributed through cultivation but often becoming a troublesome weed. In many parts of Iowa; reported from Story, Dubuque, Clinton, Polk, Boone, Allamakee, Winneshiek, Marshall, Grundy, Plymouth, Pottawattamie and other counties.

Extermination.—Easily killed by cultivation. Practice rotation of crops.

Pellitory (*Parietaria pennsylvanica* Muhl.).

Description.—A low, annual, simple, or sparingly branched minutely downy plant; oblong-lanceolate, thin leaves with opaque dots; flowers monoeciously polygamous shorter than involucre; glomerate except in the lower axils; stigma sessile.

FIG. 39. Pellitory (*Parietaria pennsylvanica*). Common in shady places near buildings.
(Photographed by Hart.)

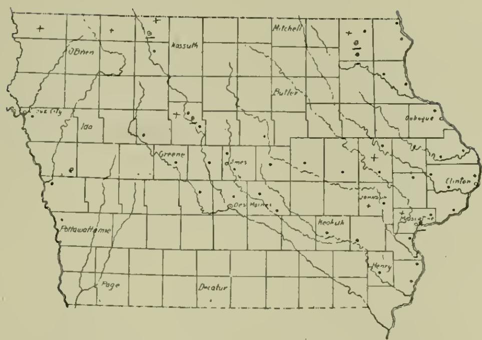


FIG. 39-A. Distribution of Pellitory.

Distribution.—Massachusetts to Minnesota and southward. Common in Iowa in shady places, lawns and woods.

FIG. 39-B. Pellitory (*Parietaria pennsylvanica.*)

Extermination.—This weed is usually exterminated by cultivation and may be destroyed by the application of iron sulphate at the rate of 100 pounds to a barrel of water.

POLYGONACEAE, SMARTWEED FAMILY.

This family contains the pie plant, canaigre, prince's feather, and buckwheat.

Curled Dock, Yellow Dock (*Rumex crispus* L.).

Description.—A smooth perennial from 3-4 ft. high; leaves with strongly wavy and curled margins, lanceolate and acute, lower leaves with bases somewhat truncate or inclined to be heart-shaped; flowers collected in dense whorls, extended or prolonged into racemes, entirely leafless above, but below with small leaves; 6 sepals, the 3 outer, herbaceous, leaflike, the 3 inner, larger and somewhat curled,

FIG. 40. Sour Dock, Curled Dock or Yellow Dock (*Rumex crispus*). Common in low grounds, clover meadows, fields, etc.
(Photographed by Colburn.)

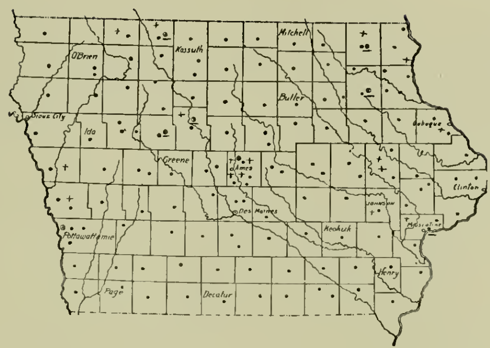


FIG. 40-A. Distribution of Curled Dock.

and after flowering forming the valves of the fruit, which surround the 3-angled fruit, each valve bearing a grain. The *R. altissimus* Wood. occurs in low ground, and is from 2-6 ft. high, with leaves oblong, lanceolate, acute, pale, thickish, but without curled margins as in *R. crispus* L., and longer; racemes long, spikelike, panicled, nearly leafless; has a conspicuous grain.

Distribution.—It is native to Europe where it has long been known as a troublesome weed; common throughout eastern North America, Pacific coast, and Rocky mountains; abundant in Iowa in clover meadows, along roadsides and in pastures.

Chemical Composition.—The following analysis has been reported.*

Water	Protein	Fat	Nitrogen free extract	Crude Fiber	Ash
81.6	21.7	3.9	39.4	11.4	9.3

Extermination.—One of the most efficient means of destroying this weed is to root it out by the hand and this is done very readily in the spring when the soil is wet by taking hold of the plant just at the surface of the ground, giving the root a slight twist and at the same time an upward pull, when it will readily come from the soil. Where it is common, however, it is sometimes plowed or a spud is used. This method is not, however, so effective as the pulling method.

*Storer and Anderson.

FIG. 41. Curled Dock (*Rumex crispus*). Roadsides, meadows, clover fields, etc. (Photographed by Charlotte M. King.)

Clark and Fletcher suggest the following treatment: "Sow clean seed. The prevalence of dock in meadows is due to sowing contaminated grass and clover seeds. Land worked under a short rotation of crops is never badly infested with docks. When the soil is soft after continued rain, they can be pulled from meadows and pastures. Pull or cut and destroy all seed-bearing plants before harvesting a clover seed crop. A handful of salt placed on the crown of docks, after cutting in dry hot weather, will extract the moisture and destroy the root; this is a remedy sometimes used in lawns and pastures when the soil is too hard and dry to permit pulling them."

Smooth Dock (*Rumex altissimus* Wood.).

Description.—A tall, smooth, perennial; leaves pale, ovate, or oblong-lanceolate, thickish; flowers in paniculate spikelike racemes, in crowded whorls, nodding pedicels, shorter than the fruiting calyx; valves broadly ovate or obscurely heart-shaped, one with a conspicuous pale grain; achene triangular, pale.

Distribution.—Common in the northern states and abundant in low grounds and highways, also in pastures throughout Iowa.

FIG. 42. Smooth or Peach-leaved Dock (*Rumex altissimus*). Low meadows, roadsides and pastures.
(Photographed by Colburn.)

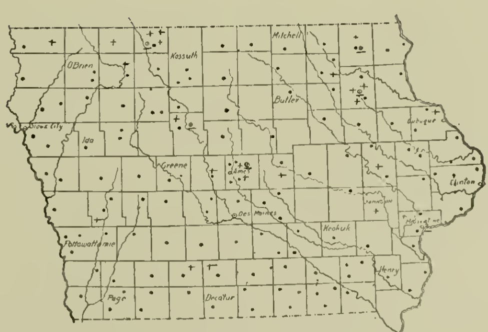


FIG. 42-A. Distribution of Smooth Dock.

Fig. 43. Smooth or Peach-leaved Dock (*Rumex altissimus*), Dandelion (*Taraxacum officinale*), and other weeds. This is where the seed comes from to spread weeds.

(Photographed by Charlotte M. King.)

Extermination.—This weed has running roots and cannot be destroyed in the same way as sour dock. The roots are, however, shallow, and can be destroyed by giving cultivation exposing the roots to the sun.

Bitter Dock (*Rumex obtusifolius* L.).

Description.—A perennial herb, with roughish stem; leaves somewhat wavy, the lowest ovate heart-shaped, obtuse, the upper oblong-lanceolate, acute; flowers inconspicuous, greenish on jointed pedicels; valves of the fruit conspicuous, toothed at the base.

Distribution.—Naturalized from Europe; eastern Canada to Wisconsin, Minnesota and south to Texas and Florida. It is found in waste places, sparingly introduced into Iowa with clover seed.

Extermination.—The yellow spindle-shaped root is easily pulled by giving the plant a slight twist, especially when the ground is moist. Clover seed containing this weed should not be sown.

FIG. 44. Bitter Dock, Red Veined Dock (*Rumex obtusifolius*). Common in some clover meadows in southern Iowa.
(Photographed by Colburn.)

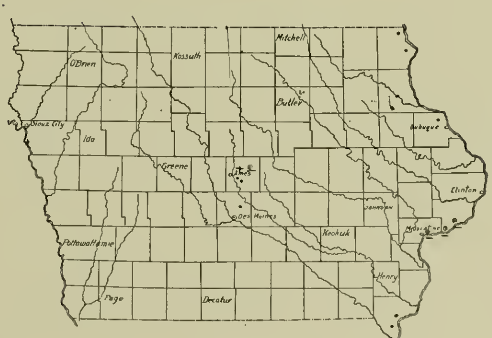


FIG. 44-A. Distribution of Bitter Dock.

Sheep Sorrel (*Rumex acetosella* L.).

Description.—A low smooth annual or perennial, usually the latter, growing from 6-12 in. high, producing an erect stem, with horizontal, creeping, woody root-stocks or rhizome; petioled, narrowly-hastate, narrow, lanceolate leaves, the upper linear; flowers on jointed pedicels, dioecious, small, in a terminal naked panicle; small green calyx; exserted stamens; the valves not enlarging in fruit.

Distribution.—Sheep sorrel has long been known as a troublesome weed in Europe, and in the northern states; perhaps indigenous to the United States; at least now common across the continent in the north. It is common everywhere in Iowa, more particularly in sandy or gravelly soils.

Extermination.—The plant succumbs quite readily to cultivation, and where the fields are thoroughly cultivated with hoed crops, it is seldom troublesome more than one season. In fact the vast majority of plants may be killed by cultivating the soil once or twice. The roots though produced abundantly seem to be unable to stand drying. The soil on which it occurs should receive a heavy coat of manure. This seems to be approved by Dr. Halsted who says: "This pest can be subdued by keeping the infested land under the plow for a short time."

Clark and Fletcher say in regard to this weed: "Sheep sorrel is said to be an index of soil characters. It seems to thrive best on sandy or gravelly soils deficient of lime. An application of lime to slightly acid soils produces a more vigorous growth of cultivated crops and curtails the opportunities of the sorrel to grow and spread. Old meadows and pastures that are overrun with it and that cannot well be brought under cultivation may be pastured with sheep for two or three years to prevent it from seeding freely.

A three-year rotation of crops with good cultivation, including shallow plowing directly after hay crop and frequent cultivation until autumn to prepare for hoed crops, will keep sheep sorrel well under control even on lands that seem to be specially suited to its growth."

Wallace's Farmer suggests the following: "To control this weed in the meadows we would suggest applying manure and thickening up the grass stand. Putting the land into a cultivated crop destroys this weed."

FIG. 45. Sheep Sorrel or Horse Sorrel (*Rumex acetosella*). Common in sandy and gravelly soil.
(After Clark and Fletcher.)

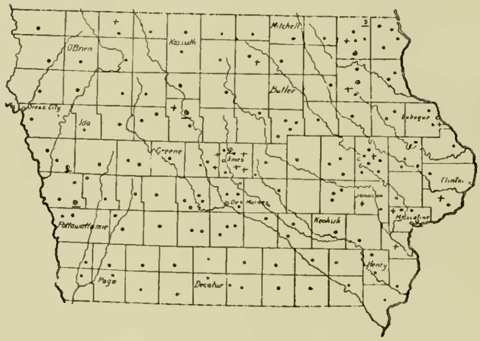


FIG. 45-A. Distribution of Sheep Sorrel.

Chemical Composition.—The ash of this weed is reported by Weinhold as follows:

Phosphoric acid	Potash	Sodium	Lime	Magnesia
9.7	19.7	1.3	14.0	9.4

Erect Knotweed (*Polygonum erectum* L.).

Description.—An annual, glabrous, stout, erect, or ascending yellowish green herb, 1-2 ft. high, with elliptical leaves; flowers yellowish and inconspicuous, 1-2 in an axil; stamens 5-6; achene dull, included.

Distribution.—Widely distributed from the northeast to Manitoba, Wisconsin, Minnesota to Arkansas, and eastward. Common in Iowa especially eastward, and in Story, Boone, Marshall, Polk, Allamakee, Clinton and Dubuque counties.

Extermination.—Easily exterminated by cultivation.

FIG. 46. Erect Knotweed (*Polygonum erectum*). Common in many parts of the state.
(Photographed by Hart.)

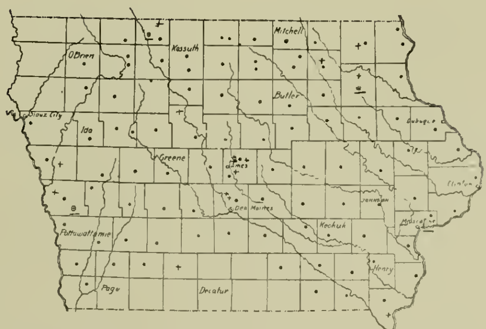


FIG. 46-A. Distribution of Erect Knotweed.

Dooryard Knotweed (*Polygonum aviculare* L.).

Description.—A scattered or somewhat ascending, bluish grey annual; leaves acute or acutish; flowers greenish with pinkish margins; achenes triangular, dull and minutely granular-striate.

FIG. 47. Dooryard Knotweed (*Polygonum aviculare*). Common in dooryards. (Photographed by Hart.)

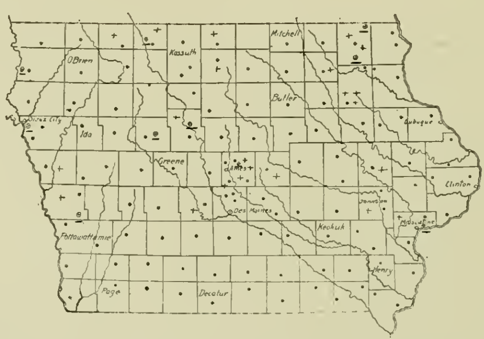


FIG. 47-A. Distribution of Dooryard Knotweed.

Distribution.—Native in the northern hemisphere, Asia and North America, common everywhere in Iowa in gardens and waste places. Usually affected by a white mildew.

Extermination.—This annual weed can be destroyed only by giving the soil on which it occurs cultivation. It frequents dry and more or less beaten soil. Where it is abundant in lawns the soil should be stirred and sown to white clover.

Bushy Knotweed (*Polygonum ramosissimum* Mx.).

Description.—An erect or ascending, green or yellowish green smooth herb 2-4 ft. high; leaves linear or lanceolate, tapering into a petiole; flowers inconspicuous, greenish; stamens 3-6; style short; achene 3-angled.

FIG. 48. Bushy or Erect Knotweed (*Polygonum ramosissimum*). Common in fields.
(Photographed by Hart.)

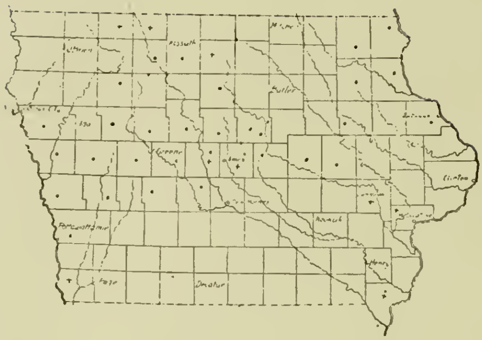


FIG. 48-A. Distribution of Bushy Knotweed.

Distribution.—From Manitoba to Texas, also in Pennsylvania; frequent in fields in many parts of Iowa, in Story, Boone, Worth, and Cerro Gordo counties.

Extermination.—Easily exterminated by cultivation.

Pink Smartweed (*Polygonum lapathifolium* L.).

Description.—Pink smartweed is a native, glabrous, erect annual, with stem swollen at the nodes; lanceolate, acuminate leaves with short ciliate petioles; racemes panicled, nodding, with many flowers; calyx white or pink, small 5-parted; 6 stamens, style included; achene lenticular.

Distribution.—This weed occurs from New England to Nebraska and Louisiana. Native to Europe, and common in eastern North America; everywhere in Iowa, particularly in moist situations.

Extermination.—Easily exterminated, after drainage of slough, by cultivation.

FIG. 49. Pink or Nodding Smartweed (*Polygonum lapathifolium*). Common in corn fields.
(Photographed by Colburn.)

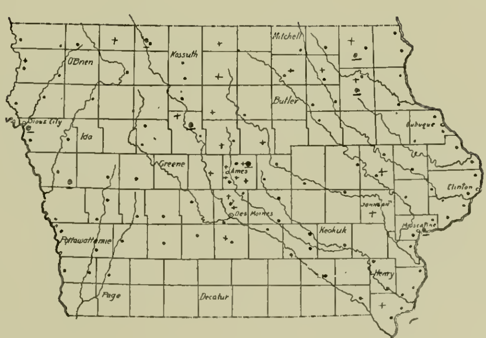


FIG. 49-A. Distribution of Pink Smartweed.

Marsh Smartweed (*Polygonum muhlenbergii* (Meisn.) Wats.).

Description.—A somewhat pubescent or scabrous perennial with large black roots, decumbent or erect; leaves lanceolate to ovate, narrowly acuminate; flowers in rather long hispid spikes; sepals 5,

FIG. 50. Tanweed, Marsh or Muhlenberg's Smartweed, Devil's Shoe-string or Shoe-string (*Polygonum muhlenbergii*); *a*, plant hairs. Low meadows and fields.
(Photographed by Colburn. Drawing by Charlotte M. King.)

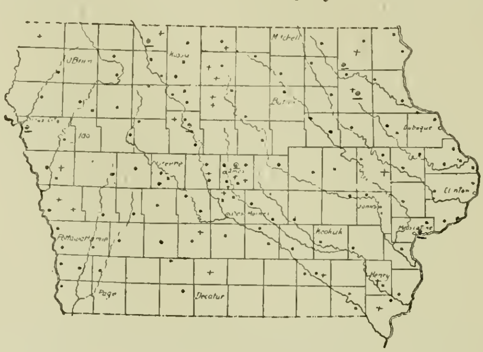


FIG. 50-A. Distribution of Marsh Smartweed.

bright rose color; stamens 5, styles 2-cleft, exerted. Frequently only sterile plants, or flowering rather late in the season; trichomes multicellular, at base with thick outer epidermal walls.

Distribution.—Common from Canada to Florida and west, found in all parts of Iowa; an exceedingly variable plant; sometimes found in very moist situations, and in stagnant water, or in somewhat higher but poorly drained situations. The black, thickish roots are quite characteristic of the plant.

Extermination.—Marsh smartweed or tanweed, as it is sometimes called, is a persistent perennial and since the weed grows in wet places it is particularly difficult to destroy. The best method of

FIG. 51. Tanweed, Marsh Smartweed (*Polygonum muhlenbergii*). (Photographed by W. Newell.)

treating it is by thorough cultivation, exposing all the root-stocks to the sun, then removing the young plants as rapidly as they make their appearance.

Wallace's Farmer suggests the following treatment: "It grows less vigorously on well drained land, hence the first step in eradication is to drain the field thoroughly. The summer fallow is perhaps the best course of treatment. Plow the infested patch early and keep the disk and plow working on it regularly all summer long. All the roots that can be located should be pulled up and burned after drying out. A heavy pitchfork and plenty of muscle will soon fill a wagon box with the long, tough, yellow roots. A heavy seeding of sorghum helps to weaken the stand, but we have seen patches as vigorous as ever a year after two succeeding crops of sorghum had been grown in an effort to smother out the pest."

Smartweed (*Polygonum pennsylvanicum* L.).

Description.—An annual 1-2 ft. high, with lanceolate leaves; branches below the flowers beset with numerous stalked glands; flowers whitish or rose-colored; stamens 6-8, style 2-cleft; fruit an achene, 1¾ lines long, flattened, brown, shining, part of the calyx remaining attached to the base.

Distribution.—Pennsylvania smartweed is common from New England southwestward and westward and in every part of Iowa, coming up abundantly in corn fields, sometimes forming a mass of rose-colored flowers; also growing up abundantly in grain fields after harvest.

Extermination.—This smartweed is easily exterminated by cultivation.

FIG. 51-A. Pennsylvania Smartweed (*Polygonum pennsylvanicum*). Common in corn fields.
(Photographed by Colburn.)

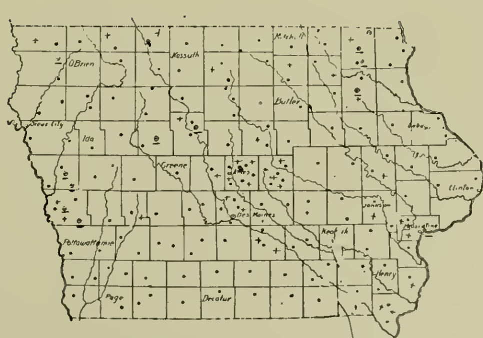


FIG. 51-B. Distribution of Pennsylvania Smartweed.

FIG. 51-C. Smartweed (*Polygonum pennsylvanicum*). (Photographed by W. Newell.)

Water Pepper (*Polygonum hydropiper* L.).

Description.—Much like *P. persicaria* but more slender and often decumbent; flowers greenish on slender nodding spikes; achenes dull in color and the whole plant more or less acrid.

Distribution.—Water pepper is widely distributed in eastern North America; naturalized from Europe or may be indigenous in the northwest. Widely distributed in Iowa.

Extermination.—This weed is usually found in moist places and is not very troublesome in cultivated fields except in low places. Fields that are badly infested with it should be plowed and drained and if possible some leguminous plants like alsike clover sown.

FIG. 52. Common Smartweed or Water Pepper (*Polygonum hydropiper*). (Photographed by Colburn.)

Lady's Thumb (*Polygonum persicaria* L.).

Description.—A nodding, smooth, glabrous annual; sheaths bristly ciliate; leaves lanceolate, marked with a conspicuous dark or lunar spot; spikes short cylindric; peduncles smooth; achene flattened, smooth and shining.

Distribution.—Lady's thumb is native to Europe, common in eastern North America, Rocky mountains and on the Pacific coast. Common everywhere in Iowa, particularly in waste places and gardens, and growing up abundantly after grain has been harvested.

Extermination.—This weed is easily destroyed by cultivation. The main point, however, is that seed production must be prevented; hence it would be well to cut off the plants after they have started to produce flowers; this will effectually prevent seed production.

FIG. 53. Lady's Thumb (*Polygonum persicaria*). Common in gardens, fields and along roadsides.)
(After Clark and Fletcher.)

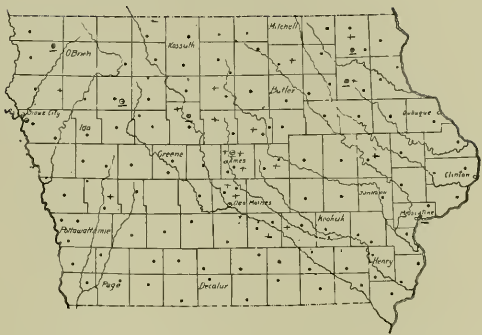


FIG. 53-A. Distribution of Lady's Thumb.

Water Pepper or Smartweed (*P. hydropiperoides* Mx.).

Description.—A perennial not acrid; leaves narrowly lanceolate or oblong; small flesh-colored flowers in erect slender spikes; smooth achenes sharply triangular.

FIG. 54. Water Pepper (*Polygonum hydropiperoides*). Common in low places, fields, etc.
(Photographed by Colburn.)

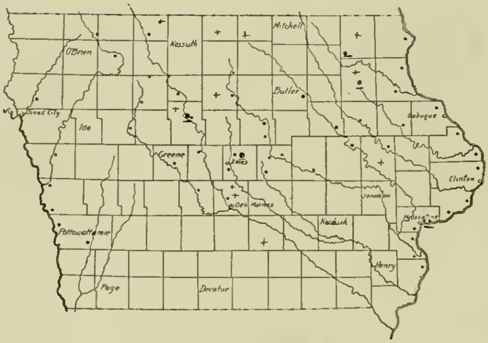


FIG. 54-A. Distribution of Water Pepper.

Distribution.—Water pepper is distributed in swamps from eastern Canada southwest to Mexico; it is also distributed across the northern states to California; common in low wet places in many parts of Iowa.

FIG. 54-B. Water Smartweed (*Polygonum acre*).

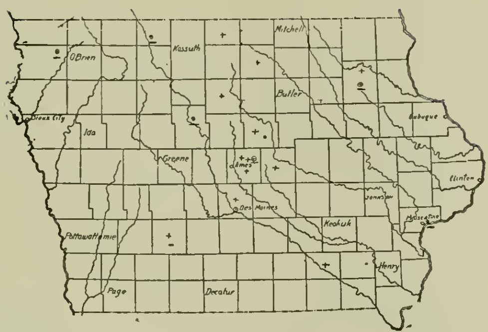


FIG. 54-C. Distribution of Water Smartweed.

Extermination.—Since this perennial weed is most abundant in sloughs, drainage must be resorted to before an effective means of extermination can be used. After this it will give little trouble in cultivation.

The Water Smartweed (*Polygonum acre* H B K) is a nearly smooth perennial with stems rooting at the decumbent base; erect, dense spikes of whitish or flesh-colored flowers. It is common in low grounds.

Black Bindweed or Wild Buckwheat (*Polygonum convolvulus* L.).

Description.—An annual, twining, with smooth joints; leaves halberd or heart-shaped; flowers in corymbose racemes; achene dull black, triangular and minutely roughened.

Distribution.—This weed is widely scattered with grain seed, especially with wheat and oats. It is often most troublesome in small grain fields. In Iowa, however, it occurs in gardens and along roadsides.

Extermination.—It is not difficult to destroy the weed by giving clean cultivation, since it succumbs easily to such treatment. Sow only clean seed.

Clark and Fletcher recommend as follows: "Sow clean seed grain. The seeds retain their vitality for a relatively short period, probably not longer than three years, except in the drier soils of the western plains. The suppression of this pest is therefore largely dependent on the prevention of a continued supply of fresh seeds to the soil. This weed gives little trouble on land under a short rotation of crops, including hay, for two years.

7

Fig. 55. Bindweed or Wild Buckwheat (*Polygonum convolvulus*). Common in grain fields and waste places.
(After Clark and Fletcher.)

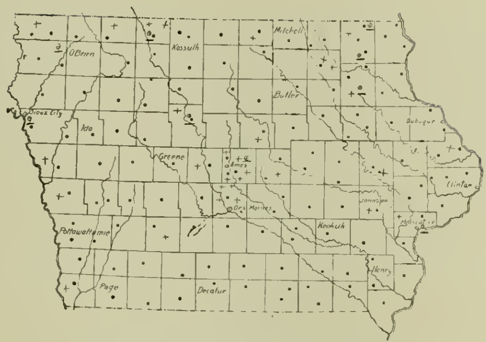


FIG. 55-A. Distribution of Black Bindweed.

The seeds of wild buckwheat do not germinate in the spring until the soil is quite warm. Most of the early plants can be destroyed in the grain crops by an application of the harrow when the grain is about three inches high. The young plants soon root firmly and the harrowing, to be effective, must be done just as they emerge from the ground.''

CHENOPODIACEAE, GOOSEFOOT FAMILY.

This family contains the spinach, sugar beet, beet and salt bushes.

Winged Pigweed (*Cycloloma atriplicifolium* (Spreng.) Coult.).

Description.—An annual with alternate sinuate-toothed petioled leaves; small inconspicuous flowers in open panicles; winged seeds; herb diffusely spreading or often spherical in form similar to the Russian thistle or Iowa tumbleweed.

Distribution.—Native from Manitoba, Minnesota, to Illinois, Arkansas and the Rocky mountains. In Iowa it is found along Mississippi river in Dubuque and Muscatine counties, in Linn county, and along Missouri river.

Extermination.—This weed is easily exterminated by cultivation. In Iowa has probably been spread with western grass seed and in stock cars.

FIG. 56. Western Tumbleweed or Winged Pigweed (*Cycloloma atriplicifolium*)
Sandy soil, Muscatine Island, etc.
(Photographed by Colburn.)

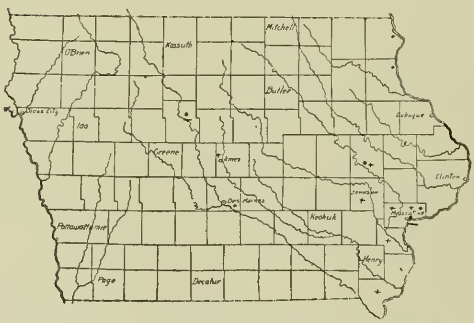


FIG. 56-A. Distribution of Winged Pigweed.

FIG. 57. Winged Pigweed (*Cycloloma atriplicifolium*). Seed and cross section of ovary.
(After W. J. Beal, Mich. Agr. Exp. Sta.)

Mexican Fireweed (*Kochia scoparia* Schrad.).

Description.—An annual, erect, puberulent or glabrate herb; leaves lanceolate to linear, ciliate acuminate; flowers sessile in the axils of the upper leaves, forming short dense-bracted spikes; fruiting calyx segments each with a short triangular horizontal wing.

FIG. 58. Mexican Fireweed. (*Kochia scoparia*). A frequent escape from cultivation.
(Drawn by F. C. Collins.)

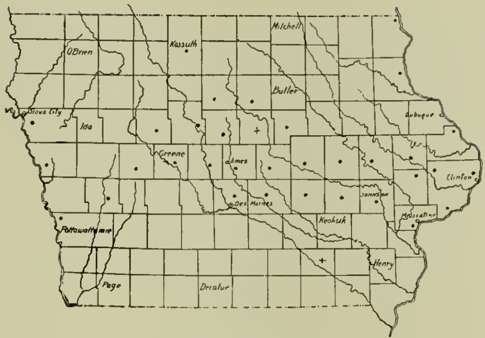


FIG. 58-A. Distribution of Mexican Fireweed.

Distribution.—In waste places commonly cultivated and now a frequent escape in Iowa. Common in many of the northern states, Rocky mountains and the Pacific coast. From eastern Europe and western Asia.

Extermination.—This weed is easily exterminated by cultivation.

Mexican Tea (*Chenopodium ambrosioides* L.).

Description.—A smoothish annual, or slightly pubescent; strong scented; leaves oblong or lanceolate, entire or cut-pinnatifid, nearly sessile; spikes densely flowered, leafy; flowers in small, dense, axillary spikes; calyx 3-parted enclosing the fruit. The wormseed (*C. anthelminticum*) is an annual or sometimes a perennial; leaves more strongly toothed; the flowers usually in bractless panicled spikes.

Distribution.—Mexican tea is found southward, occurring, however, from Maine to California. The wormseed has nearly the same distribution occuring northward to Minnesota and Wisconsin. Neither of these weeds is common in Iowa.

Extermination.—In Iowa both of these weeds are easily exterminated by cultivation. Do not permit any of their seeds to mature.

FIG. 59. Mexican Tea (*Chenopodium ambrosioides*). In southern Iowa; streets and fields.
(Photographed by Colburn.)

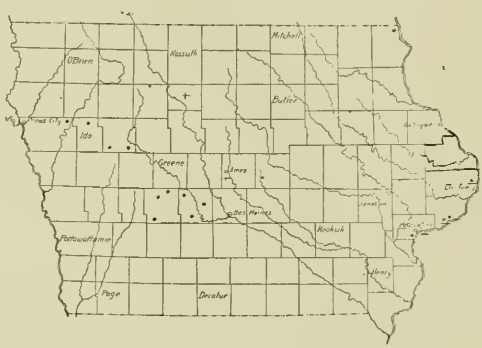


FIG. 59-A. Distribution of Mexican Tea.

FIG. 59-B. Plant hair or trichome of (*Chenopodium botrys*). *a*, from stem; *b*, glandular trichomes from calyx.
(Drawn by Charlotte M. King.)

Maple-leaved Goosefoot (*Chenopodium hybridum* L.).

Description.—A bright green annual from 2-4 ft. high; widely branching, with an unpleasant odor like stramonium; leaves thin, triangular, heart-shaped sinuate-toothed; flowers inconspicuous, in loose, racemose panicles; calyx covering the fruit; seed firmly attached to the pericarp.

Distribution.—Frequently found in woods and waste places; extending from Kansas to Manitoba, Wisconsin and Minnesota and southward; common in Story, Boone, Marshall, Clinton, Polk, Woodbury, Pottawattamie, Dubuque, Allamakee and Cerro Gordo counties.

Extermination.—This annual weed can be killed by giving clean cultivation. Sometimes distributed with clover seed, but less frequently than the other species. Sow clean clover seed.

FIG. 60. Maple-leaved Goosefoot (*Chenopodium hybridum*). Frequent in woods and waste places.
(After Mich. Agr. Exp. Sta.)

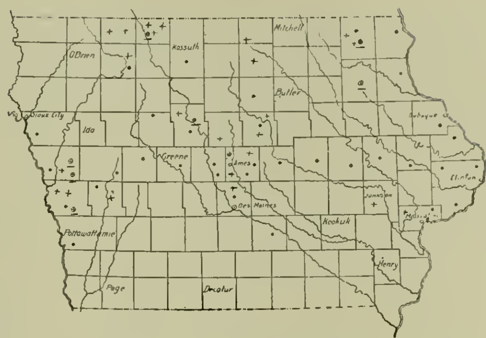


FIG. 60-A. Distribution of Maple-leaved Goosefoot.

Lamb's Quarters, Pigweed. (*Chenopodium album* L.).

Description.—An erect annual from 1-4 ft. high; young plants generally mealy, older plants smooth; leaves rhombic-ovate to lanceolate or the upper sometimes linear, acute, lower commonly toothed; flowers produced in clustered, dense-spiked panicles; calyx 5-parted, nearly covering the seed; seeds surrounded by a loose pericarp forming an utricle.

Distribution.—Native to Europe; widely naturalized in eastern North America and the Rocky mountains; occurs in Utah and on the Pacific coast; found everywhere in Iowa in cultivated fields and in gardens as well as along highways.

Extermination.—Plants of this species produce an enormous number of seeds. The young plants are easily destroyed by cutting off below the ground. Covering the young plants is not effective unless the entire plant is covered. Older plants may be destroyed by pulling them up. The weed on account of the shade it produces destroys other vegetation underneath it.

Chemical Composition.—According to a report of the Bussey Institution, the chemical composition is as follows:*

*Bull. Bussey Inst., 1877: Jenkins and Winton; Office Exp. Sta., Bull. 11.

FIG. 61. Lamb's Quarters (*Chenopodium album*). Common in gardens and fields. (After Clark and Fletcher.)

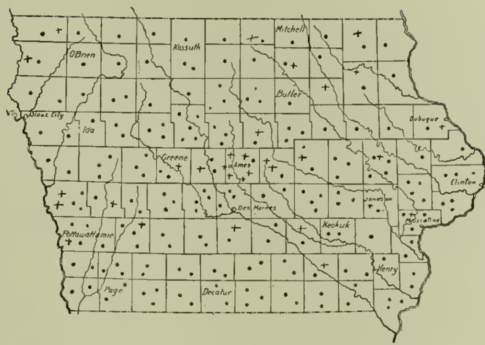


FIG. 61-A. Distribution of Lamb's Quarters.

FRESH OR DRY AIR MATERIAL.

Water	Ash	Protein	Fiber	Nitrogen free extract	Fat
80.80	3.02	3.94	2.55	8.93	0.76

WATER FREE SUBSTANCE.

	15.7	20.5	13.3	46.5	4.0

Orach (*Atriplex patula* L. var. *hastata* (L.) Gray.).

Description.—A pale green or purplish, slightly scurfy, annual, 2-3 ft. high; leaves slender-petioled narrowly lanceolate-hastate, entire or somewhat sinuate-dentate; flowers inconspicuous, interrupted, slender-panicled spikes.

Distribution.—Found from eastern Canada northeast to Wisconsin and Iowa. In Iowa somewhat widely scattered.

Extermination.—Easily exterminated by cultivation. Sheep are fond of it and may be utilized to destroy the weed.

FIG. 62. Orach (*Atriplex patula* var. *hastata*). Streets, gardens, roadsides. (Photographed by Colburn.)

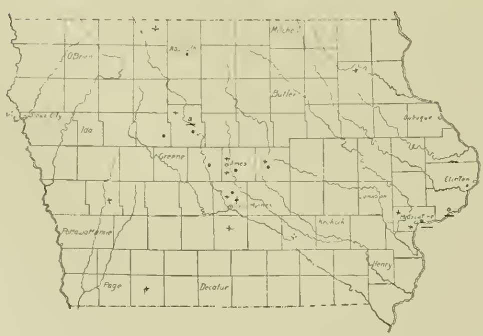


FIG. 62-A. Distribution of Orach.

Russian Thistle (*Salsola Kali* L. var. *tenuifolia* G. F. W. Mey).

Description.—An herbaceous, smooth or slightly pubescent annual, diffusely branched from the base, from 1½-3 ft. high, spherical in the mature form; leaves fleshy, alternate, succulent, linear, subterete, 1-2 in. long, pointed in the older specimens, upper leaves in the mature plant persistent, each subtending 2 leaf-like bracts and a flower; stem and branches red; apetalous flowers solitary and sessile; calyx consisting of 5 persistent lobes, enclosing the dry fruit which is usually rose-colored, about 1-12 in. long; 5 stamens nearly as long as the calyx; pistils with 2 slender styles producing a single obconical depressed seed, dull gray or green, without albumen; embryo spirally coiled; on germination cotyledons are subterete. The plant flowers in July or August, the seeds maturing in August.

Distribution.—Russian thistle is native of Russia and western Asia. Since its introduction into the Dakotas it has been widely scattered in the northern states and is common from Minnesota to the Pacific northwest and in the Rocky mountains from Montana to New Mexico. It is widely scattered in Iowa but abundant only during dry years, along the right of way of railways, and in the vicinity of stockyards.

Extermination.—The Russian thistle as said before, is an annual, hence it would seem an easy matter to destroy it; and as a matter of fact, when taken in time, it is not a difficult weed to remove. Its noxiousness comes largely from the fact that the plant is so productive. If a Russian thistle is once cut off at the surface of the ground it never grows again; hence in cultivated fields it is not likely to prove a great pest. The question is, however, a very different one in pastures, meadows and roadsides; here the weeds cannot be removed by cultivation and many of the plants mature their seeds unobserved. The removal of the weeds along the roadsides is important, because it is largely from this source that our fields become infested. The removal of such weeds can be best accomplished by running over the patch with a mower.

Fletcher and Clark recommend as follows: "Hand-pull wherever practicable. Harrowing growing crops is an effective remedy; it is easily killed by this method when young. The harrow should be applied just before the grain emerges from the ground and again when the crop is three inches high."

FIG. 63. Russian Thistle (*Salsola kali* var. *tenuifolia*). Common in western Iowa. Fleshy herb becoming spiny.
(Photographed by Gardner.)

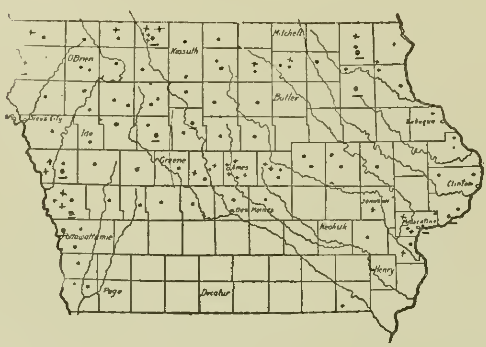


FIG. 63-A. Distribution of Russian Thistle.

Wallace's Farmer suggests the following treatment: "Russian thistle is easily controlled by cutting it off just below the surface of the ground before it seeds in August. It has not proved a dangerous weed east of Mississippi river."

CHEMICAL COMPOSITION.

	Original Sample		Dry Matter	
Water		84.52		--------
Dry matter		15.48		--------
100 parts contain:				
Water		84.52		--------
Crude ash		3.41		22.01
Ether extract (crude fat)		.34		2.20
Nitrogen free extract (soluble carbohydrates)		6.10		39.39
Crude fiber.		2.78		17.94
Crude protein (total nitrogen x 6.25)		2.86		18.46
True albuminoids (albuminoid N x 6.25)	(2.22)		(14.35)	
		100.00		100.00

AMARANTHACEAE, PIGWEED FAMILY.

This family contains few economic plants. Some, like the cock's-comb, are grown for ornamental purposes.

Pigweed, Redroot (*Amaranthus retroflexus* L.).

Description.—A roughish, more or less pubescent annual; 3-5 ft. tall; leaves ovate or rhombic-ovate, undulate; long-margined petiole, entire; flowers in thick spikes crowded in a stiff or bunchy, spiky panicle; bracts subulate, longer than the mucronate or obtusely-tipped sepals.

Distribution.—A weed throughout North America, especially eastward; abundant in every county in the state.

Extermination.—Frequently distributed with clover seed; sow clean clover seed in a clean field. Easily exterminated by cultivation.

Fletcher and Clark recommend as follows: "When embedded in the soil, the seeds retain their vitality for several years, though probably not more than five in a moist soil, and produce seedling plants only when brought by cultivation within about two inches of the surface."

FIG. 64. Pigweed, Redroot (*Amaranthus retroflexus*). Common in gardens, roadsides and fields.
(After Clark and Fletcher.)

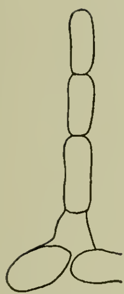


Fig. 64A

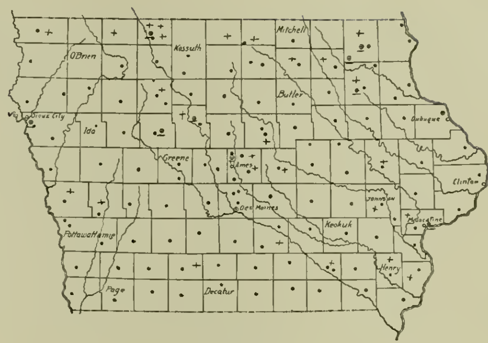


Figure 64B

FIG. 64-A. Trichomes or plant hairs from stem of pigweed. (Drawing by Charlotte M. King.)

FIG. 64-B. Distribution of Pigweed.

Chemical composition.—According to the University of Minnesota the composition is as follows:*

Dry Matter	Crude Protein	Ether Extract	Nitrogen free extract and fiber	Ash
97.00	26.54	1.36	62.86	9.24

Tumbleweed (*Amaranthus graecizans* L.).

Description.—A smooth, pale green much-branched annual; at maturity a spherical mass, which separates easily from the root; leaves oblong-spatulate or ovate; small flowers greenish, inconspicuous, polygamous, several together in small axillary clusters, small and pointed.

Distribution.—Common in North America especially from Ohio westward. In waste grounds. The detached leafless plants may be seen rolling over fields.

Extermination.—Easily exterminated by cultivation.

*Bull. Minn. Agr. Exp. Sta. 11, by Harry Snyder.

FIG. 65. Iowa Tumbleweed or Tumbling Pigweed (*Amaranthus graecizans*). Common in corn fields. Plant grows in circular form, separates from the root in the autumn and rolls over and over, scattering the seeds. (Photographed by Hart.)

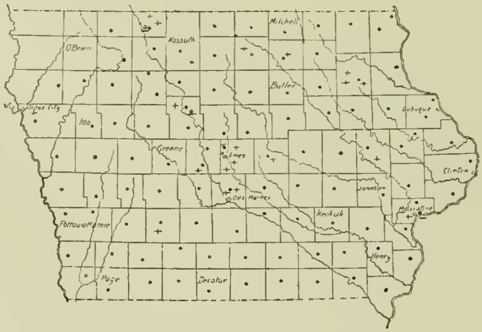


FIG. 65-A. Distribution of Tumbleweed.

Prostrate Pigweed (*Amaranthus blitoides* Wats.).

Description.—A diffusely branched, prostrate herb, spreading on the ground, often in mats 4 or 5 ft. long; leaves obovate or spatulate; flowers inconspicuous, greenish, in short axillary clusters.

FIG. 66. Prostrate Pigweed (*Amaranthus blitoides*). Common along roadsides, streets, fields, and in waste places. (Photographed by Hart.)

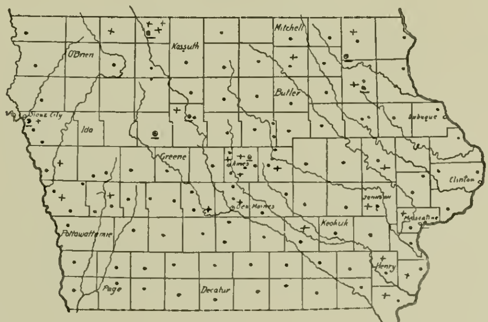


FIG. 66-A. Distribution of Prostrate Pigweed.

Distribution.—Common in every county in the state of Iowa and east to northeast; indigenous to the Rocky mountains.

Extermination.—Easily exterminated by cultivation.

Water Hemp (*Acnida tuberculata* Moq.).

Description.—A tall, erect annual; leaves lanceolate to rhombic-ovate, acute, or acutish; flowers dioecious; pistillate flowers small, green, clustered in naked or leafy terminal and axillary spikes; staminate flowers pale; dehiscent pericarp thin.

The *Acnida tamariscina* (Nutt.) Wood, of similar habit. Has circumscissille fruit, otherwise like the *A. tuberculata.*

Distribution.—Common along water courses, prairies and marshes from northeast to Minnesota and Dakota. Found in Iowa in Story, Boone, Polk, Pottawattamie, Woodbury, Emmet, Cerro Gordo, Clinton, Linn, Marshall and Allamakee counties.

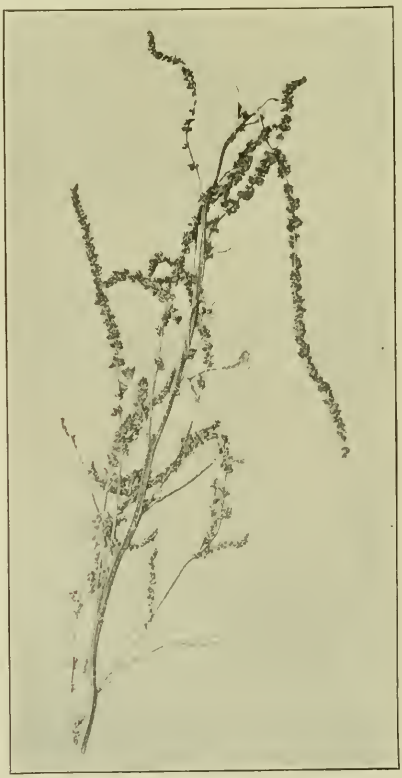


FIG. 67. Water Hemp (*Acnida tuberculata*). Common plant with yellowish aspect. In old lake beds and prairies.
(Photographed by Colburn.)

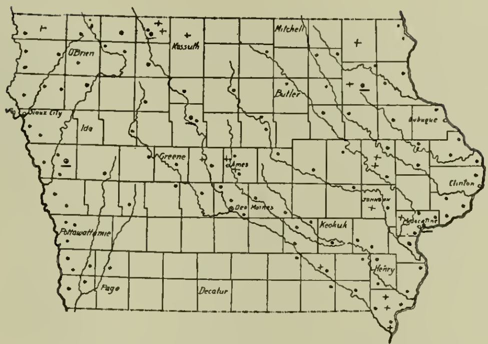


FIG. 67-A. Distribution of Water Hemp.

Extermination.—Easily exterminated by cultivation; not infrequent in clover seed, and not long present in well cultivated fields especially when they are well drained.

NYCTAGINACEAE, FOUR-O'CLOCK FAMILY.

This family contains the well known cultivated four-o'clock.

Four-o'clock, Umbrella Plant (*Oxybaphus nyctagineus* (Mx.) Sweet.)

Description.—A nearly smooth, deep-rooted perennial 2-4 ft. high; forking leaves, broadly ovate, cordate, or lanceolate, opposite, rounded or truncate at base; petioled involucre; flowers persistent; fruit obovoid, pubescent; calyx bell-shaped, rose or purple; stamens generally 3.

Distribution.—From Manitoba to Louisiana, introduced eastward; common in cultivated fields, on railway embankments and in waste places.

Extermination.—This weed propagates both by its seed and root; however, it is not difficult to destroy when the roots are cut off during dry weather.

Wallace's Farmer suggests the following treatment: "The wild four-o'clock, although not yet very common in the corn belt, has possibilities of becoming a bad weed. It is a perennial, with a big, fleshy root and spreads freely from the seed. It spreads very little from the root. This weed may be exterminated in time by cutting it off close to the ground every year just before it seeds."

FIG. 68. Wild Four-o'clock (*Oxybaphus nyctagineus*). Common in fields, along roadsides and on railway embankments. Plants have a long, stout root. (Photographed by Colburn.)

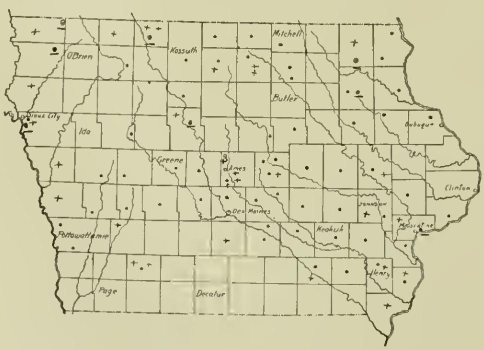


FIG. 68-A. Distribution of Wild Four-o'clock.

CARYOPHYLLACEAE, PINK FAMILY.

This family contains the well known carnation, spurrey and garden pink.

Chickweed (*Stellaria media* (L.) Cyrill.).

Description.—An annual, or winter annual, whose spreading stems are marked with one or more pubescent lines; leaves ovate

(After Clark and Fletcher.)
FIG. 69. Chickweed (*Stellaria media*). Gardens, lawns, dooryards.

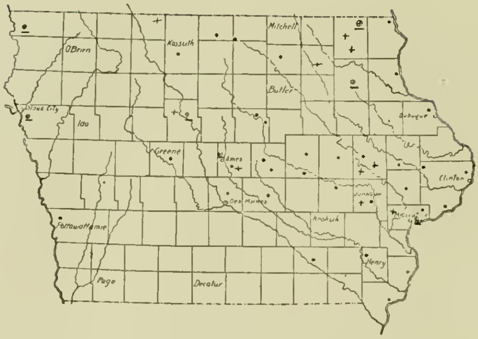


FIG. 69-A. Distribution of Chickweed.

or oblong, from ½ to 2½ in. long, lower leaves on hairy petioles, sepals 4 or 5, greenish; petals 4 or 5; shorter than the calyx and 2-parted; stamens 3-10; styles 3. Pod ovoid.

Distribution.—Chickweed is widely distributed in the northern states to the Pacific coast; naturalized from Europe; common in many places in lawns and in shady places, not especially troublesome except on the lawn, where often it runs out blue grass.

Extermination.—This weed is easily exterminated by cultivation. Since the lawn, however, cannot be cultivated the best and most effective means of exterminating the weed is to spray with iron sulphate at the rate of 100 pounds to a barrel of water. Spray as soon as the plants make their appearance and repeat 2 to 5 times during the season.

Nodding Chickweed (*Cerastium nutans* Raf.).

Description.—A clammy, pubescent, much-branched annual with slender, erect stems 6-20 in. high; leaves oblong, lanceolate, acute, the lowest spatulate; flowers numerous in open loose cymes; pods nodding on the stalks, curved upward, larger than the calyx. The larger mouse-ear chickweed (*Cerastium viscosum*) is a perennial with obovate, clammy, hairy stem; leaves varying from oblong to lanceolate; flowers clustered at first; sepals rather obtuse, small.

The common mouse-ear or chickweed (*C. vulgatum*) is a perennial with clammy pubescence.

Distribution.—From New England to Minnesota, especially southward in southern Iowa and Missouri.

FIG. 70. Nodding Chickweed (*Cerastium nutans*). Common in fields, waste places and streets, southern Iowa.
(Photographed by Colburn.)

Extermination.—This annual is easily exterminated by cultivation. When it occurs in places that cannot be cultivated, like pastures and lawns, iron sulphate at the rate of 100 pounds to a barrel of water may be used.

FIG. 70-A. Mouse-ear or Chickweed (*Cerastium vulgatum*). Common in pastures.
(Photographed by Colburn.)

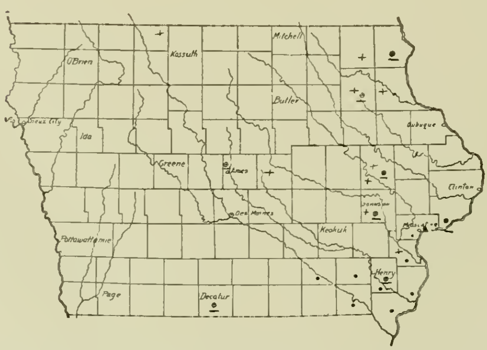


FIG. 70-B. Distribution of Larger Mouse-ear or Chickweed (*Cerastium viscosum*).

Corn Cockle (*Agrostemma githago* L.).

Description.—A hairy, annual weed, clothed with long, soft hairs; leaves linear-lanceolate, acute or long-acuminate; flowers purple and

FIG. 71. Corn Cockle (*Agrostemma githago*). In grain fields. (After Clark and Fletcher.)

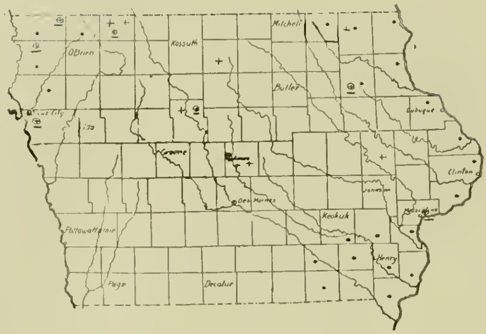


FIG. 71-A. Distribution of Corn Cockle.

long peduncled; calyx lobes long, linear, surpassing the purplish red petals; seeds large, roughened and black.

Distribution.—A weed long known as troublesome in European grain fields, and widely scattered throughout the grain growing section of North America. It is most abundant in Iowa in the wheat-growing section but occasionally is found in other places around grain elevators.

Extermination.—This weed is an annual and in order that it may be checked in its spread, use only clean seed. The seed should be put in clean soil.

Fletcher and Clark recommend as follows: "In the prairie provinces, harrowing the grain crop just before it emerges from the gound and again when it is about three inches high keeps down this weed. Where the land is infested with purple cockle, a thorough summer fallow is the best method of getting rid of it."

White Campion (*Lychnis alba* Mill.).

Description.—A freely branching biennial, with a slightly pleasant odor; leaves ovate-oblong or ovate-lanceolate; flowers loosely paniculate, white or pink, fragrant; capsule ovoid-conical, swelling with the ripening of the pod; petals 2-cleft, crowned.

Distribution.—Introduced with clover seed from Europe, not, however, as common in the east as *Lychnis dioica*.

FIG. 72. White Cockle (*Lychnis alba*). In clover meadows. (After Clark and Fletcher.)

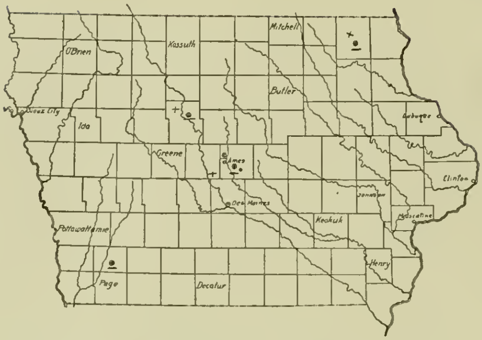


FIG. 72-A. Distribution of White Cockle.

Extermination.—This weed can be exterminated by cutting off the plants when in bloom or by cutting them off a few inches below the surface of the ground. Since this weed is being spread with European clover seed, care should be used to sow only clean clover seed.

Catchfly (*Silene dichotoma* Ehrh.).

Description.—A tall, more or less hirsute, annual, somewhat viscid, pubescent; leaves lanceolate or oblanceolate; flowers in branched racemes, short-pediceled in the forks, or solitary at the nodes; calyx 5-ribbed, hirsute; petals white or pink, bifid.

Distribution.—Introduced from Europe, spreading occasionally in clover fields from the northeast to Iowa and Texas, also to the Pacific coast.

Extermination.—A remedy in this case is to sow only clean seed, clean clover or alfalfa seed in clean soil in localities where the weed occurs. Give thorough cultivation. Do not allow any of the plants to go to seed.

FIG. 73. Catchfly (*Silene dichotoma* Ehrh.). In waste places. (W. J. Beal, Mich. Agr. Exp. Sta.)

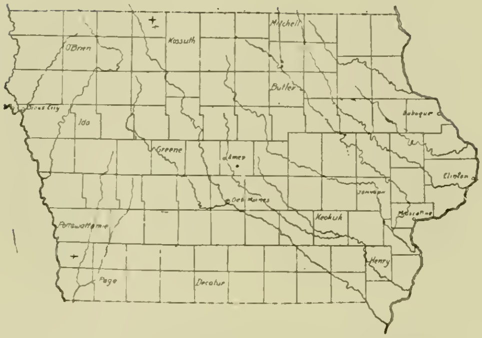


FIG. 73-A. Distribution of Catchfly.

Night-flowering Catchfly (*Silene noctiflora* L.).

Description.—A viscid, pubescent annual from 2-3 ft. high; lower leaves spatulate, upper lanceolate and pointed; flowers few, large, peduncled, white, fragrant; calyx prominent veined; pod enlarged in ripening of the fruit.

Distribution.—In waste places in Europe, Canada to Manitoba and southward, found in many counties in Iowa.

Extermination.—This weed is easily exterminated by cultivation. It has been widely spread in recent years with clover seed, particularly clover seed coming from the east and from Europe. Sow only clean clover seed on clean soil.

Fletcher and Clark make the following suggestions for exterminating the weed: ''Farmers who sow clover and grass seed free from the seeds of catchfly will not long have trouble with it on lands worked under a short rotation of crops. A rotation of crops exclusive of alsike seed should be adopted for six or eight years. Grass

FIG. 74. Night-flowering Catchfly (*Silene noctiflora*). In clover meadows, gardens, etc.
(After Clark and Fletcher.)

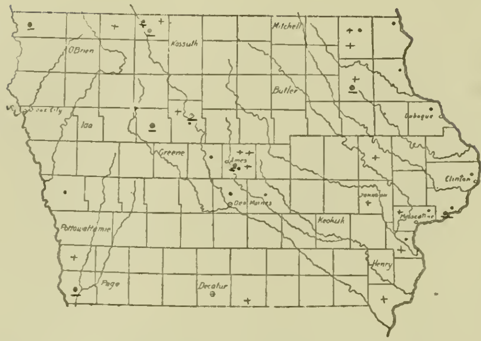


FIG. 74-A. Distribution of Night-flowering Catchfly.

or clover seed containing catchfly should be thoroughly cleaned in mills equipped with screens specially designed to remove this impurity, and should not be used on land that may later be required for the production of alsike seed.''

Cow-herb (*Saponaria vaccaria* L.).

Description.—A glabrous annual, from 1-2 ft. high with opposite ovate-lanceolate leaves; flowers in corymbed cymes; calyx 5-angled, enlarged and angled in fruit; petals pale red.

Distribution.—This weed has long been known as troublesome in grain fields of Europe, and is common in North America. It is common in Iowa only where wheat is grown.

Extermination.—Clean seed sown in clean soil is the only method of exterminating the weed.

Clark and Fletcher suggest the following treatment: ''Sow clean seed. Prevention is the best and least expensive method of fighting it. It is a large showy plant and when not present in excessive numbers can easily be hand-pulled. The seed will not retain its vitality long; when land is seeded to timothy or western grass and left for a few years, the supply of vital seeds in the soil will be greatly reduced, if not entirely exhausted.''

FIG. 75. Cow-herb (*Saponaria vaccaria*). In grain fields.
(Clark and Fletcher.)

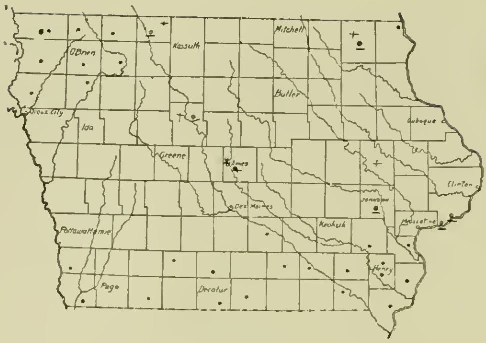


FIG. 75-A. Distribution of Cow-herb.

Bouncing Bet (*Saponaria officinalis* L.).

Description.—Perennial herbs with large flowers in cymose clusters; calyx narrowly ovoid or oblong, 5-toothed; petals clawed or unappendaged, stamens 10, styles 2, pod 1-celled or incompletely 2 or 4-celled and 4-toothed at the apex.

Distribution.—About 40 species in Europe, Asia, and Northern Africa. *Saponaria officinalis* is frequently cultivated in old gardens. The mucilaginous juice forms a lather with water and is valuable for taking grease spots out of woollen cloth. Commonly escaped from gardens to roadsides and railway embankments in many parts of Iowa but especially in northeastern and eastern Iowa.

Extermination.—Though this weed is a perennial it is not difficult to destroy in cultivated fields and gardens. In lawns and places where the soil is not cultivated it is best to dig up the patches, remove the dirt from the roots and let the sun dry them; covering with tarred paper will kill the weed, if it is kept covered long enough, say from 6 to 8 weeks.

PORTULACACEAE, PURSLANE FAMILY.

This family contains the well known moss rose, spring beauty, etc.

FIG. 76. Bouncing Bet, Soapwort (*Saponaria officinalis*).

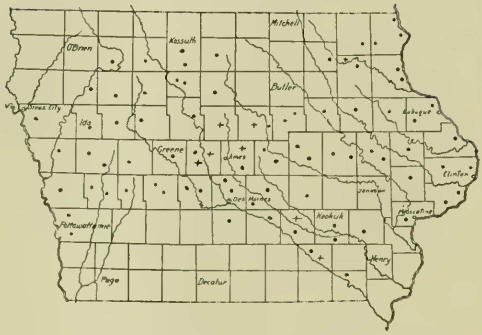


FIG. 76-A. Distribution of Bouncing Bet.

FIG. 77. Bouncing Bet (*Saponaria officinalis*). Near a building. Seeds mature and spread from such places.
(Photographed by Charlotte M. King.)

Pusley, Purslane (*Portulaca oleracea* L.).

Description.—A fleshy, prostrate, smooth annual with scattered obovate or wedge-shaped leaves; small sessile flowers with a 2-cleft calyx; 5 small, yellow petals, inserted on the calyx; stamens 7-12, style deeply 5-6-parted; seeds small, finely rugose.

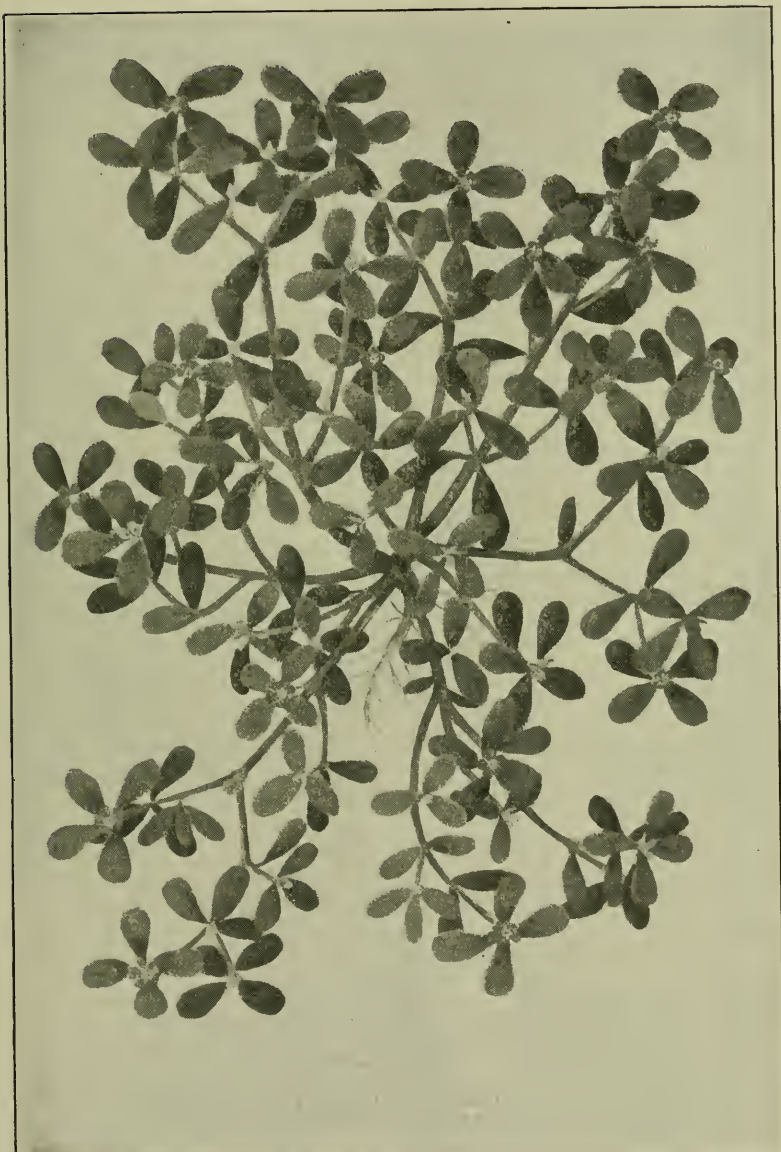


FIG. 78. Purslane or Pusley (*Portulaca oleracea*). Gardens and corn-fields. (After Clark and Fletcher.)

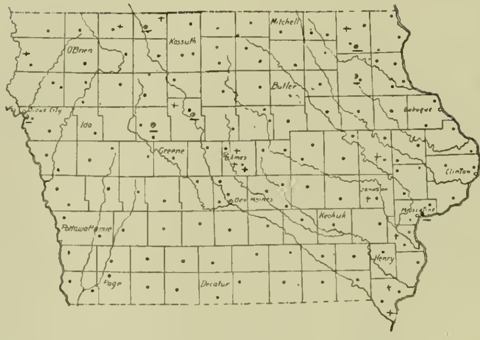


FIG. 78-A. Distribution of Purslane.

Distribution.—Purslane is native to Europe and is common from the Atlantic to the Pacific especially in cultivated soil. Common everywhere in the state in gardens and in corn fields.

Extermination.—Purslane is not difficult to exterminate if the green weeds are placed in piles or removed from the garden. They may be fed to hogs. It should be said that the leaves and stems show considerable vitality, since the whole plant is fleshy. Fletcher and Clark say: "A three-year rotation, including summer-fallow directly after the removal of a crop of early clover, followed by a hoed crop and again by cereal grain for the third year, will keep it in check. If given access to corn and potato fields, sheep will feed on late plants, and if their pasture is short, will prevent many of them from seeding."

Chemical Composition.—According to a report of the Bussey Institution* the chemical composition is as follows:

FRESH OR AIR DRY MATERIAL.

Water	Ash	Protein	Fiber	Nitrogen free extract	Fat
92.61	1.56	2.24	1.03	2.16	0.40

WATER FREE SUBSTANCE.

	21.1	30.2	19.9	29.4	5.4

*Bull. 1877: Jenkins and Winton, Bull. Off. Exp. Sta. 11.

RANUNCULACEAE, BUTTERCUP FAMILY.

The plants of this family are acrid. There are few economic plants among them; some like the peony, columbine, buttercup, larkspur, and aconite are cultivated for ornamental purposes.

Small-flowered Crowfoot (*Ranunculus abortivus* L.).

Description.—A small, slightly pubescent, succulent biennial; from 6 in.-2 ft. high with multiple roots; root leaves roundish or kidney-shaped, crenate; stem leaves often 3-5-lobed or parted, mostly toothed; petals small, pale yellow; shorter than the reflexed calyx; carpels minute.

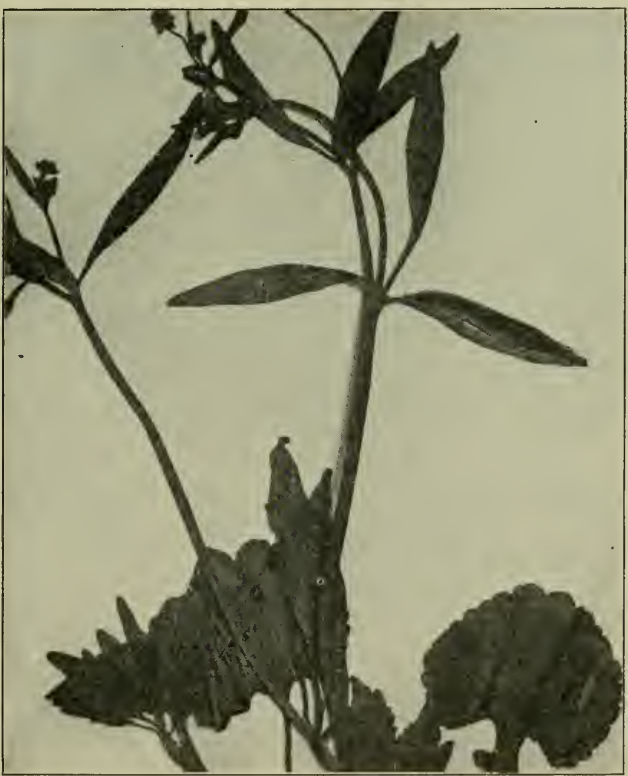


FIG. 79. Crowfoot (*Ranunculus abortivus*). Common in woodland pastures, pastures.
(Photographed by Hart.)

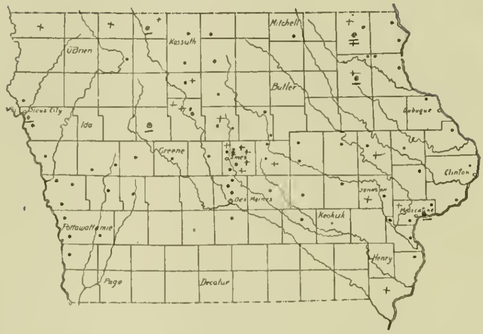


FIG. 79-A. Distribution of Crowfoot.

Distribution.—Common everywhere in Iowa in waste places along roadsides and in fields, occasionally eastward to Newfoundland, south to Florida and north to Manitoba, also in the Rocky mountains.

Extermination.—This weed is easily exterminated by cultivation.

Swamp Buttercup (*Ranunculus septentrionalis* Poir.).

Description.—A branching, prostrate, smooth or sometimes pubescent perennial with multiple fibrous roots, frequently rooting at the nodes and often forming long runners; leaves large, petioled, 3-divided, divisions mostly cuneate, petals obovate, larger than the spreading calyx; achenes flat, strongly margined, pointed by a stout straight beak.

Distribution.—Common in fields, especially low grounds from eastern Canada to Manitoba; south to Kansas and Kentucky. Common everywhere in Iowa in low places in Story, Boone, Marshall, Polk, Linn, Clinton, Buchanan, Emmet, Worth, Woodbury, Pottawattamie, Plymouth, Kossuth, Dallas and Allamakee counties.

Extermination.—Drainage of the soil and thorough cultivation will soon exterminate this weed.

FIG. 80. Creeping Buttercup (*Ranunculus septentrionalis*). Common in low grounds. Flowers yellow.
(Photographed by Hart.)

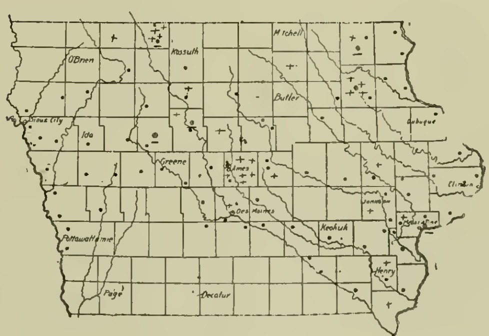


FIG. 80-A. Distribution of Creeping Buttercup.

Prairie Larkspur (*Delphinium penardi* Huth.).

Description.—A perennial pubescent or hairy herb, more or less glandular above, with simple, erect stem, 3-5 ft. high; leaves 3-5 parted, divisions 2-3 cleft; the numerous flowers white, or bluish-white, in elongated raceme, spur ascending or erect; follicle many-seeded.

Distribution.—From Illinois and Wisconsin, westward and northward. Common on gravelly knolls along railroads throughout the state of Iowa.

Extermination.—This perennial is easily exterminated by cultivation. The roots of the plant readily succumb when exposed to the sun.

Fig. 80-B. Prairie Larkspur (*Delphinium penardi*). Common on gravelly knolls. (Drawing by Ada Hayden.)

CRUCIFERAE, MUSTARD FAMILY.

This family contains the well known sweet alyssum, cabbage, cauliflower, rape, radish, turnip, white and black mustard, water cress, etc. They are all pungent herbs.

Pennycress (*Thlaspi arvense* L.).

Description.—An annual or winter annual with simple, smooth, erect or branching stem; leaves of stem clasping, with arrow-shaped

Fig. 81. Stinkweed or Field Pennycress (*Thlaspi arvense*). Grain and clover fields.
(After Clark and Fletcher.)

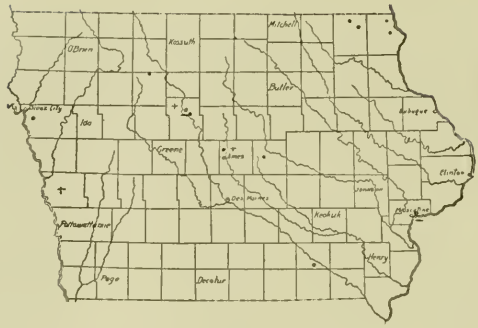


FIG. 81-A. Distribution of Pennycress.

base; root leaves petioled; flowers white; petals nearly equal; seeds purplish brown, longer than broad; cotyledons accumbent.

Distribution.—Common in waste places, particularly in clover fields; Story, Woodbury, Winneshiek, Allamakee and some other counties in the state. Common in Manitoba, Minnesota, Dakota, and eastern Canada, particularly in the prairie provinces. The weed is abundantly distributed by spring floods and also to some extent by clover seed.

Large Peppergrass (*Lepidium virginicum* L.).

Description.—An erect annual, at first quite simple, later much branched, 8 in.-2 ft. high; leaves divided, entire or with irregular, pointed teeth; flowers small, white; pod circular or oval with a little notch at the upper end; seeds light brown, elongated, with a prominent ridge on one side, on addition of water becoming mucilaginous; cotyledons accumbent.

Distribution.—Large peppergrass is native to the Mississippi valley, east to New England; more common in Missouri, Illinois and Ohio. It is widely scattered in Iowa, being particularly common in timothy meadows in some years.

Extermination.—This peppergrass sometimes comes up abundantly in the fall. The fields should, therefore, be plowed in the fall and when sowing small grain given a thorough dragging. In corn fields the ordinary methods of cultivation will destroy the weed. Do not permit any of the plants to seed. Frequent in timothy seed. Sow only clean timothy seed.

FIG. 82. Large or Virginia Peppergrass (*Lepidium virginicum*). Common in fields, gardens, etc.; along roadsides.
(Photographed by Colburn.)

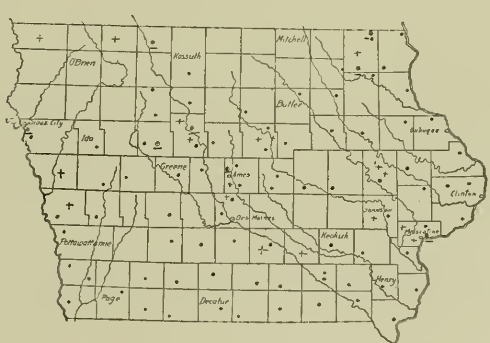


FIG. 82-A. Distribution of Large Peppergrass.

Small Peppergrass (*Lepidium apetalum* Willd.).

Description.—Much like the foregoing, an annual 8 in-2 ft. high, but leaves and pods smaller; flowers small, greenish; seeds light

FIG. 83. Small Peppergrass (*Lepidium apetalum*). Common in timothy meadows, fields, etc.
(After Clark and Fletcher.)

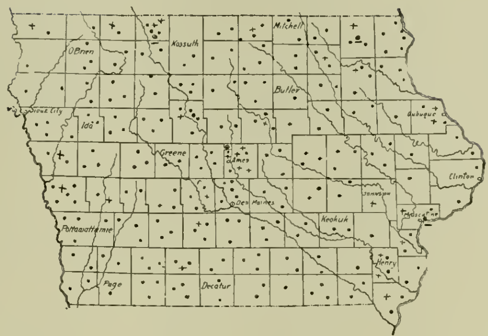


FIG. 83-A. Distribution of Small Peppergrass.

brown, elongated, with prominent ridge on one side, becoming mucilaginous when moistened with water; cotyledons incumbent.

Distribution.—Small peppergrass is common in the northern states from New England across the continent; apparently native in the west; in the east introduced from Europe. It is abundant in fields and waste places. In some years it is particularly common in timothy and clover meadows.

Extermination.—The peppergrasses are not difficult to exterminate in cultivated fields since they are annuals. In growing timothy seed it is important above all to have a field as clean from weeds as possible. Timothy should therefore be sown in a field that has been under thorough and clean cultivation for several years and clean seed only should be used. In this way the peppergrass can largely be prevented from growing.

Fletcher and Clark make the following suggestions: "Only autumn plants which live through the winter give trouble in grain. Thorough surface cultivation in the spring, with the plow, disc or broad-shared cultivator, is efficacious. Immature seeds may ripen in the pods when plowed down."

Hoary Alyssum (*Berteroa incana* (L.) DC.).

Description.—A tall, green, erect annual or biennial with entire, pubescent, pale green, lanceolate leaves; flowers white, 2-parted; pods canescent.

FIG. 84. Hoary Alyssum (*Berteroa incana*); *a*, flowering stem; *b*, flower; *c*, pods; *d*, section of ovary. Weed of clover fields.

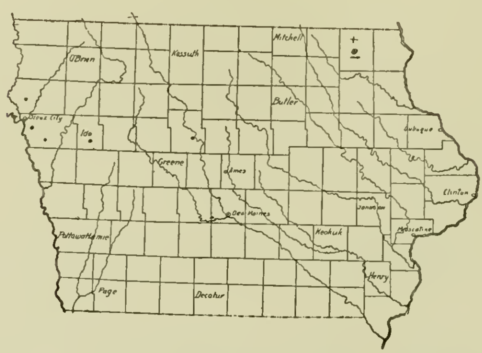


Fig. 84-A. Distribution of Hoary Alyssum.

Distribution.—Said to be common in northeastern United States and becoming frequent in other Atlantic states; found in Mississippi and adjacent states; found not infrequently in Iowa; reported from Ida county in 1912, and said to have been introduced with clover seed.

Extermination.—Sow clean clover and alfalfa seed. Succumbs readily to cultivation.

False Flax (*Camelina sativa* Crantz.).

Description.—An erect annual with single or sparingly branched stem, 1½ ft. long, smooth or slightly pubescent stellate hairs; leaves erect, lanceolate or arrow-shaped, entire or nearly so; flowers small, yellow, pedicels in fruit spreading; pod obovoid 4-6 in. long, smooth, reticulated, margined from beak down along placental side with smaller ribs between them; seeds light brown, 1 line long, minutely pitted, caulicle prominent, running lengthwise with a prominent groove between it and the cotyledons which are incumbent; on the addition of water seeds become mucilaginous.

Distribution.—This weed is particularly common in the grain growing sections of the north, as Dakota, Manitoba and Saskatchewan. In recent years it has become more common in Iowa, particularly in the northern counties.

Extermination.—Clark and Fletcher recommend the following treatment: "When a crop of winter wheat is infested with false flax, harrowing in the spring kills the young plants without injuring the wheat. A thorough summer-fallow, with cultivation the previous fall and continuous cultivation throughout the summer, is recommended for fields badly infested with this weed."

Fig. 85. False Flax (*Camelina sativa*). In grain and flax fields, waste places. (After Clark and Fletcher.)

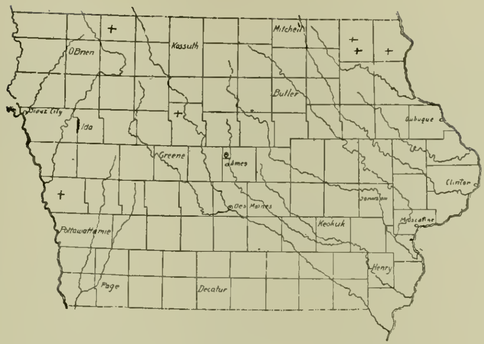


Fig. 85-A. Distribution of False Flax.

Shepherd's Purse (*Capsella bursa-pastoris* Moench.)

Description.—An annual or winter annual 1-1½ ft. high; root leaves clustered, nearly divided or merely toothed; stem leaves sessile; flowers small, white, in fruit spreading; pods much wider above than below, many-seeded; seeds light brown, elongated, with a prominent ridge, mucilaginous when moistened with water; cotyledons incumbent; trichomes stellate, roughened.

Distribution.—Shepherd's purse is native to Europe and one of the most common early spring flowers from the Atlantic to the Pacific. Common everywhere in gardens and fields in the state.

Extermination.—Clark and Fletcher state: "It has an enormous power of propagation; a single plant will ripen 50,000 seeds. Waste places should be cleared as far as practicable and seeded to grass. It does not give serious trouble on lands worked under a short rotation, with clean cultivation of hoed crops. Sow clean grass and clover seeds."

Fig. 86. Shepherd's Purse (*Capsella bursa-pastoris*). Common in gardens, fields and waste places.
(After Clark and Fletcher.)

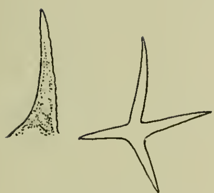


Figure 86A

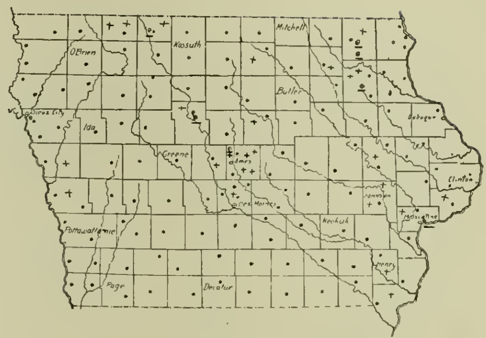


Figure 86B

Fig. 86-A. Plant hair or trichome of Shepherd's Purse. (Drawing Charlotte M. King.)

Fig. 86-B. Distribution of Shepherd's Purse.

Fig. 86-C. Shepherd's Purse (*Capsella bursa-pastoris*). Weed in city streets. (Photographed by Charlotte M. King.)

Jointed Charlock (*Raphanus raphanistrum* L.).

Description.—Biennial or annual, having a slender root, rough leaves, lyrate, pinnatifid, with a large terminal lobe; flowers yellowish fading to white, or purplish veined; pods linear or oblong, jointed, 2-8-seeded.

Fig. 87. Wild Radish or Jointed Charlock (*Raphanus raphanistrum*). In oat fields in northern Iowa.
(After Clark and Fletcher.)

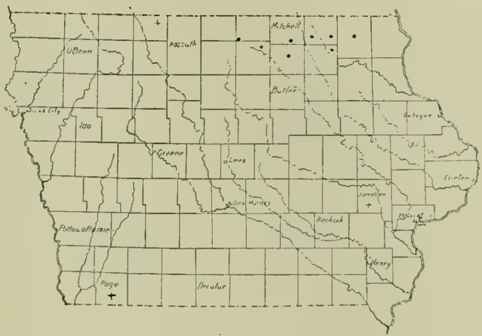


Fig. 87-A. Distribution of Jointed Charlock.

Distribution.—Common; spreading eastward in fields and waste places; reported in grain fields in Worth and a few other counties in the northern part of Iowa. It is said to have been largely distributed with oats seed.

Extermination.—Exterminated by cultivation. Sow only clean oats seed in clean fields.

Mustard or English Charlock (*Brassica arvensis* (L.) Ktze.).

Description.—Lower leaves nearly divided to the middle, with divisions unequal, terminal lobe larger, upper leaves not stalked as a rule, much smaller than the lower; flowers yellow, large and very fragrant; pods 1-2 in. long, irregular in outline, appearing somewhat nodose, 3-7-seeded or occasionally more, upper part of pod forming a beak; seeds round, brownish black, darker than in *B. nigra* and minutely pitted, when moistened becoming mucilaginous.

Distribution.—Mustard or charlock has been known as a pest of the grain fields from the earliest historical record, throughout the grain growing section of the world; common everywhere in Iowa, but most abundant in the grain growing section of northern and northwestern Iowa where it was introduced with flax.

Extermination.—The first and most important consideration in connection with the extermination of mustard is that the oats or wheat should be freed from mustard seed. Then this grain should be sown on clean fields, preferably fields that have been in pasture or meadow. Nothing has done so much to remove the weeds from the fields of northwestern Iowa as the pasture and meadow. If the grain is sown in a corn field there should have been no mustard the

Fig. 88. Wild Mustard or Charlock (*Brassica arvensis*). Common in roadsides and grain fields.
(After Clark and Fletcher.)

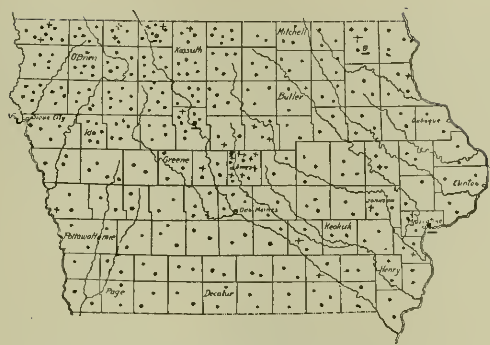


Fig. 88-A. Distribution of Wild Mustard.

previous season. Having sown the small grain on a clean field there is always a chance that some of the seeds will retain their vitality in the soil. If much of this mustard should come up it may become necessary to spray it with iron sulphate. Where the mustard is abundant this is a very effective means of destroying the weeds, using the sulphate at the rate of 100 pounds to a barrel of water.

Chemical Composition.—According to the University of Minnesota the chemical composition is as follows:*

Dry Matter	Crude Protein	Ether Extract	Nitrogen free extract and fiber	Ash
91.79	15.75	1.55	75.59	7.11

Black Mustard (*Brassica nigra* Koch.).

Description.—A tall, coarse, much-branched annual, 2-5 ft. high; leaves variously divided or only deeply cut, the terminal lobe the largest, sharply toothed, upper leaves small, simple, as a rule linear; leaves as a rule not smooth, but somewhat bristly, at least on the veins; flowers yellow, smaller than in charlock; pods smooth, about ½ in. long, 4-cornered, tipped with a slender beak; seeds black or reddish brown, smaller than in charlock; cotyledons incumbent; trichomes not stellate, simple, rough.

*Snyder: Bull. Minn. Agr. Exp. Sta., 101.

Fig. 89. Black Mustard (*Brassica nigra*). Fields, gardens and roadsides. (Photographed by Colburn.)

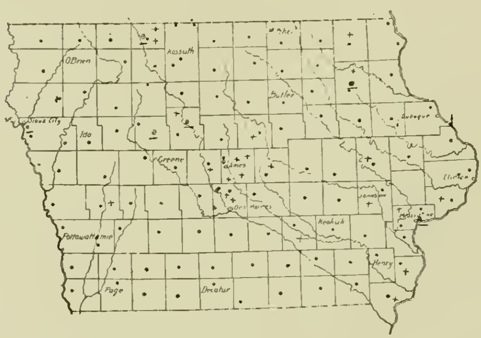


Fig. 89-A. Distribution of Black Mustard.

Distribution.—This weed is common in the northern states and extends across the continent. It is abundant in Iowa, at times, in waste places and vacant lots; apparently, however, it is less common than common charlock.

Extermination.—This weed can be exterminated by the same method that is used with common charlock.

Rocket (*Eruca sativa* L.).

Description.—An annual or biennial herb with stout, 4-sided stem; lower leaves lyrate, incised or pinnatifid, upper leaves,

Fig. 90. Rocket (*Eruca sativa*). Introduced with alfalfa seed. (Drawn by F. C. Collins.)

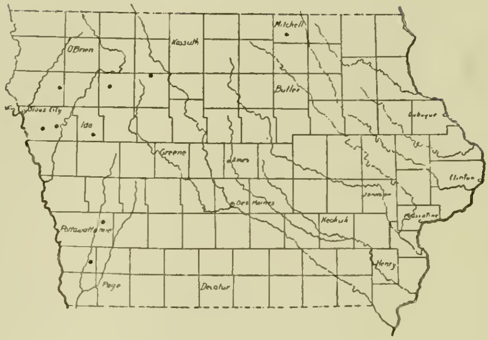


Fig. 90-A. Distribution of Rocket.

smaller, lobed, or entire; flowers white or yellowish-white with dark veins; fruit an oval, elongated silique containing many, more or less compressed, seeds in 2 rows.

Distribution.—A native of western Asia and the Mediterranean region, but cultivated as a salad plant and often an escape. Introduced into Iowa with alfalfa seed in Woodbury, Plymouth, O'Brien, Clay, Mitchell, Pottawattamie, Mills, Ida, and Sac counties.

Extermination.—The weed can be exterminated by cutting the plants off a few inches below the surface of the ground or by giving thorough cultivation.

Hare's-ear Mustard (*Conringia orientalis* (L.) Dumort.).

Description.—Slightly succulent annual; leaves light green, sessile, obtuse, racemes becoming elongated in fruit; petals much longer than the sepals; pods long, linear 4-angled, spreading; cotyledons incumbent.

Distribution.—Common eastward and appearing in the Mississippi valley; occurring in Woodbury, Webster and Page counties and probably in many other places in Iowa.

Extermination.—Easily exterminated by cultivation.

FIG. 91. Hare's-ear Mustard (*Conringia orientalis*). In grain fields, and waste places in northwestern Iowa.
(After Clark and Fletcher.)

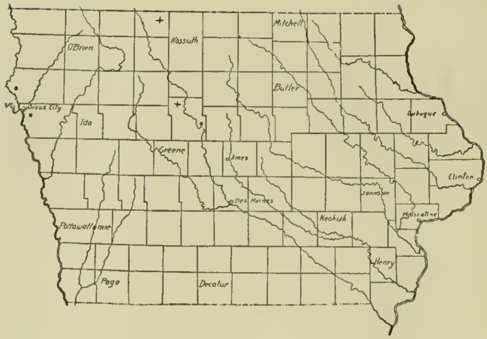


Fig. 91-A. Distribution of Hare's-ear Mustard.

Fig. 91-B. Hare's-ear Mustard (*Conringia orientalis*). Flowering stem, seed and cross section of seed. Appearing in several counties in Iowa.

Ball Mustard (*Neslia paniculata* (L.) Desv.).

Description.—An erect, slender annual or biennial, 1-3 ft. high with stem simple up to the inflorescence; stem and leaves, both being covered with stellate pubescence; sessile leaves oblong, very

FIG. 91-C. Ball Mustard (*Neslia paniculata*); *a*, flowering stem; *b*, pod; *c*, seed. (Schuyler Mathews in Mich. Agr. Exp. Sta. Bull.)

narrow, sagittate at base; racemes elongate; flowers small, yellow, about ⅛ in. in diameter; seed-pods nearly spherical, 2-celled with 1 small yellow seed in each cell, sometimes but one developing.

Distribution.—In grain fields, Canada, the Dakotas and occasionally in northwestern Iowa.

Extermination.—Clean seed; easily destroyed by cultivation.

Hedge Mustard (*Sisymbrium officinale* (L.) Scop.).

Description.—A slender, erect annual or winter annual, 1½-2½ ft. high; lower leaves divided, upper entire or hastate at base; flowers small, yellow, borne in spikelikc racemes; seeds small, brown; cotyledons incumbent.

Distribution.—Found everywhere in the state, notably in Story, Boone, Polk, Clinton, Linn, Marshall, Hardin, Black Hawk, Woodbury, Pottawattamie, Carroll, Jasper, Monroe, Scott, Lee, and Allamakee counties.

Extermination.—Easily exterminated by cultivation; also by using the formula 100 pounds of iron sulphate to one barrel of water.

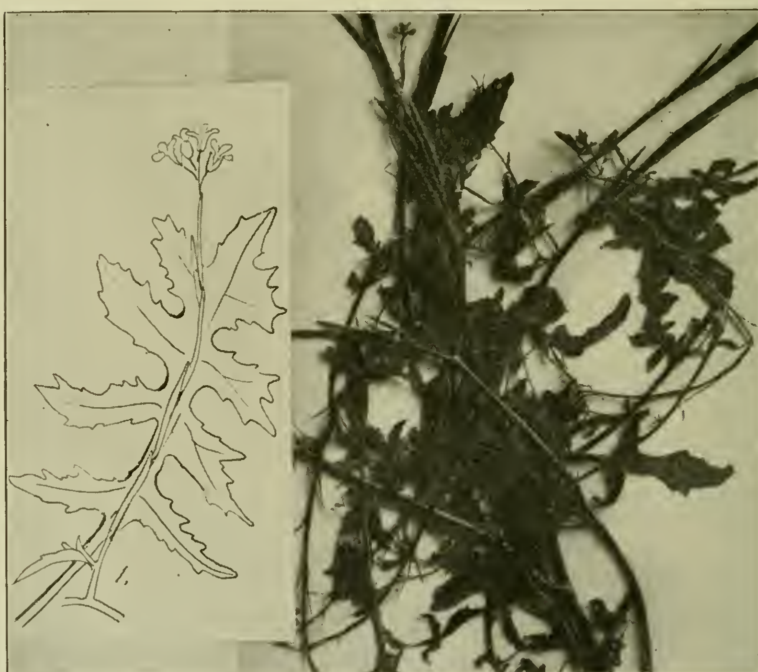


Fig. 92. Hedge Mustard (*Sisymbrium officinale*). Common in gardens, fields and waste places.
(General aspect of plant photographed by Hart. Drawing by Charlotte M. King.)

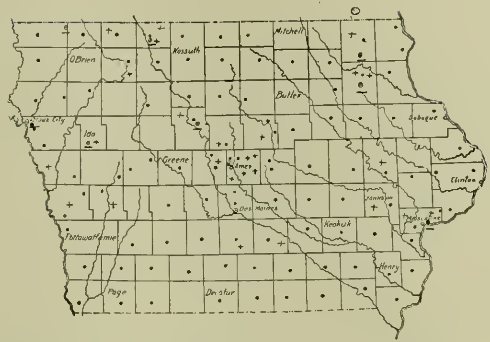


Fig. 92-A. Distribution of Hedge Mustard.

Chemical Composition.—According to the University of Minnesota it is as follows:*

Dry Matter	Crude Protein	Ether Extract	Nitrogen free extract and fiber	Ash
94.5	16.52	1.43	74.18	7.87

Tumbling Mustard (*Sisymbrium altissimum* L.).

Description.—A leafy, branched annual from 1-4 ft. high, lower leaves runcinate, pinnatifid, irregularly toothed, or wavy margined, upper leaves smaller, threadlike.

Distribution.—This weed is native to east Europe. It has become widely scattered in the northern states, particularly in the west from Minnesota to Washington and in Canada. It is widely scattered in Iowa in the vicinity of railroad watering tanks, elevators and stockyards. It is less common in the southern half of the state.

Extermination.—The young mustard plants are easily killed by cultivation. They are likely to occur in some commercial seed like timothy, therefore, sow only clean seed.

*Snyder: Bull. Minn. Agr. Exp. Sta., 101.

Fig. 93. Tumbling Mustard (*Sisymbrium altissimum*). In grain fields, railways, etc.
(After Clark and Fletcher.)

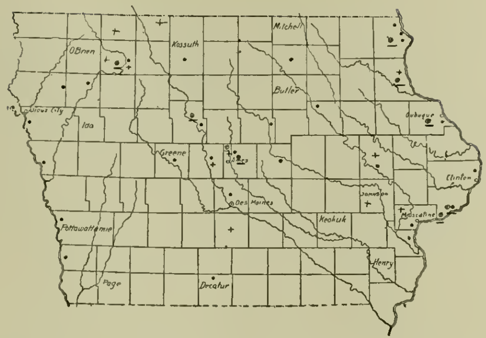


Fig. 93-A. Distribution of Tumbling Mustard.

Marsh Cress (*Radicula palustris* (L.) Moench.).

Description.—An annual or biennial; erect, smooth, or slightly pubescent herb; from 1-1½ ft. high; leaves pinnately cleft or parted, pinnatifid; the lobes toothed; upper leaves sessile; flowers yellowish in racemes; pods ellipsoid or ovoid.

Fig. 94. Marsh Cress (*Radicula palustris*). Common in low grounds. (Photographed by Colburn.)

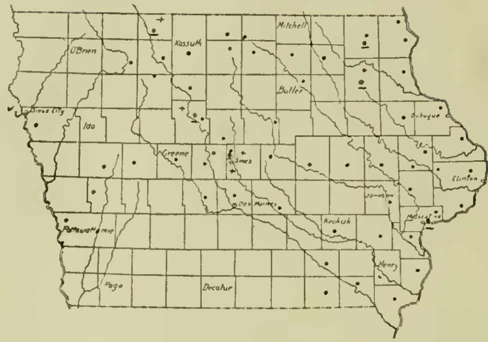


Fig. 94-A. Distribution of Marsh Cress.

Distribution.—In wet places or in low grounds; frequent in oat fields and meadows; abundant in Iowa especially in northern Iowa; common throughout the northern United States. Not infrequently distributed with clover seed that is grown in Iowa.

Extermination.—This weed may be exterminated by first draining the soil and then giving clean cultivation.

Horseradish (*Radicula armoracia* (L.) Robinson).

Description.—A stout perennial with long, deep roots; leaves large, oblong, crenate or pinnatifid, the latter produced in the spring; stem leaves lanceolate, or oblong cordate; flowers with 4 green sepals and 4 white petals, not common; pods short, globular, but fruit seldom found. At least I have never observed any in Iowa.

Distribution.—Horseradish is native to eastern Europe and introduced in west Europe and the United States; common from the Atlantic to the Pacific; largely an escape from cultivation; found in every part of Iowa.

Extermination.—The horseradish is one of the most persistent of our weeds; no other weed will stand such rough treatment. It may be hoed and cultivated and still it persists in coming up. Some years ago we tried the following plan: The land was plowed, then harrowed; the roots were picked up and the process repeated after the lapse of a week, when young plants again made their appearance. After that, young plants were cut off with a hoe below the ground as soon as they appeared. This treatment was kept up for

FIG. 94-B. Horseradish (*Radicula armoracia*). Escaped from cultivation; a rather persistent weed.
(Drawing by Charlotte M. King.)

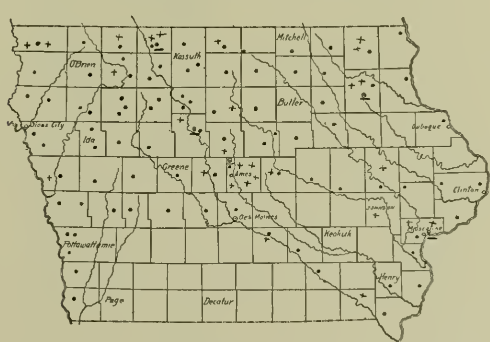


Fig. 94-C. Distribution of Horseradish.

two years, and in this way most of it was removed. Quack grass near the horseradish received the same treatment and was killed in a single season, the season being dry. Very little progress in destroying the plant would have been made in a wet season.

Winter Cress (*Barbarea vulgaris* R. Br.).

Description.—A biennial, with yellow flowers 1-2 ft. high; stem furrowed, simple or branched; lower leaves simple or pinnately parted, terminal lobe the largest, round or ovate; upper leaves obovate, cut, toothed or pinnatifid at the base; flowers bright yellow; pods erect or slightly spreading; cotyledons accumbent.

Distribution.—Eastern North America from Labrador to Maryland, Iowa, Manitoba, Rocky Mountains, Pacific slope; common in northern Iowa. A cosmopolitan weed in Europe, Asia, Africa and Australia.

Extermination.—This perennial weed is not difficult to kill if the field is given an early plowing followed by a subsequent disking and harrowing, thus getting the field in a good state of tilth for a crop.

Fig. 95. Winter Cress (*Barbarea vulgaris*).
(Photographed by Colburn.)

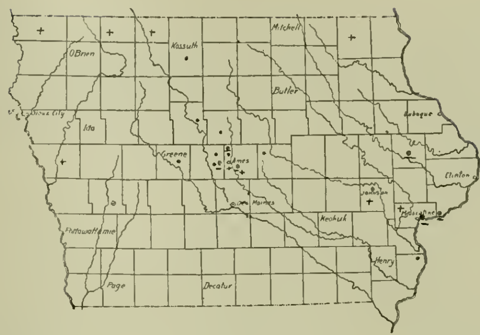


Fig. 95-A. Distribution of Winter Cress.

CAPPARIDACEAE, CAPER FAMILY.

This family contains the caper which is used for pickling, the Rocky Mountain bee plant, etc.

Stinkweed (*Polanisia graveolens* Raf.).

Description.—A fetid annual with glandular hairs; leaves with 3 oblong leaflets; flowers in leafy racemes; 6 petals, white, with claws, notched at the apex; stamens about 11, scarcely exceeding the petals; not elongated, bearing a gland behind the base of the ovary; pod short, stalked; seeds rough. The *P. trachysperma* T. & G. has larger flowers with long exserted stamens and sessile pods.

Distribution.—Iowa to Kansas and eastward to New England; common in sandy soil, railroad embankments, Muscatine Island.

Extermination.—Easily exterminated by cultivation. The land should be cultivated as soon as a fresh growth of the weed develops. Great care must be taken not to plow down any full-sized pods, even though they may be green, as it has been proven that in the dry climate of the west such seeds can ripen beneath the soil. The most important measure to be used in order to clear the land of stinkweed is harrowing the growing crop to kill the seedlings. The harrowing should commence before the crop emerges from the ground and be repeated when the grain is about three inches high.

Fig. 96. Clammy Weed or Stinkweed (*Polanisia graveolens*). In sandy places, gravelly soils, etc.
(Photographed by Hart.)

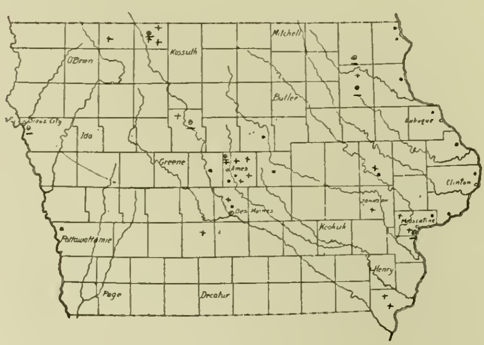


Fig. 96-A. Distribution of Stinkweed.

Fig. 97. Stinkweed (*Polanisia trachysperma*). Common in sandy soils, railway embankments and gravelly soils.
(Photographed by Colburn.)

Rocky Mountain Bee-plant or Stinking Clover (*Cleome serrulata* Pursh.).

Description.—A smooth annual; leaves of 3 lanceolate, oblong leaflets, somewhat fleshy; flowers in bracteate racemes; petals usually rose-colored, short-clawed; stipe of pod as long as the pedicel.

Distribution.—From western Iowa, Minnesota and northward, Utah, Colorado, Montana and westward; common in Iowa in Fremont, Mills, Pottawattamie, and Woodbury counties, occasionally eastward in Polk county.

Extermination.—Easily exterminated by cultivation.

Fig. 98. Rocky Mountain Bee-plant (*Cleome serrulata*). Fields, roadsides in western Iowa.
(Photographed by Colburn.)

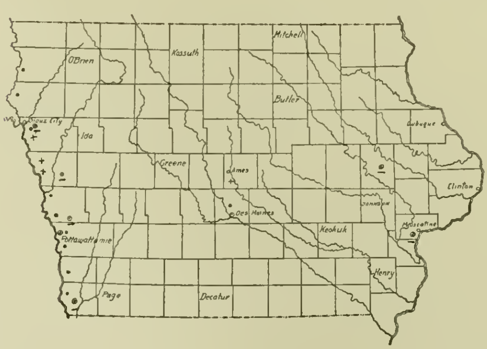


Fig. 98-A. Distribution of Rocky Mountain Bee-plant.

Fig. 98-B. Rocky Mountain Bee-plant (*Cleome serrulata*). (Drawing by Charlotte M. King.)

ROSACEAE, ROSE FAMILY.

This family contains the well known rose, apple, pear, quince, plum, peach, almond, strawberry, blackberry, raspberry, spiraea, etc.

Cinquefoil, False Strawberry (*Potentilla monspeliensis* L.).

Description.—A hairy annual or winter annual from 1-2½ ft. high; leaves 3-foliolate, leaflets obovate to oblanceolate, the uppermost toothed, nearly the whole length; flowers in close cymes, calyx large, 5-cleft with 5 bractlets; petals 5, yellow, small; stamens 15-20; style terminal; trichomes simple, long pointed, thick walled.

Distribution.—Naturalized from Europe; eastern Canada, New England, to Kansas; common in Iowa, in Story, Boone, Polk, Clinton, Lyon, Carroll, Woodbury, Kossuth, Webster, Marshall, Cerro Gordo, Worth, Winnebago, Allamakee and other counties.

Extermination.—Frequently introduced with clover seed. Sow only clean clover seed in a clean field. Cut the weed off below the surface of the ground and give thorough cultivation.

FIG. 99. Cinquefoil, False Strawberry, Five-finger (*Potentilla monspeliensis*). Common in gardens, timothy meadows, etc. *a*, Plant hair; *b*, showing cell-wall. (*a* and *b*, drawn by Charlotte M. King, general aspect of plant photographed by Hart.)

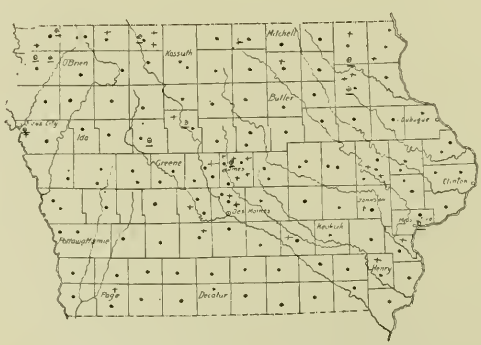


Fig. 99-A. Distribution of Cinquefoil.

Silverweed (*Potentilla anserina* L.).

Description.—Herbaceous perennial, spreading by slender runners; numerous white-tomentose and silky-villous leaves, all radi-

Fig. 100. Silverweed (*Potentilla anserina*). In marshes. (Drawing by Ada Hayden.)

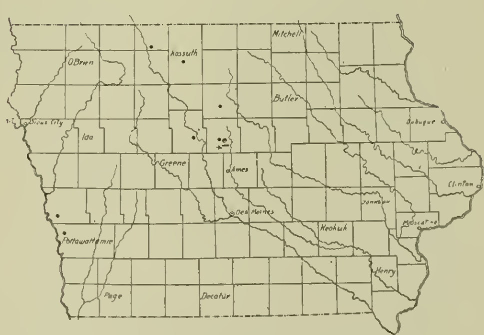


Fig. 100-A. Distribution of Silverweed.

cal; pinnate leaflets, 7-21 with smaller ones between, oblong, sharply serrate, silky-tomentose beneath; flowers with 5 bright yellow petals; peduncles elongated; styles filiform.

Distribution.—Common eastward in brackish marshes; also in the Dakotas and the Rocky mountains; common in Wright county, Iowa; perhaps in other places.

Extermination.—Give a shallow cultivation; expose the roots to the sun. Care must be used to kill the weed on its first appearance as it is quite persistent.

Wild Rose (*Rosa pratincola* Greene).

Description.—Low shrub with very prickly stem; compound leaves of 7-11 leaflets, broadly elliptical to oblong-oblanceolate, sub-cuneate at base, short stalked or sessile, serrate; stipule narrow,

Fig. 101. Wild Rose (*Rosa pratincola*). Grain fields, roadsides. (Photographed by Colburn.)

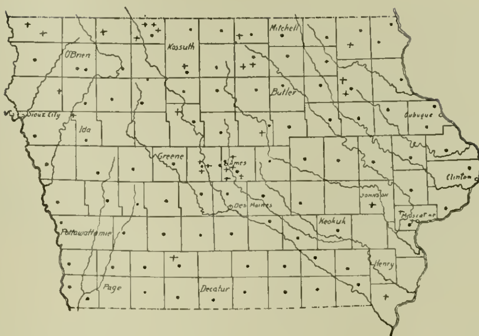


Fig. 101-A. Distribution of Wild Rose.

Fig. 101-B. Wild Prairie-rose (*Rosa pratincola*).
(Drawn by Ada Hayden.)

glandular toothed; flowers corymbose, calyx tube urn-shaped, 5 sepals, smooth or occasionally hispid, petals 5, rose-colored; fruit oblong, ovaries hairy.

Distribution.—Common in prairies and field from Texas to Minnesota, west to Colorado. Common everywhere in Iowa; Story, Polk, Emmet, Dickinson, Palo Alto, Clay, Kossuth, Winnebago, Allamakee, Clinton, Muscatine, Scott, Decatur, and Pottawattamie counties.

Extermination.—This weed often persists in grain fields of northern Iowa. Thorough cultivation for a few seasons will, however, usually destroy the weed.

Stickweed (*Geum canadense* Jacq.).

Description.—A perennial herb from 1½-2 ft. high; leaves pinnate, the lower of 3-5 leaflets or undivided; stem leaves 3-divided or 3-lobed, sharply toothed; stipules ovate-oblong; flowers white; calyx bell-shaped; deeply 5-cleft; petals 5; stamens many; pistils numerous; styles jointed and bent near the middle, the upper part falling away and the lower part hooked.

Distribution.—Widely distributed in northern United States, and frequently found in woods or fields adjacent thereto; common especially in northeastern Iowa.

Extermination.—This weed is easily scattered by animals because of the hooked achenes; thorough cultivation will, however, destroy it.

LEGUMINOSAE, PULSE FAMILY.

This family contains the clover, pea, beans, cowpea, soybean, honey locust, lupines, vetches, coffee bean, senna, and ornamental plants as red bud, sweet pea, caragana, etc.

Fig. 102. Stickweed, White Avens (*Geum canadense*). White flowers with bur-like fruit scattered by animals. In pastures and fields. (Photographed by Hart.)

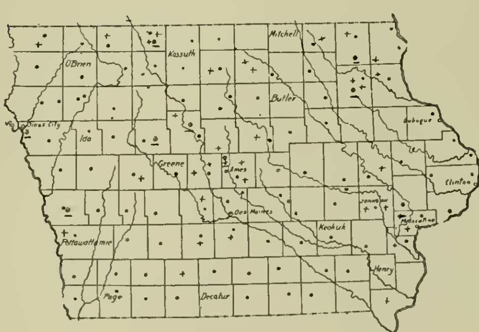


Fig. 102-A. Distribution of Stickweed.

Rattle-box (*Crotalaria sagittalis* L.).

Description.—A hairy annual from 3 in-1 ft. high, with a small tap root; stem branched, villous, terete or wing-margined; leaves oval or oblong-lanceolate, from ½-⅓ in. wide, edge of the leaf entire or somewhat wavy and hairy; stipules united and decurrent on the stem, becoming inversely arrow-shaped; peduncles produce a few yellow flowers about ¼ in. in diameter; calyx 5-cleft, standard of the flower large, heart-shaped; keel scythe-shaped; stamens monadelphous, anthers of two sizes, 5 smaller and roundish; pod large, inflated, bears a close resemblance to that of the garden pea, greenish at first, becoming blackish varying in size from ¾-1 in. in length and about 1 in. in diameter; seeds from ½-1/10 in. in diameter, flattish, kidney-shaped, when mature breaking away from the point of attachment and rattling in the pod, hence the name "rattle-box".

Fig. 103. Rattle-box (*Crotalaria sagittalis*). Common in sandy soil, Missouri river bottoms.
(Photographed by Colburn.)

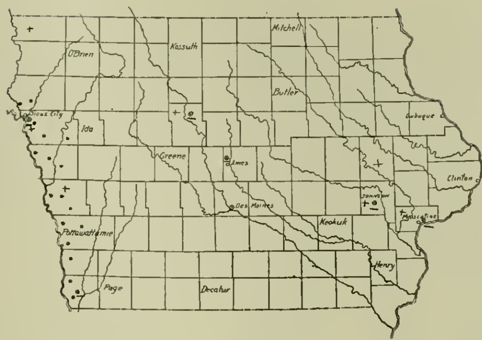


Fig. 103-A. Distribution of Rattle-box.

Distribution.—Common from New England to Minnesota, southwest to North Texas. In Iowa abundant only along Missouri river, the Des Moines near Ft. Dodge, and at other points along sandy beaches of our streams.

Extermination.—This weed occurs mostly in the Missouri bottoms, generally on more or less sandy soil. It succumbs readily to cultivation. The raw sandy prairies on which it occurs should be broken up and sown to some leguminous crop, like alfalfa, which will crowd the weed out.

The Yellow Clover (*Trifolium agrarium* L.).

Description.—A smoothish annual, usually upright, with obovate-oblong leaflets, all 3 from the same point (palmate) and nearly sessile; stipules narrow; corolla yellow, persistent.

Distribution.—Common in sandy fields and roadsides from eastern Canada west to Wisconsin and Minnesota and to Iowa; common along roadsides in northeastern Iowa.

Extermination.—Same as for low hop-clover.

Fig. 104. Yellow or Hop Clover (*Trifolium agrarium*). Along roadsides. Yellow flowers.
(Photographed by Colburn.)

Low Hop-clover (*Trifolium procumbens* L.).

Description.—A pubescent annual with spreading or ascending stems; leaves of 3 leaflets pinnate, the lateral at a small distance from the other, obovate, notched at the end; stipules ovate, short; flowers yellow, persistent, becoming dry in age.

Distribution.—Naturalized from Europe; common in eastern states.

Extermination.—Readily succumbs to cultivation. The seeds, however, may retain their vitality for some time in the soil. Sow clean seed in clean soil.

Fig. 105. Low Hop-clover, Yellow Clover (*Trifolium procumbens*). Clover fields, meadows, waste places.

(1. Drawn by Charlotte M. King, the general aspect photographed by Hart.)

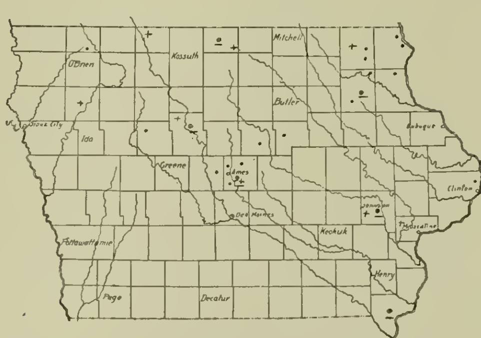


Fig. 105-A. Distribution of Low Hop-clover.

Yellow Sweet Clover (*Melilotus officinalis* (L.) Lam.).

Description.—An upright, usually tall, fragrant annual or biennial; leaves compound, leaflets obovate-oblong, obtuse, closely serrate; flowers yellow, pod smooth, prominently cross-ribbed. The *M. indica* also with yellow flowers has a gibbous and alveolate pod. This has recently been introduced.

Distribution.—Yellow sweet clover is also native to Europe. Widely scattered throughout the United States, more abundant upon the Pacific coast, in the Great Basin country and the Rocky mountains. Not abundant in the northern Mississippi valley. More or less frequent in many parts of Iowa, however, as in Humboldt and parts of Greene and Woodbury counties.

Fig. 106. Yellow Sweet Clover (*Melilotus officinalis*). Roadsides, streets and some fields.
(Photographed by Colburn.)

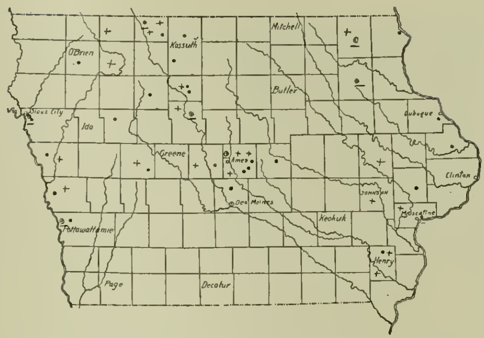


Fig. 106-A. Distribution of Yellow Sweet Clover.

Extermination.—The seeds preserve their vitality for some time. The weed is easily destroyed by cultivation.

Sweet Clover (*Melilotus alba* Lam.).

Description.—An erect annual or biennial 2-4 ft. high; rather distant, compound leaves, leaflets obovate, oblong, obtuse, serrate, narrowed at the base, truncate, emarginate or rounded at the apex; flowers with white petals, small, fragrant; pod ovoid, reticulated and smooth.

Distribution.—Sweet clover is native to Europe and abundant in all parts of the United States. It has been widely scattered by bee-keepers who sowed it as a honey-bee plant. Abundant now along highways, right of ways of railways; also in some fields; found in every part of Iowa.

Extermination.—The only way to exterminate this plant is to prevent seed formation. This may be done by cutting the plants underneath the ground. In fact the young plants are easily exterminated in this way. The plants occur in the meadows and pastures, coming largely from the weeds left growing along the roadsides. Road overseers should see that these chance plants are removed. According to a recent investigation of Prof. Ewart of Australia some of the seeds retain their vitality for a long time, sometimes more than half a century. It is imperative, therefore, to prevent the formation of seeds so as not to sow for a future generation to eradicate. Sweet clover is used as a forage plant and considered quite valuable. Mr. Coverdale of Maquoketa considers it a most valuable plant. Mr. Westgate has recently brought together many valuable points in its favor.

Fig. 107. White Sweet Clover (*Melilotus alba*). Common along roadsides. (Photographed by Colburn.)

The Farmer's Review says regarding the plant: "In Minnesota, Wisconsin, and Ohio there are laws against the plant known as sweet clover. We fail to see why this plant should be singled out and denominated as a weed. It certainly is not objectionable as a cover for waste places, and is easily controlled where its presence is not desired."

Chemical Composition.—The chemical composition according to the University of Wyoming is as follows.*

*Bull. No. 70 compiled by Henry G. Knight, Frank E. Hepner, chemists, and Aven Nelson, botanist; Wyoming Experiment Station.

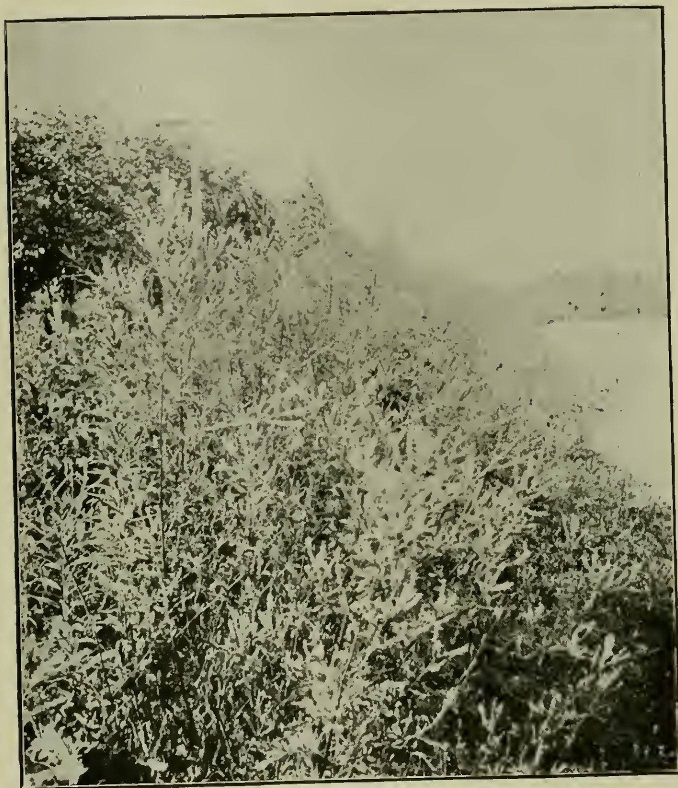


Fig. 108. White Sweet Clover (*Melilotus alba*). Along roadsides. (Photographed by Charlotte M. King.)

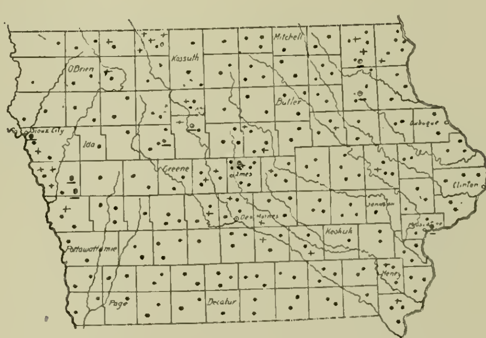


Fig. 108-A. Distribution of White Sweet Clover.

	Green	Air Dry	Water free
Water	79.35	6.02	-----
Ash	2.10	9.57	10.18
Ether extract	0.53	2.42	2.52
Crude fiber	4.78	21.77	23.16
Crude protein	3.96	18.00	19.15
Nitrogen free extract	9.28	42.22	44.99

Black Medic (*Medicago lupulina* L.).

Description.—A procumbent, pubescent, annual; compound leaves trifoliate; leaflets wedge-shaped, obovate, toothed at the apex; flowers yellow, in short spikes; pods kidney-form, 1-seeded.

Distribution.—Native from Europe, common in alfalfa fields in the Rocky mountains and on the Pacific coast; common in waste places in eastern North America; reported from a number of counties in Iowa, as Wright, Kossuth and Story.

Extermination.—This annual is not difficult to exterminate by giving thorough cultivation; care should be used in planting clover and alfalfa seed, because this weed seed is a common impurity of the latter. The seed also retains its vitality for some time.

*Chemical Composition.**

FRESH OR AIR DRY MATERIAL.

Water	Ash	Protein	Fiber	Nitrogen free extract	Fat
78.52	1.37	3.40	6.31	9.20	1.11

WATER FREE SUBSTANCE.

	6.4	15.8	29.3	43.4	5.1

*Compiled by Jenkins and Winton, Bull. Off. Exp. Sta., Bull. 11.

Fig. 109. Black Medic (*Medicago lupulina*). Clover and alfalfa meadows. (Photographed by Hart.)

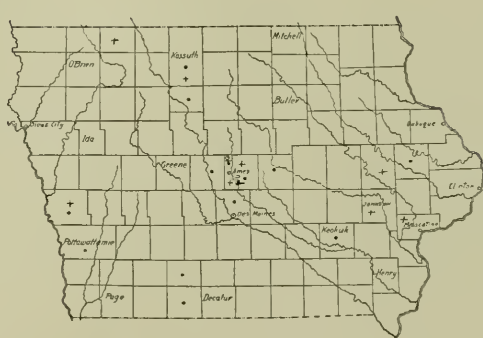


Fig. 109-A. Distribution of Black Medic.

Pink Parosela (*Dalea alopecuroides* Willd.).

Description.—An erect annual from 2-3 ft. high, with pinnately-compound leaflets; smooth flowers, whitish or light rose-color, in cylindrical spikes; calyx villous; seeds kidney-shaped.

Distribution.—From Minnesota to Alabama and the Rocky mountains, common in western Iowa and introduced eastward in Wright, Boone, and Story counties.

Extermination.—It is sometimes found in clover seed grown in western Iowa, also in alfalfa seed from the west, therefore care should be used in the selecting of seed; succumbs readily to cultivation.

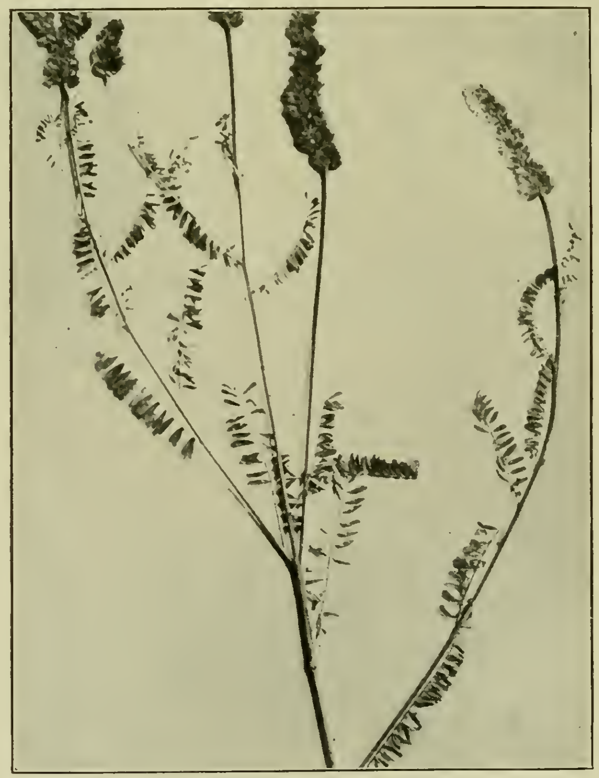


Fig. 110. Parosela (*Dalea alopecuroides*). Common in western Iowa and along railroads.
(Photographed by Quade.)

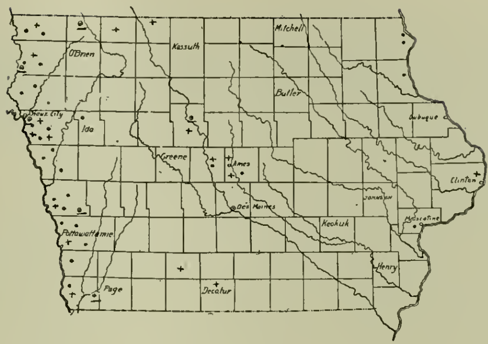


Fig. 110-A. Distribution of Parosela.

Rattle-box or Milk Vetch (*Astragalus canadensis* L.).

Description.—A tall, erect, smooth or pubescent perennial, 1-4 ft. high; leaves compound, leaflets 21-27, oblong; flowers greenish cream-colored in spike of variable length; pods crowded, smooth, terete, occasionally somewhat sulcate; the seeds separate from the pod, rattling, hence the common name.

Distribution.—Common in the northern Mississippi valley, east to New York and south to Georgia. Common on borders of thickets, woods and native meadows.

Extermination.—This weed is easily exterminated by cultivation.

Fig. 111. Rattle-box (*Astragalus canadensis*). Woodland pastures. (Photographed by Charlotte M. King.)

Purple or Stemless Loco Weed (*Oxytropis lamberti* Pursh.).

Description.—Nearly acaulescent, perennial herbs or shrubby plants, with tufts of very numerous short stems coming from a hard and thick root-stock containing many scaly stipules; stems and leaves covered with silky and finely appressed hairs, or smoothish; leaves pinnate; leaflets linear; flowers racemose or spicate, rather large and elongated, purple, violet, or sometimes white; stamens diadelphous; keel tipped with a sharp projecting point. This is one of the loco weeds, poisonous to cattle.

Distribution.—Western Minnesota, western Iowa, and Missouri to Texas, and New Mexico, north to British Columbia, and northwest territory.

Extermination.—It seldom gives much trouble in cultivated fields.

Fig 112. Purple Loco Weed (*Oxytropis lamberti*). A weed poisonous to cattle. (Drawn by F. C. Collins.)

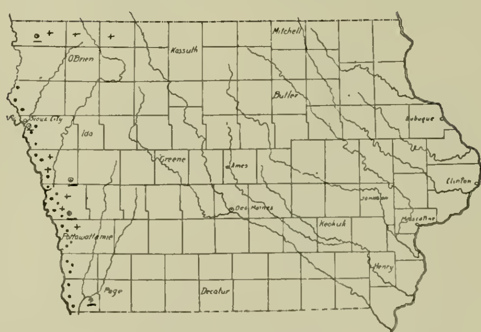


Fig. 112-A. Distribution of Purple Loco Weed.

Wild Liquorice (*Glycyrrhiza lepidota* (Nutt.) Pursh.).

Description.—A branching perennial 2-3 feet high, leaves compound of 15-19 oblong-lanceolate leaflets with mucronate points; young leaflets sprinkled with a resinous material; flowers in spikes; short peduncled; whitish; pods oblong, covered with hooked prickles, resembling a cocklebur.

Distribution.—Common in the west, western Iowa to Rocky mountains, Utah, New Mexico, and Montana to Canada, also re-

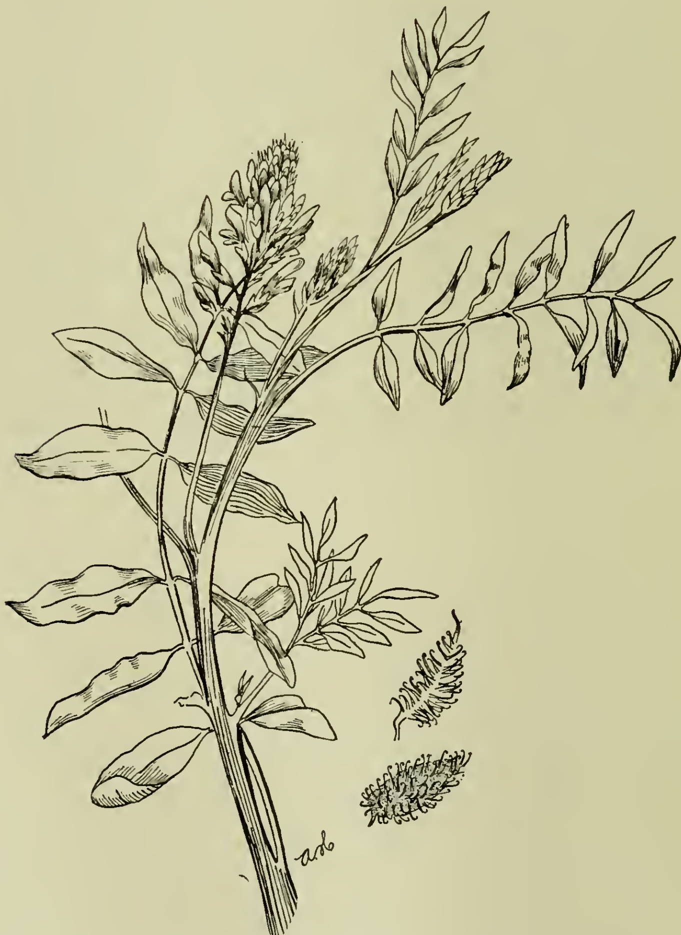


Fig. 113. Wild Liquorice (*Glycyrrhiza lepidota.*) Occurs in western and central parts of the state.

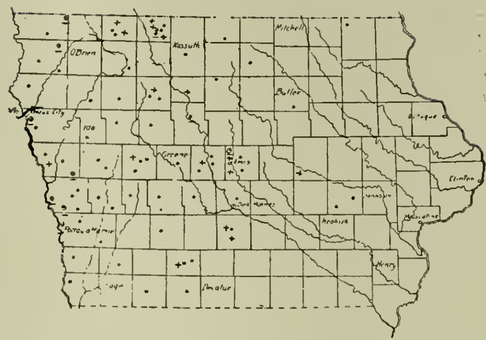


Fig. 113-A. Distribution of Wild Liquorice.

ported from the Great Lakes; commonly reported from Story, Greene, Pottawattamie, Harrison, Monona, Fremont, and Decatur counties.

Extermination.—This perennial plant whose burs resemble the cocklebur is easily exterminated by cultivation. Do not permit the seeds to mature. Cut off the plants at the surface of the ground to prevent flowering, if they occur in the pasture or meadow. Where the land can be cultivated, give the ordinary plowing, followed with harrowing to bring the roots to the surface so they are exposed to the sun. A few days' exposure to the sun will kill them.

Common Vetch (*Vicia sativa* L.).

Description.—A smooth or slightly pubescent annual from 1-2½ ft. high with simple stem; leaflets 5-7 pairs, obovate-oblong to linear, notched or mucronate at the tip; 1 or 2 nearly sessile flowers borne in the axils of the leaves, corolla violet-purple; pod linear, several-seeded, seeds black.

Distribution.—This weed has long been known as troublesome in the grain fields of Europe, and in the northern states. It is particularly abundant in northeastern and northwestern Iowa and in some of the grain growing sections of the southern part of the state.

Extermination.—Clean seed sown in clean soil is the only method of displacing the weed.

Fig. 114. Common Vetch (*Vicia sativa*). Common in grain fields, especially wheat fields, frequently found in screenings from flour mills. (Photographed by Colburn.)

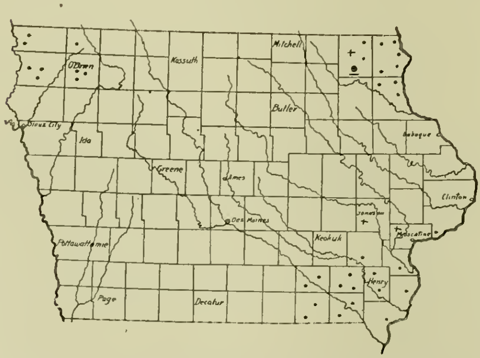


Fig. 114-A. Distribution of Common Vetch.

Chemical Composition.—The chemical composition of vetch (*Vicia sativa*) according to U. S. Dept. Agr., *1880;* p. 152, is as follows:

FRESH OR AIR DRY MATERIAL.

	Water	Ash	Protein	Fiber	Nitrogen free Extract	Fat
Cut 6-4; in full bloom	86.20	1.60	4.14	2.11	5.34	0.61

WATER FREE SUBSTANCE.

		11.6	3.00	15.3	38.7	4.4

Wild Bean (*Strophostyles helvola* (L.) Britton).

Description.—An annual, with prostrate stem; compound leaves ovate to oblong-obovate, with a prominent rounded lobe at the base; corolla greenish white and purplish; pod 4-8-seeded, large, usually pubescent.

Distribution.—Common in sandy places in northern United States; from Wisconsin, Minnesota, and Texas east to Massachusetts; common in gravel pits on Muscatine Island, along Des Moines, Cedar and Iowa rivers.

Extermination.—Easily exterminated by cultivation.

OXALIDACEAE, WOOD SORREL FAMILY.

This family contains the cultivated yellow and purple-flowered oxalis. Few of the plants are economic.

Fig. 115. Wild Bean (*Strophostyles helvola*). Common in sandy or gravelly soil, sandy river bottom.
(Photographed by Colburn.)

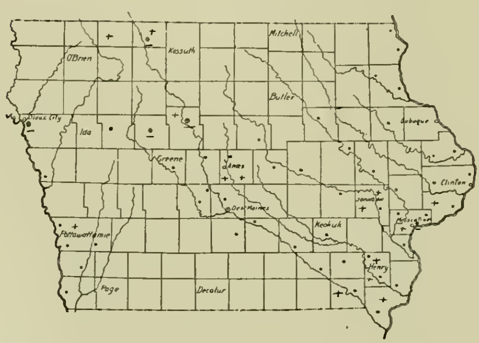


Fig. 115-A. Distribution of Wild Bean.

Field Sorrel (*Oxalis stricta* L.).

Description.—A pale green pubescent annual or perennial; leaves compound, with evident stipules; flowers pale yellow, cymose, 1-4, at length deflexed; in fruit columnar, short-pointed.

Distribution.—Common in fields and waste places from New England to Dakota; common in Iowa probably over the entire state.

Extermination.—Persistent cultivation and crop rotation will usually exterminate the weed.

Fig. 116. Yellow Field Sorrel (*Oxalis stricta*). Common in fields. *a*, Trichome or plant hair.

(*a* drawn by Charlotte M. King. The whole plant photographed by Hart.)

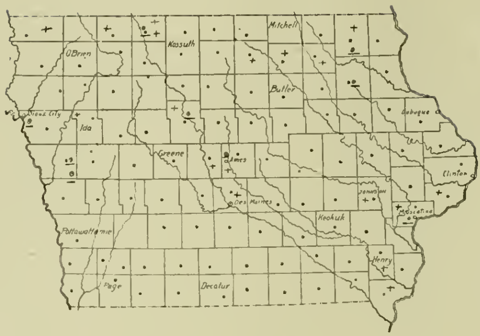


Fig. 116-A. Distribution of Yellow Field Sorrel.

Field Sorrel (*Oxalis corniculata* L.).

Description.—An erect or decumbent perennial herb, spreading by numerous slender, pale runners; leaflets 3; flowers in cymose clusters, yellow; peduncle ascending and sparingly pubescent.

Fig. 117. Field Sorrel (*Oxalis corniculata*). Fields, gardens, etc. (Photographed by Colburn. 1. Drawn by Charlotte M. King.)

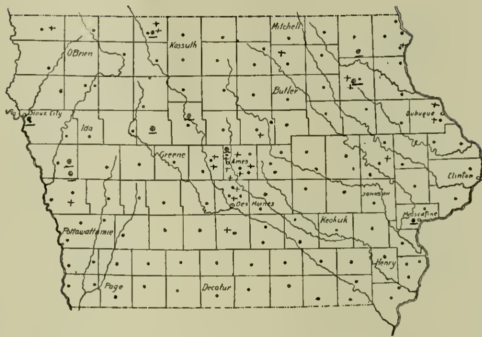


Fig. 117-A. Distribution of Field Sorrel.

Distribution.—A very common weed in dry or moist soil throughout eastern North America.

Extermination.—Apply the same method as to the preceding species.

ZYGOPHYLLACEAE, CALTROP FAMILY.

A small family.

Caltrop (*Tribulus terrestris* L.).

Description.—The caltrop is a hairy, procumbent annual, branching from the base, producing a stem which is a foot or more long, branches bear numerous small, compound leaves with short peduncles and small stipules at the base; each compound leaf has 4-8 pairs of short-stalked leaves; small, yellow, axillary flowers about ½ in. across with peduncle much shorter than leaves; fruit very spiny and divided into two nearly equal parts, each part consists of 2 long spines, 2 shorter and a row of very short ones, forming a crest on the back; 5-angled, spiny fruit splits into 3-5 divisions.

Distribution.—Introduced from the Old World and occurs from the Atlantic states to Nebraska and Kansas; in Iowa has been found only on Muscatine Island.

Extermination.—Caltrop is disseminated by wool, and hence the waste of woolen mills should not be thrown in fields. The weed is easily destroyed by cultivation.

Fig. 118. Caltrop, Ground Bur-nut (*Tribulus terrestris*). Sandy soil, waste places, Muscatine Island.
(Drawing by Charlotte M. King.)

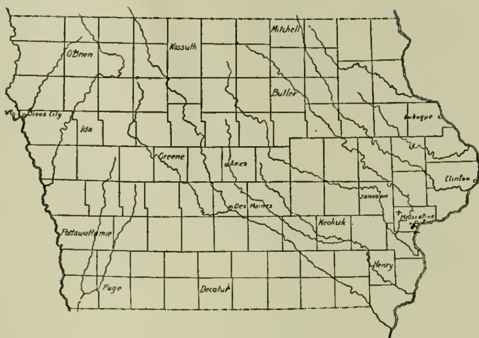


Fig. 118-A. Distribution of Caltrop.

EUPHORBIACEAE, SPURGE FAMILY.

Many of the plants of this family contain an irritating milky juice. Few are of economic importance. The poinsettia commonly cultivated in greenhouses, snow-on-the-mountain in gardens, and castor-oil bean belong to this family.

Three-seeded Mercury (*Acalypha virginica* L.).

Description.—A smoothish or hairy annual from 1-2 ft. high, turning purple especially in the autumn; leaves ovate or oblong-ovate, sparingly serrate, long-petioled; sterile spike, few-flowered, pistillate flowers 1-3 at the base of staminate peduncle surrounded by a large leaf-like bract; capsule 3-lobed, subglobular, 2-valved carpels.

Distribution.—From Nova Scotia to Texas and northward to Minnesota. Common everywhere in Iowa along roadsides and in fields. Especially noticeable in the fall on account of the purple bracts.

Extermination.—Three-seeded Mercury is not a difficult weed to exterminate. The small, reddish, striate seeds are expelled from the plant to some little distance in a manner similar to the dispersal of the castor-oil bean. Thorough cultivation by preventing the formation of seed will eradicate the weed.

Fig. 119. Three-seeded Mercury (*Acalypha virginica*). Common in many parts of the state.
(Drawing by Charlotte M. King.)

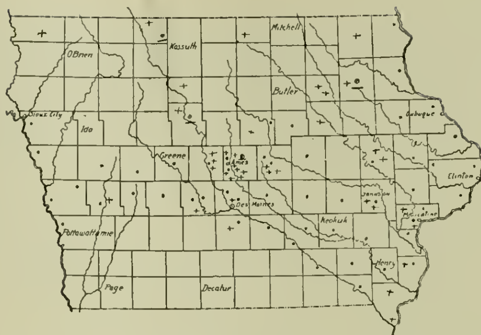


Fig. 119-A. Distribution of Three-seeded Mercury.

Spurge (*Euphorbia preslii* Guss.).

Description.—An annual from 1-1½ ft. high; erect or ascending; leaves oblique at the base, ovate, oblong, or sometimes oblong-linear,

Fig. 120. Spotted Spurge (*Euphorbia preslii*). Common everywhere in the state.
(Drawing by Charlotte M. King.)

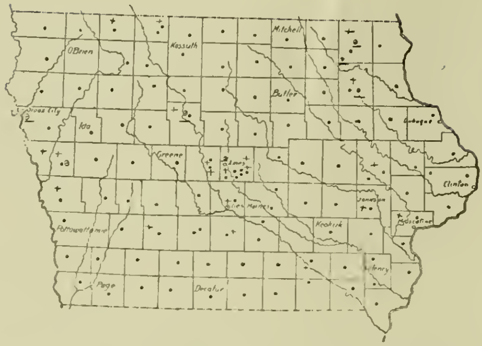


Fig. 120-A. Distribution of Spotted Spurge.

frequently falcate, serrate, generally with a conspicuous red spot, or margin; flowers pedunculate in terminal cymes; appendages entire; pod glabrous; seeds ovate sometimes wrinkled.

Distribution.—In loose soils and fields from New England and Canada to Wisconsin, Minnesota and Nebraska, also southward.

Extermination.—This annual weed is easily exterminated by cultivation; therefore practice rotation of crops and give thorough cultivation. Seeds of several species of this genus retain their vitality for some length of time.

Milkweed or Creeping Spurge (*Euphorbia maculata* L.).

Description.—Slightly pubescent or hairy annual, with prostrate stems; leaves oblong-linear, oblique at the base; pubescent or sometimes nearly smooth, usually with a brown-red spot in the center; serrulate above, stipules lanceolate; flowers pedunculate in lateral clusters; glands of the involucre minute; appendages usually red; pods acute-angled; seed sharply 4-angled with 4 shallow grooves across the sides; trichomes several-celled, gradually tapering to apex.

Distribution.—Found in sandy fields, or generally in fields from New England and Canada westward; common in every part of Iowa.

Extermination.—May be exterminated in the same way as the preceding species.

Fig. 121. Milkweed or Prostrate Spurge (*Euphorbia maculata*). Sandy fields. (Photographed by Quade. *a*, drawn by Charlotte M. King.)

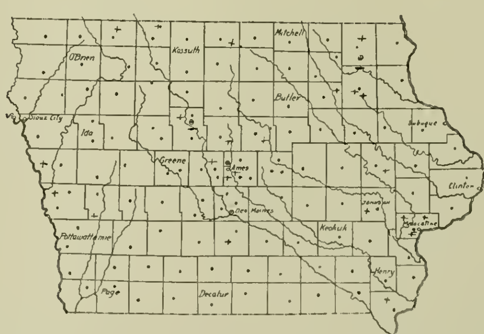


Fig. 121-A. Distribution of Prostrate Spurge.

Snow-on-the-mountain (*Euphorbia marginata* Pursh.).

Description.—Stems stout, high, erect, hairy or smoothish; annual, from 2-3 ft. high; leaves sessile ovate-oblong, acute; uppermost leaves white, petal-like margins.

The flowering spurge (*Euphorbia corollata* L.) with white flowers in forked umbels; long peduncles; involucres showy, white appendages appearing like petals; deep perennial root; is common in gravelly and sandy soils in many parts of the state, and it is often weedy.

Distribution.—Snow-on-the-mountain occurs from Minnesota to Missouri and Colorado; also reported eastward to Ohio and South Carolina. A frequent escape from gardens in Iowa; common only in the western part.

Fig. 122. Snow-on-the-Mountain (*Euphorbia marginata*). A frequent escape from gardens. *a*, Whole plant, one-third natural size; *b*, seed capsule, natural size.

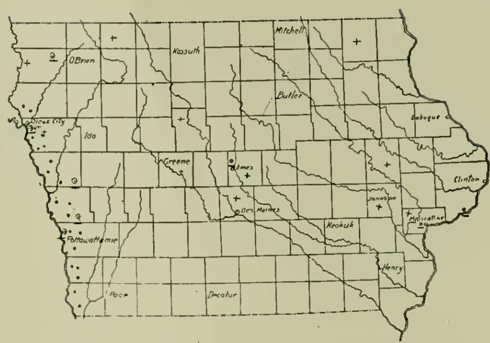


Fig. 122-A. Distribution of Snow-on-the-Mountain.

Fig. 123. Flowering Spurge (*Euphorbia corollata*). Common in sandy fields, gravel knolls, and roadsides.
(Drawing by Lois Pammel.)

Extermination.—This annual weed is easily exterminated by cultivation. The young plant should be cut off below the surface of the ground.

Cypress Spurge (*Euphorbia cyparissias* L.).

Description.—Plant with perennial running root-stocks and densely clustered stems from 6 in.-1 ft. high; linear, crowded leaves; many-rayed umbel with glands crescent-shaped and granular pods.

Distribution.—Common westward from New England to Nebraska usually in the vicinity of gardens and cemeteries.

Extermination.—This perennial weed because of its running root-stocks is often difficult to exterminate. The ground should be given a shallow plowing and the root-stocks exposed to the sun. It may be necessary to repeat this process two or three times during the summer. In addition to its propagation by the running root-stocks it also propagates by its seeds.

Fig. 124. Cypress Spurge (*Euphorbia cyparissias*). Yellow "flowered" plant with milky juice and narrow leaves. Escaped from gardens to roadsides. (Photographed by Colburn.)

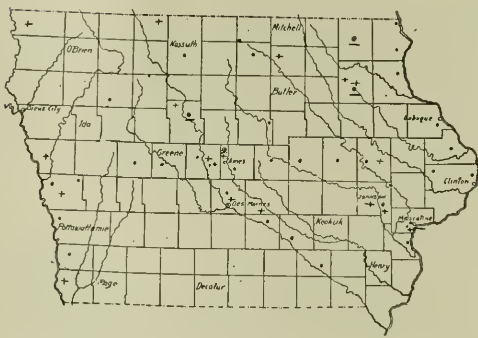


Fig. 124-A. Distribution of Cypress Spurge.

ANACARDIACEAE, SUMACH FAMILY.

Many of the plants are poisonous. Many, like sumach, contain tannin. Some, as the smoke tree, are cultivated for ornamental purposes.

Poison Ivy (*Rhus toxicodendron* L.).

Description.—A climbing or trailing shrub sometimes erect, clinging to trees or other objects by aerial rootlets; 3 leaflets; inconspicuous flowers; waxy fruit, frequently remaining on plant until late winter or early spring. It is often mistaken for Virginia creeper (*Psedera quinquefolia* (L.) Greene) which, however, has 5 leaflets. Many persons are sensitive to poisoning from this plant, every part of which contains the poisonous principle. The usual remedy for infection from it is to wash the skin with a solution of sugar of lead.

Distribution.—Poison ivy is abundant throughout eastern North America and the Rocky mountains. It is common everywhere in Iowa, in hedge rows, thickets or woods.

Extermination.—Poison ivy is not easily destroyed because in most cases it is troublesome in wood lots along fences and in yards. It is difficult to destroy except by giving thorough cultivation. If persistently cut off below the surface of the ground it can be destroyed. Sodium arsenite at the rate of one and one-half to two pounds to 52 gallons of water will help to destroy the weed. It is not, however, safe to use this since it is a strong poison.

MALVACEAE, MALLOW FAMILY.

Cotton, hollyhock and okra are well known plants of the family.

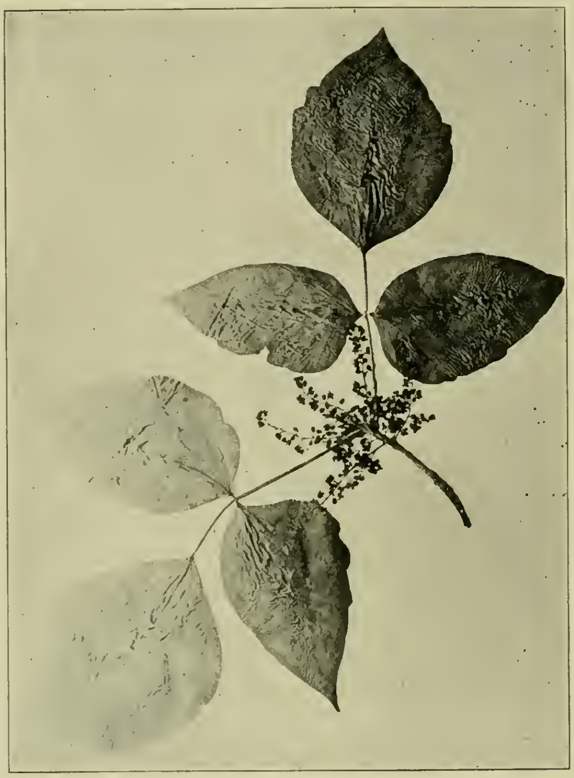


Fig. 125. Poison Ivy (*Rhus toxicodendron*). Common in woods and along fences.
(Photographed by Colburn.)

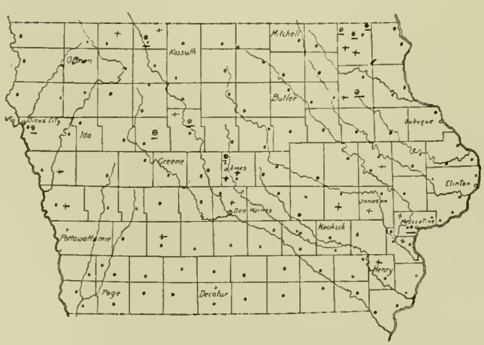


Fig. 125-A. Distribution of Poison Ivy.

Fig. 125-B. Poison Ivy (*Rhus toxicodendron*). *a*, spray showing rootlets; *b*, fruit.
(After Chesnut, U. S. Dept. Agr.)

Indian Mallow or Velvet-leaf, Butter-print (*Abutilon theophrasti* Medic.).

Description.—A usually tall annual from 2-4 ft. high; plant with strong odor; leaves velvety, roundish heart-shaped, taper-pointed; peduncles shorter than the petioles; corolla yellowish; carpels 12-15, hairy-beaked seeds rough, rather large and blackish.

Distribution.—Common in waste places, corn fields, vacant lots, barnyards, etc. Common throughout eastern North America, naturalized from tropical regions, probably India.

Extermination.—This plant propagates only by its seed, which retains its vitality for some length of time, having been known to germinate after a period of 60 years. The young plants are easily exterminated. The plant should be pulled up before it begins to

Fig. 126. Indian Mallow, Velvet Leaf, or Butter-print (*Abutilon theophrasti*).
Common in corn fields, waste places, barnyards.
(Photographed by Colburn.)

flower. Wallace's Farmer suggests the following treatment: "It has been seriously thought of by some persons as a substitute for manilla or sisal in the manufacture of binder twine. It is an annual, and if not allowed to go to seed, the farm can in time be cleared of it. But it will be a long time. The seeds have a most astonishing vitality. We have known cases where it has been pulled up for fifteen years, not a plant allowed to go to seed, and yet it makes its appearance every spring. Fortunately, it grows only on rich land, and is therefore found in evidence largely in hog yards and feed lots and other places where the land is exceedingly rich. In fact, in sections of the country where it is being introduced, it may be found in almost every farmyard. Why farmers allow it to mature seed passes our comprehension. It goes variously by the

Fig. 126-C. Pigweed, Foxtail, and Velvet Leaf, in a potato patch. Too many such garden patches in Iowa.
(Photographed by Pammel.)

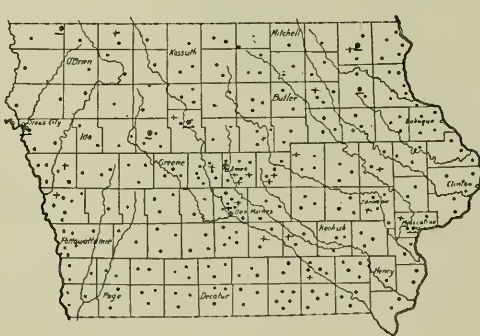


Fig. 126-B. Distribution of Indian Mallow.

names of velvet weed, butter print and in the locality of one of our farms, Davis weed, from the fact that it was introduced many years ago by a man named Davis, who regarded it as a rather good ornamental plant."

Sida (*Sida spinosa* L.).

Description.—An annual from 10-20 in. high; frequently much-branched; leaves ovate-lanceolate; serrate with a long petiole, peduncles in axils of leaves, 1-flowered; flowers small, yellow; 5 carpels, each 2-beaked.

Distribution.—Common in the southern states, as far north as Massachusetts to southern Iowa and Kansas.

Extermination.—This weed propagates entirely by its seeds which retain their vitality for a considerable length of time, as the seed coat is hard. The growing plant is, however, easily destroyed by pulling the weed or by cultivation.

Fig. 127. Sida (*Sida spinosa*). Common in fields in southern Iowa. (Photographed by Hart.)

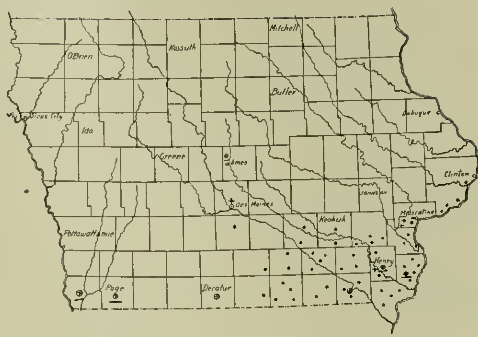


Fig. 127-A. Distribution of Sida.

Cheeses or Common Mallow (*Malva rotundifolia* L.).

Description.—A procumbent biennial; leaves round, heart-shaped on long petioles, crenate; flowers white, petals longer than the calyx; a 3-leaved involucre at the base of the calyx; carpels pubescent.

Distribution.—A widely distributed weed in eastern North America, native to Europe, common in eastern and central Iowa in dooryards, barn lots, etc., in Story, Marshall, Polk, Marion, Linn, Clinton, Winneshiek and Allamakee counties.

Extermination.—This weed is easily exterminated by cultivation. Do not permit any of the seeds to mature. The seeds retain their vitality for a considerable length of time.

Fig. 127-B. Common Mallow or Cheeses (*Malva rotundifolia*). Common in dooryards, barn lots, etc.
(Mich. Agr. Exp. Sta.)

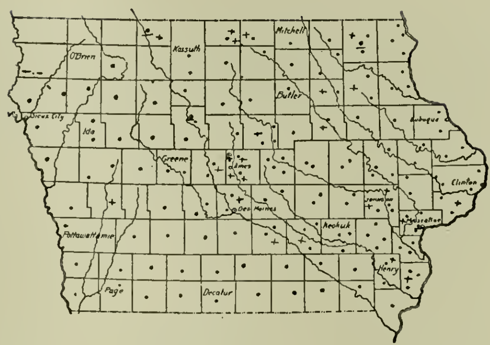


Fig. 127-C. Distribution of Common Mallow.

Shoo-fly (*Hibiscus trionum* L.).

Description.—A low, rather hairy annual from 1-2 ft. high; upper leaves 3-parted with 3 lanceolate divisions, the middle longest; calyx inflated in fruit, membranous, 5-winged, with numerous dark nerves; flowers sulphur-yellow with a blackish eye, ephemeral.

Distribution.—Common in fields and waste grounds in the southern states and eastward; abundant in some places in Iowa, especially in gardens where it has become naturalized from cultivation.

Extermination.—A growing plant is not difficult to exterminate. A thorough cultivation and exposing the roots to the sun will destroy the plant. The seeds, however, retain their vitality for a considerable length of time. A correspondent of southeastern Iowa stated that this weed kept coming up in spite of constant and thorough cultivation. This was owing to the prolonged vitality of the seed.

HYPERICACEAE, ST. JOHN'S-WORT FAMILY.

This small family contains a few ornamental plants with yellow flowers, commonly found in northern states.

Fig. 127-D. Bladder Ketmia or Shoo-fly (*Hibiscus trionum*). Gardens and corn fields. Large white flower with a dark spot at the base of each petal. *a* and *b* trichomes or plant hairs.
(*a* and *b* drawn by Charlotte M. King. The general aspect photographed by Colburn.)

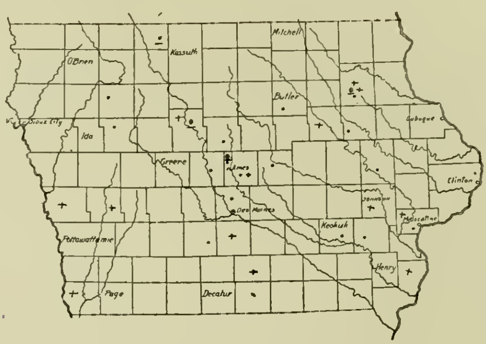


Fig. 127-E. Distribution of Shoo-fly.

St. John's-wort (*Hypericum perforatum* L.).

Description.—A branched perennial, $1\frac{1}{2}$-2 ft. high with runners; leaves elliptical, or linear-oblong, with pellucid dots; flowers numerous in cymes, petals deep yellow, black-dotted, twice the length of the lanceolate sepals.

Distribution.—Common in eastern North America in clay soils. Abundant in Iowa only in eastern counties, especially northeastward.

Extermination—This weed spreads both by seeds and by runners. It is difficult to exterminate. Clark and Fletcher give the following methods: "Close cutting several times during the summer will reduce it in pastures. An application of salt—a small handful to

Fig. 128. St. John's-wort (*Hypericum perforatum*). Old fields and woodland pastures, eastern and northeastern Iowa.
(Photographed by Quade.)

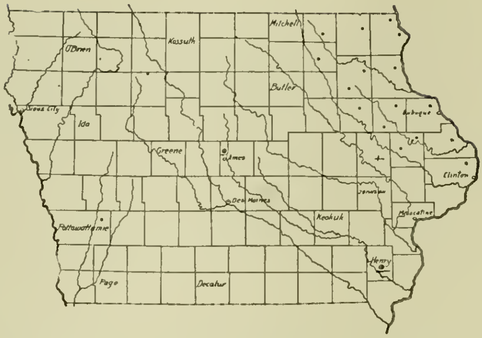


Fig. 128-A. Distribution of St. John's-wort.

each plant after close cutting in hot dry weather—will kill it and may be practicable where the pest is not abundant and the land cannot be brought under cultivation. Prevent it from going to seed. St. John's-wort is easily suppressed on land that can be cultivated under a systematic rotation of crops. Where it is established, it would be well not to seed to grass until it is suppressed."

ONAGRACEAE. EVENING PRIMROSE FAMILY.

A small family, some plants with showy flowers, a few cultivated for ornamental purposes.

Evening Primrose (*Oenothera biennis* L.).

Description.—A stout, erect, pubescent or hirsute perennial, 3-5 feet high, sparingly branched; leaves lanceolate, or rarely ovate-lanceolate, denticulate, acute, bracts shorter or as long as the capsule; flowers yellow, petals obovate, stigma lobes linear, capsule subcylindrical; seeds small, brownish.

Distribution.—Common everywhere in eastern North America, Rocky mountains and Utah. Occurs in every county in Iowa.

Extermination.—Spreads by seed. This plant is not difficult to exterminate. Cut off the young plants a few inches below the surface of the ground.

UMBELLIFERAE, CARROT FAMILY.

Carrot, celery, parsnips and caraway are members of this family. It includes also many poisonous plants.

Fig. 129. Evening Primrose (*Oenothera biennis*). Fences, gardens, meadows and pastures.
(Photographed by Hart. *a*, drawn by Charlotte M. King.)

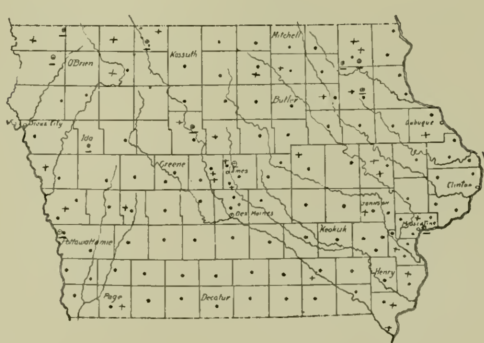


Fig. 129-A. Distribution of Evening Primrose.

Caraway (*Carum carvi* L.).

Description.—A smooth, erect, slender herb 1-2½ feet high with fusiform roots; leaves pinnate with filiform divisions; flowers in umbels, white; calyx teeth small; fruit ovate, or oblong with filiform ribs.

Distribution.—Common in eastern North America, the Rocky mountains, Utah and scattered in places in Iowa.

Extermination.—Easily exterminated; cut off the plants below the surface of the ground.

Fig. 130. Caraway (*Carum carvi*). Commonly escaped from gardens. Flowers white.
(Photographed by Quade.)

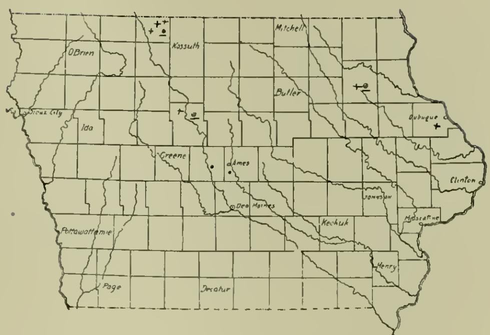


Fig. 130-A. Distribution of Caraway.

Wild Carrot (*Daucus carota* L.).

Description.—A bristly, hirsute biennial from 2-2½ feet high; leaves pinnately decompound; involucral bracts foliaceous; flow-

Fig. 131. Wild Carrot (*Daucus carota*). Common in clover meadows. Flowers in white umbels.
(Photographed by Colburn.)

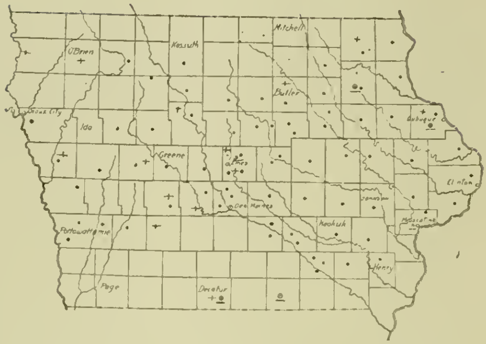


Fig. 131-A. Distribution of Wild Carrot.

ers in compound umbels, white, or occasionally pink; fruit oblong, flattened dorsally, carpel with 5 slender bristly primary ribs, and 4 winged secondary ones, each of these bearing a single row of barbed prickles.

Distribution.—Common in eastern North America, especially in dry fields. Becoming common in Iowa clover fields in Scott, Story, Polk, Franklin, Linn, Clinton, Cerro Gordo, Boone, Webster, Sac and Clay counties.

Extermination.—Plant clean seed in a clean field. Easily killed by cutting off the plant a few inches below the surface of the ground.

Parsnip (*Pastinaca sativa* L.).

Description.—A tall, stout, glabrous biennial with grooved stem; leaves pinnately compound, cut-toothed; flowers yellow, small; calyx teeth obsolete; fruit oval, flattened dorsally, the lateral ribs with broad wings.

Distribution.—Common in eastern North America, Rocky mountains and the Pacific coast. Common on roadsides in every part of Iowa.

Extermination.—Propagated by seeds. Easily exterminated by cultivation; cut off the young plants a few inches below the surface of the ground.

Fig. 132. Wild Parsnip (*Pastinaca sativa*). Common along roads. (Mich. Agr. Exp. Sta.)

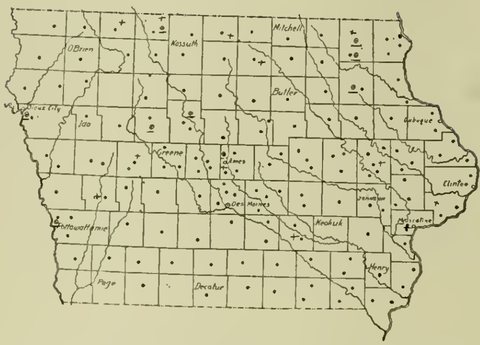


Fig. 132-A. Distribution of Wild Parsnip.

Cowbane (*Cicuta maculata* L.).

Description.—A smooth, marsh perennial, 2-5 ft. high, with pinnately compound leaves, 2 or 3 times pinnate; leaves with long petioles; coarsely serrate leaflets lanceolate to oblong-lanceolate, 1-5 in. long; stalks of umbellets numerous and unequal; flowers white; fruit broadly ovate to oval, small, 1½ in. long. The plant grows in marshes and in low grounds, the stems springing from thick fleshy underground roots tapering at the lower end, usually numbering from 3-8 although single specimens are also met with. On cutting the roots there is given off a sharp pungent odor, which becomes intensified on boiling.

Distribution.—Common throughout the northern states, southwest to Louisiana, Rocky mountains and Utah. Very common in low grounds and swales in northern Iowa, less common in southern Iowa.

Extermination.—The field where cowbane occurs needs drainage; plow the field, break up the sod, and expose the fascicled roots to the sun. This will soon destroy the weed.

Fig. 133. Cowbane (*Cicuta maculata*). In low moist meadows and roadsides. (Photographed by Colburn.)

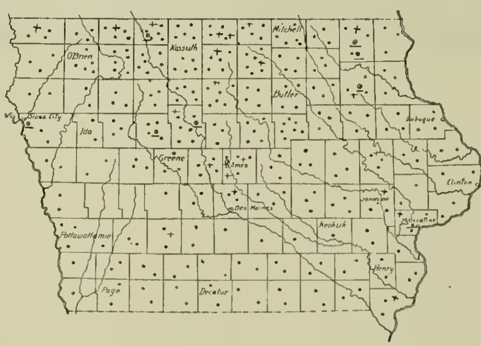


Fig. 133-A. Distribution of Cowbane.

Fig. 133-B. Cowbane (*Cicuta maculata*). In low woods. (Photographed by Caughey.)

Fig. 133-C. Cowbane roots (*Cicuta maculata*). In low places. (Photographed by Gardner.)

Cow Parsnip (*Heracleum lanatum* Michx.).

Description.—A stout, hairy, pubescent perennial 4-8 ft. high; leaflets broad and large, irregularly cut-toothed; flowers white, in broad umbels.

Fig. 134. Cow Parsnip (*Heracleum lanatum*). Common in woodland pastures. (Photographed by Charlotte M. King.)

Distribution.—From the Atlantic coast, Newfoundland, through the northern states and Allegheny mountains to California. Common in the Rocky mountains.

APOCYNACEAE, DOGBANE FAMILY.

In the tropics several species are important rubber producing plants. They are commonly called milk-weeds in Iowa.

Spreading Dogbane (*Apocynum androsaemifolium* L.).

Description.—Root-stock horizontal, smooth, or rarely soft-tomentose, branched above, spreading, leaves ovate, petioled, cymes loose, spreading, both terminal and axillary; the latter pale rose color, open, bell-shaped; calyx segments shorter than the tubes of the corolla.

Distribution.—Common along borders of thickets from eastern Canada to British Columbia to Arizona and Georgia. Abundant in Iowa in grain fields near thickets.

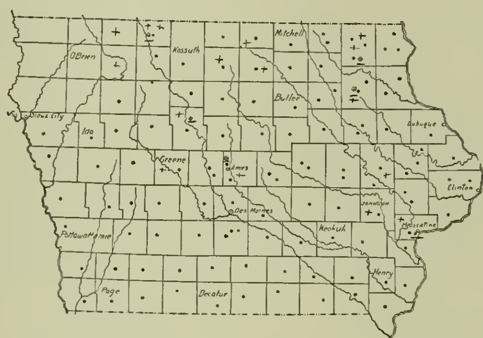


Fig. 135. Distribution of Spreading Dogbane (*Apocynum androsaemifolium*).

Extermination.—Spreading dogbane produces long, creeping roots, which are quite tenacious of life. In order to destroy the weed, the field should be given a shallow plowing after the grain is harvested, followed by a disking in a week or ten days, depending on the character of the weather. This should be followed by a harrow. If the fall is dry dragging will probably get the larger number of these weeds.

Indian Hemp (*Apocynum cannabinum* L.).

Description.—Glabrous or more or less softly pubescent; 2-3 ft. high, smooth, terminated by an erect, close, many-flowered cyme; corolla lobes nearly erect, the tube not longer than the lanceolate segments of the calyx, greenish white; appears in July and August.

Distribution.—Common species eastward and troublesome as a weed in northern Mississippi valley. Common in small-grain fields and pastures.

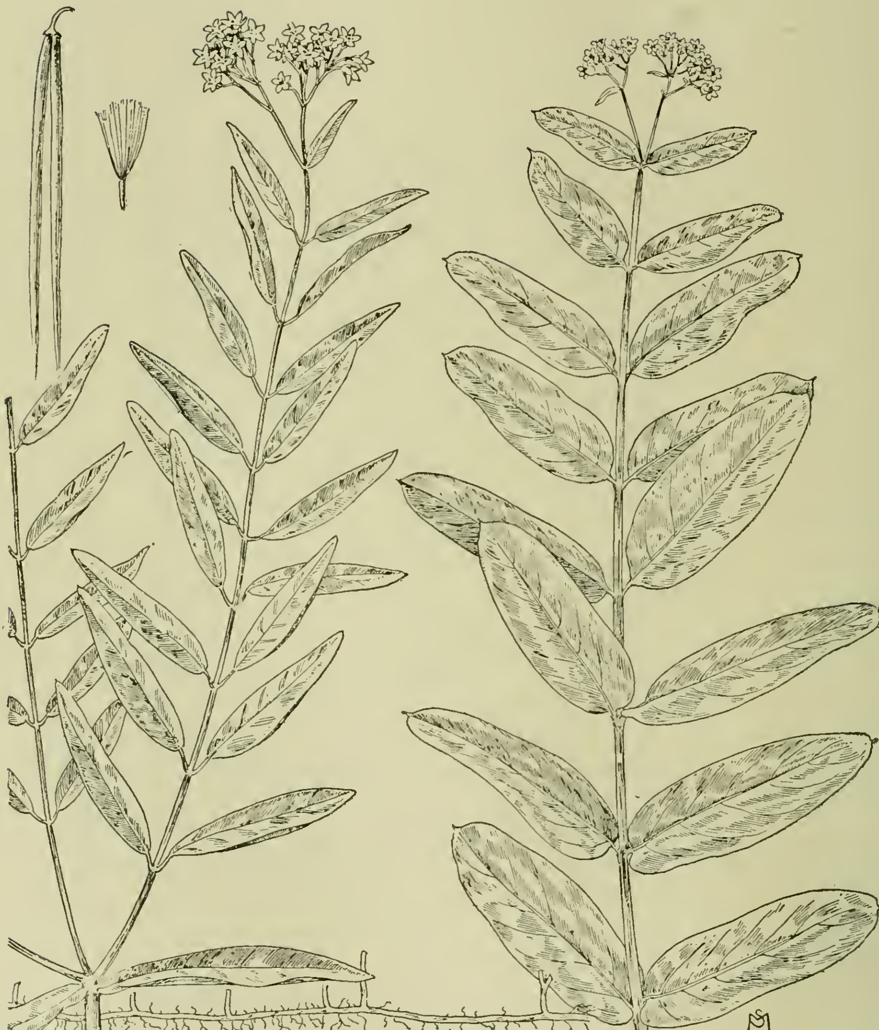
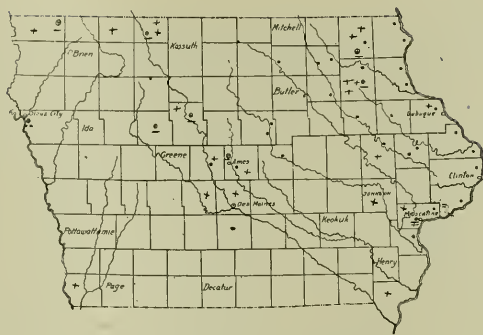


Figure 136 Figure 136A

Fig. 136. Indian Hemp (*Apocynum cannabinum*).

Fig. 136-A. *Apocynum cannabinum hypericifolium.* A low growing variety of the above, but with leaves broader at base and more abruptly pointed at apex.

(Schuyler Mathews in Mich. Agr. Exp. Sta. Bull.)



136-B. Distribution of Indian Hemp.

Extermination.—This weed should be treated like spreading dogbane.

ASCLEPIADACEAE, MILKWEED FAMILY.

A few plants, only, are of economic importance. Some are cultivated for ornamental purposes. In Iowa they are commonly called milkweeds.

Showy Milkweed (*Asclepias speciosa* Torr.).

Description.—A perennial 1-4 ft. high, white-tomentose or canescent; leaves thick, broadly ovate or oval, petioled; pedicel glabrate above; flowers borne in dense umbels or rarely solitary, the pedicels stout; corolla purplish green, large, follicle erect or spreading on the recurved pedicels.

Distribution.—Showy milkweed is common from Minnesota to southern Iowa, Kansas, the Rocky mountains and Utah. In Iowa it is abundant in Emmet, Palo Alto and Dickinson counties.

Extermination.—This weed should be treated like common milkweed.

Fig. 137. Showy Milkweed (*Asclepias speciosa*). In grain fields, meadows and roadsides, northern Iowa.
(Photographed by Colburn.)

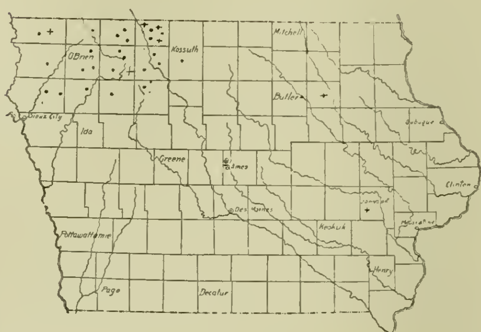


Fig. 137-A. Distribution of Showy Milkweed.

Milkweed (*Asclepias syriaca* L.).

Description.—A perennial herb with a stout stalk 2-5 ft. high, finely, softly pubescent or tomentose; leaves oblong, oval or ovate, obtuse or roundish at the base, the young leaf somewhat pubescent above, soon becoming glabrate; petioles stout, flowers from a few to many, borne in umbels; peduncles pubescent or tomentose; corolla dull purple or greenish purple, occasionally pale in color; fruit a follicle and borne on erect pedicels; trichomes multicellular from a single cell, somewhat floccose.

Distribution.—This milkweed is common from New England to North Carolina and Kansas. In Iowa it is abundant in oat fields, on highways and in gardens throughout the state.

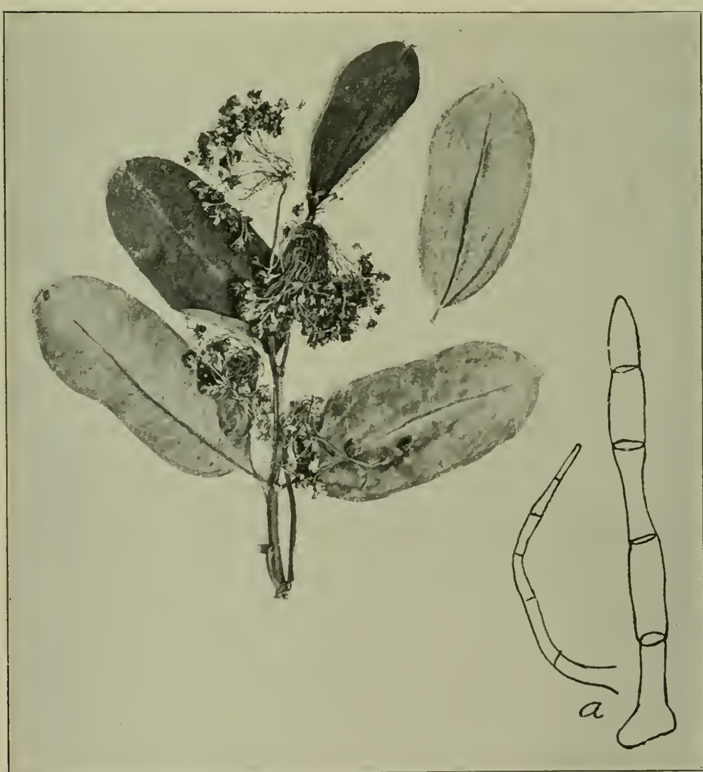


Fig. 138. Common Milkweed (*Asclepias syriaca*). Fields, meadows, roadsides, etc. *a* trichomes or plant hairs.
(Drawing by Charlotte M. King; general aspect photographed by Colburn.)

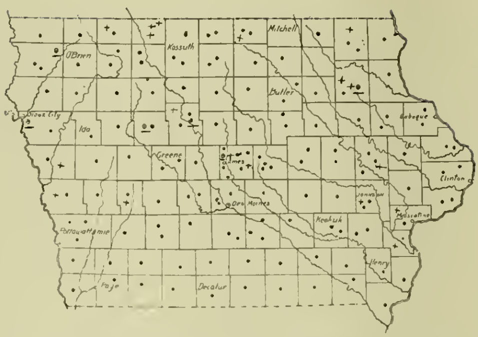


Fig. 138-A. Distribution of Common Milkweed.

Extermination.—Both milkweeds have the same habit of growth. The weed is perhaps known by its long roots which are frequently 10-15 ft. in length; another important point is that it produces adventitious buds at frequent intervals from which new shoots arise.

Fig. 138-B. Common Milkweed (*Asclepias syriaca*). Grain fields, waste places. (Photographed by Charlotte M. King.)

Wallace's Farmer says concerning this weed: "We would advise our correspondent to plow this field as soon as possible and prepare his seed bed for winter wheat. By plowing it again next August he will undoubtedly weaken the stand. He will fail, however, unless in working his corn he uses surface cultivation. These weeds have no doubt been distributed through the field during the three years it was in corn by using a shovel cultivator, which takes up the roots and carries them over the field in the same way that many northern farmers are now seeding their fields with quack grass and damaging them to the extent of from five to twenty dollars per acre. By giving these two thorough August plowings and taking care of the roots that may be thrown up, then preparing the seed bed very thoroughly for corn and giving it as far as practical surface cultivation, he will probably get rid of these noxious weeds."

Climbing Milkweed (*Gonolobus laevis* Michx.).

Description.—A climbing perennial; leaves oblong, cordate with a deep, narrow sinus; flowers borne in axillary umbel-like cymes, 5-10 flowered, large greenish flowers; calyx 5-parted; corolla 5-parted, wheel-shaped, the lobes narrowly linear-lanceolate, obtuse, larger than the calyx; anthers horizontal under the flattened stigmas; pollen masses 5 pairs, follicles with soft warty projections.

Distribution.—Troublesome in woods and fields in the southern states. It is reported as troublesome from a few counties in southern Iowa.

Extermination.—This perennial weed is as difficult to destroy as common milkweed. Give thorough cultivation. If this will not suffice get the field into a meadow.

CONVOLVULACEAE, MORNING-GLORY FAMILY.

Few economic plants. Sweet potato and cultivated morning glory are representatives.

Fig. 139. Climbing Milkweed (*Gonolobus laevis*). Troublesome in fields in southern Iowa.
(Drawing by Ada Hayden.)

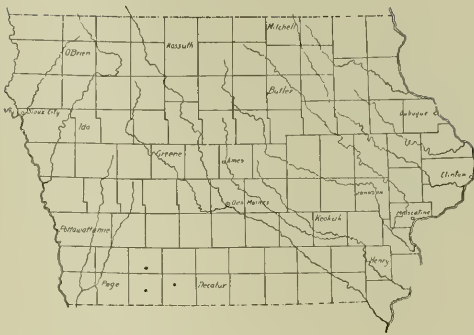


Fig. 139-A. Distribution of Climbing Milkweed.

Morning-glory (*Ipomoea hederacea* Jacq.).

Description.— Stems retrorsely hairy; leaves heart-shaped, 3-lobed, the lobes usually acute; peduncle variable in length; 1-3

Fig. 140. Blue Field Morning-glory (*Ipomoea hederacea*). Fields, common southern Iowa and Missouri.
(Photographed by Colburn.)

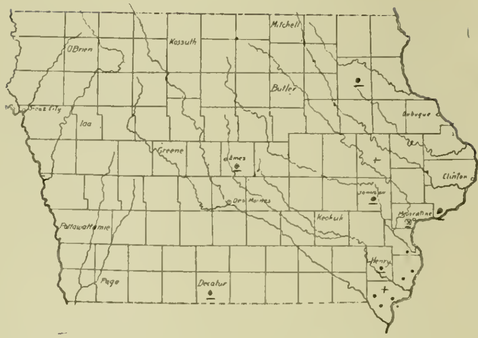


Fig. 140-A. Distribution of Morning-glory.

flowers; calyx densely hairy below; corolla funnel-form, white and purple or pale blue; lobes of stigma and cells 3.

Fig. 141. Annual Morning-glory (*Ipomoea purpurea*). A frequent escape from gardens into fields.
(Photographed by Colburn.)

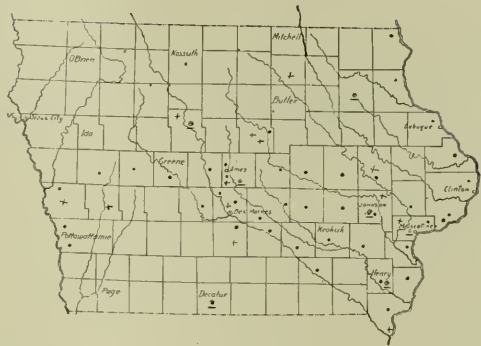


Fig. 141-A. Distribution of Annual Morning-glory.

The *I. purpurea* has heart-shaped leaves with retrorsely hairy stem; peduncles long, umbellately 3-5 flowered, purple to white.

Distribution.—Common in waste and cultivated grounds from New England southwestward; abundant from Missouri southward; native from tropical America; rare in Iowa. The *I. purpurea* is commonly cultivated and is a frequent escape from cultivation in Hardin, Story, Marshall, Wapello and Marion counties.

Extermination.—It is an annual and is easily destroyed; however, the seeds retain their vitality for some time, frequently springing up for several seasons after the most thorough cultivation.

Hedge Bindweed or Morning-glory (*Convolvulus sepium* L.).

Description.—Smooth, occasionally, however, pubescent, twining around supports or trailing; leaves triangular, halberd or arrow shaped, the tip acute, or pointed, the basal lobes obliquely truncate or sinuate lobed; flowering peduncles 4-angled with 2 leaf-like bracts which are commonly acute; corolla white or tinged with rose purple.

Distribution.—Hedge bindweed or morning-glory is common in the northern states and in the southwest from Texas to Canada, also in the Great Basin country. A form of it is also found in Europe and Asia. Common in every section of Iowa not only in corn fields, but along highways and in small-grain fields.

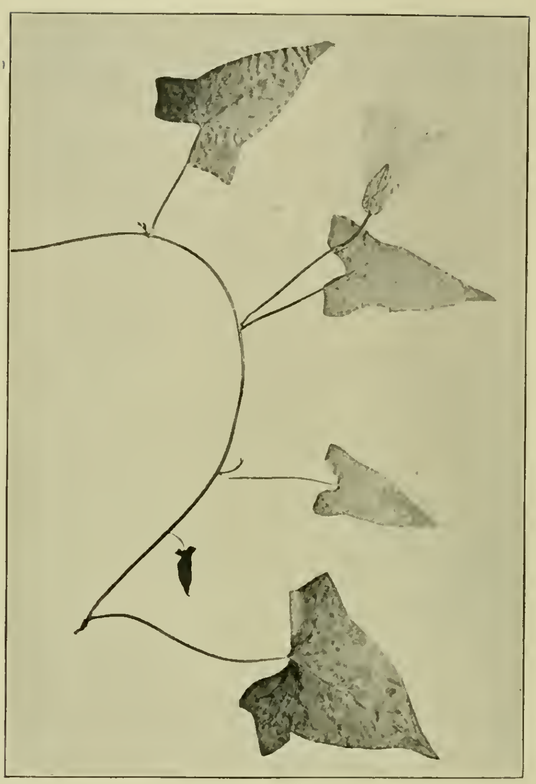


Fig. 142. Morning-glory (*Convolvulus sepium*). Common in grain, corn **fields** and meadows.
(Photographed by Colburn.)

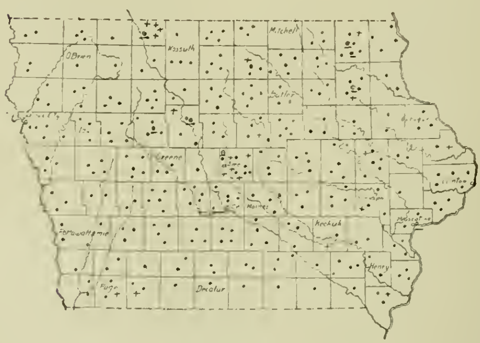


Fig. 142-A. Distribution of Hedge Bindweed or Morning-glory.

Extermination.—The morning-glory must be treated like horse nettle since it is a perennial. In addition to the usual methods of cultivation sheep have been recommended to destroy the weed. This method is certainly applicable where the weed occurs in pastures.

In Wallace's Farmer, Mr. L. C. Greene's experience in killing morning-glory is given as follows: "A large farmer had 145 acres of corn. One piece of twenty acres, fall plowed, on a south slope, was planted to corn the first of May, and by the time the plowing and planting were all done it was near the last of May. The early planted field was thick with morning-glories and had received no cultivation since they commenced to grow. By the time the corn was four inches high the morning-glories were eight or more inches tall, growing in mats on the ground hunting for something to climb upon. The proprietor viewed the field, and instead of sending out the cultivator sent out three stirring plows and the planter soon followed. In two days the field was plowed and planted again and a fine crop of corn was raised with very little bother from the vines, and even the following year the vines bothered but little.

"Some years ago I fall plowed a small field that was badly infected with morning-glory vines and smartweeds. The 24th of the next May I was ready for that field, but from a little distance it looked as if a mowing machine and a rake would be the proper tools to use. I plowed rather deep to do a good job, the planter immediately followed, and in four days after the planter some corn could be seen, and it was eight inches high when the cultivator got to it. It was just a matter of stirring the soil all season, for there were no large weeds to kill."

The Prairie Farmer makes these suggestions concerning the eradication of morning-glory: "Another way to fight the morning-glory is to grow two or three pasture crops a year on the land for sheep. One of them ought to be a cultivated crop. The morning-glory would not be able to hold out long against such treatment. The strong point in favor of this method is the profitable character of the work."

Wallace's Farmer says concerning its destruction: "They do not spread rapidly except under cultivation, as they grow mostly from the roots, and these are distributed over the fields by cultivators. If when the farmer first discovers a patch out of cultivation for a year or two he plows it shallow and frequently and harrows he can get rid of them. If he cultivates the plants with the rest of his field it is only a short time until he will find these weeds scattered all over his field. A great many ways have been suggested to get rid of this troublesome weed. Special attachments have been invented for the use on corn cultivators known as the morning-glory blades. These are designed to shave off the plants just below the surface of the ground.''

''We certainly would fence up this pasture, or part of it, and would sow a mixture of grains that would furnish hog feed, and while we were at it would sow clover and timothy, and when the grains were three or four inches high turn in the hogs. The only trouble is that there are not enough hogs to go around the whole tract. We had a field in that condition twenty years ago. We made a hog pasture of it, and while the morning-glories are yet to be seen in the road alongside, there are none of them in the pasture, and have not been since the first year.''

European Bindweed or Morning-glory (*Convolvulus arvensis* L.)

Description.—The European bindweed or morning-glory is a deep-rooting perennial; stem procumbent, twining or creeping. Like the horse nettle, this species propagates freely by underground root-stocks; leaves 1-2 in. long, ovate, oblong, arrow-shaped, lobes at the base running to a point; flowers borne in 1-flowered peduncles with very small leaf-like bracts some distance from the flowers; flowers an inch or less long, short, broadly funnel-shaped, white or commonly of a rose tinge.

Distribution.—European bindweed is a troublesome weed in Europe and in eastern North America. It occurs also in the southern states and on the Pacific coast. It is scattered in many parts of Iowa in small patches.

Extermination.—A short rotation of crops should be practiced, including late sown roots or other cultivated crops: rape is useful for this purpose. Frequent use of a broad-shared cultivator will destroy new growths and exhaust the vitality of the plants. Sow no crop seeds containing those of field bindweed. Applications of salt or lime, sometimes recommended to kill this weed, are useless unless applied in large quantities.

Fig. 143. European Morning-glory or Bindweed (*Convolvulus arvensis*). Common in gardens and becoming frequent in Iowa.
(Photographed by Colburn.)

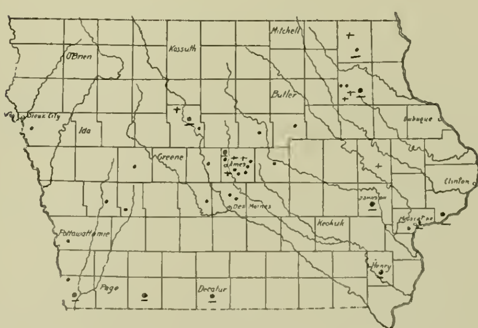


Fig. 143-A. Distribution of European Morning-glory.

Prof. H. A. Hitchcock in Farmer's Review, says: "The black bind-weed or perennial morning-glory (*Convolvulus arvensis*), which I suppose is the kind meant, is a great pest and difficult to eradicate. If a patch is not too large, heavy mulching is the best way to destroy it. Then watch the patch closely and cut off immediately any stray shoot that may appear above its surface. Nothing but persistent watching and the careful cutting off of all parts above the ground will eradicate this weed."

Prof. Ten Eyck, quoted in Wallaces' Farmer, states that the only method of culture applicable to large areas which promises any great degree of control or destruction of the pest is very late fall or winter plowing. The plots which were plowed in November (no plowing was done later than November 20th) showed a very scattering and feeble growth of bindweed on April 26th, the date of inspection.

The weeds were thinner and more feeble also on the unplowed land which produced a crop of sowed cane or sowed kaffir last season, than they were on any of the lots cultivated in intertilled crops.

Clover Dodder (*Cuscuta epithymum* Murr.).

Description.—A spreading, climbing plant; yellowish or reddish with a few minute scales in place of leaves; flowers whitish or pinkish in heads, small, globular, urn-shaped; cylindrical tube longer than the nearly erect, acute sepals; scales large-toothed; stigma elongated; style longer than the ovary; stamens exserted, fruit in capsules.

Distribution.—This weed has long been known as troublesome in Europe and has been more or less common in the Rocky mountains on clover and alfalfa. For some years also frequent in the east; becoming more abundant on clover and alfalfa.

Extermination.—Where the plant occurs cut down the clover at once and burn. Sow the patch or field to another crop, preferably to small grain or with corn.

Clark and Fletcher recommend the following treatment: "As soon as the pest is noticed, the infected patches should be at once mown with a scythe and the refuse removed and destroyed. Fields

Fig. 144. Clover Dodder (*Cuscuta epithymum*). A yellow twining plant on clover and alfalfa.
(Photographed by Colburn.)

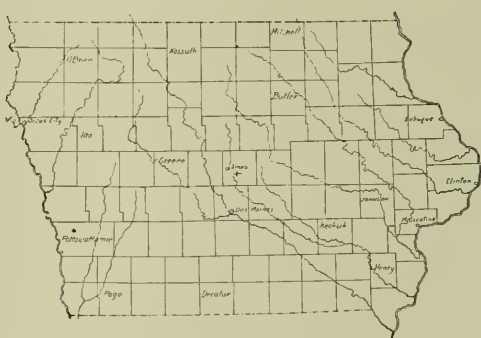


Fig. 144-A. Distribution of Clover Dodder.

badly contaminated should be plowed before the seed has formed, or the crop cut early for hay and the land then plowed. Clover seed should never be taken from fields infested with this pest."

The Wisconsin Farmer states: "The problem of dodder control is strongly influenced by the character of the crop infested. Red clover remains but two, or at most but three, years without reseeding. If the dodder is prevented from seeding it should be eradicated within this time, or at least not interfere with the course of crop rotation. Alfalfa should remain indefinitely, and if dodder reseeds itself its control becomes much more difficult or impossible. This is the prevailing condition in the west. The fact that the small-seeded alfalfa dodder of the west has not become established in the east is of special interest in this connection. Clover dodder appears likely to prove the most troublesome in alfalfa culture in the east.

"If the dodder occurs only in patches in the field it usually can be controlled by hand methods. If it covers the greater part or all of the field, plowing under the stand will probably be found necessary. It then becomes important to know how far the crop can be utilized without reseeding the land to dodder."

Field Dodder (*Cuscuta arvensis* Beyrich.).

Description.—Stems pale and slender, filiform; flowers rather small, in sessile clusters; calyx with 5 obtuse broad lobes; corolla with a short, wide tube, inflexed points, 5-lobed, acute or acuminate, about ½ as long as the tube, tips reflexed; scales large and deeply fringed; stigmas capitate; capsules globose, indehiscent. Occurs on shrubs, clover and other herbs.

Distribution.—Massachusetts to Wisconsin and westward. Introduced with clover and alfalfa seed in Iowa.

Extermination.—The dodders are largely spread through commercial seeds, like flax, clover and alfalfa. Alfalfa dodder is a somewhat troublesome weed in sections of the United States and Europe where alfalfa is grown; in this way it has made its way into the Mississippi valley in recent years. There has been much complaint about the appearance of clover and field dodder in the same region, largely spread, of course, through commercial seeds. The dodder may be exterminated in the following way:

First by the herbicidal treatment. For this purpose a liberal application of a 10 per cent solution of copper sulphate will be found efficacious.

In addition, the European investigators recommend a strong solution of salt, sulphide of lime, carbolic acid, and sulphate of iron. These solutions will destroy the dodder when found in the vegetative condition, but should seed occur, then it will be necessary to take the additional precaution of cutting the dodder after the application of the herbicide and burning it. It should be remembered that these solutions will not be effective unless they come in direct contact with the plant. They will injure the clover plant as well.

Figure 145 Figure 145A Figure 145B

Fig. 145. Field Dodder (*Cuscuta arvensis*).
Fig. 145-A. Flax Dodder (*Cuscuta epilinum*).
Fig. 145-B. Lesser Clover Dodder, Thyme Dodder (*Cuscuta epithymum*).

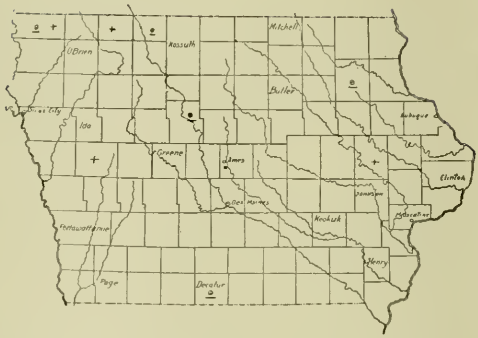


Fig. 145-C. Distribution of Field Dodder.

It is advisable to mow the patch if it is a small one, to rake the material into a pile, and after allowing it to dry to burn it. The field should be watched carefully, for if the seed is formed, young dodder plants will make their appearance upon the new growth of clover. It is best therefore to follow the mowing by hoeing if the spot is a small one and continuing this for several weeks until all danger of infection is passed. Dewey recommends keeping the soil stirred for about two inches and not allowing any young plants to come in contact with the clover.

Wallace's Farmer suggests the following treatment: "Where our readers find this yellow vine twining around their clover or alfalfa they must act promptly and effectively. If when they discover dodder they will cut it off close to the ground before it seeds no damage will follow, as dodder is an annual. It will not do, however, to trust to the scythe or mower, for the least particle of dodder which remains attached to the stubble will grow much more certainly than any corn or wheat will grow. Where a whole field is infested perhaps the safest way is to mow it before the dodder goes to seeding, use it for hay, and then plow it up for a crop the next year. Or, if we would rather lose a crop of hay than lose the stand, mow it, let it dry, and burn it, so as to destroy the dodder in the stubble."

HYDROPHYLLACEAE. WATERLEAF FAMILY.

The common waterleaf belongs to this family. Representatives of the family are more numerous in the west and south than in the east and north.

Common Ellisia (*Ellisia nyctelea* L.).

Description.—Minutely or sparingly roughish hairy; stems forked, 6-14 in. high; leaves pinnately parted into 7-13 sparingly cut-toothed divisions; peduncles 1-flowered, opposite the leaves; flowers with calyx lobes lanceolate; pointed corolla white.

Fig. 146. Ellisia (*Ellisia nyctelea*). Common in early spring fields. (Photographed by Colburn.)

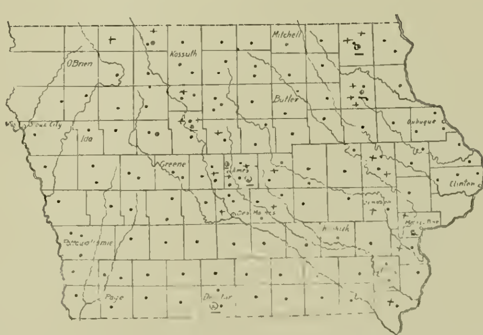


Fig. 146-A. Distribution of Ellisia.

Distribution.—Common in shady and damp places everywhere in Iowa and a weed in cultivated fields. It is distributed from New Jersey to Kansas, and in the northwest territory.

Extermination.—This is a spring weed of waste, shady places. Sow thickly with some leguminous crop, like clover, or get blue grass started. The weed is easily destroyed by cultivation.

BORAGINACEAE, BORAGE FAMILY.

Comfrey, bugloss, alkanct, blueweed and borage belong to this family. Many of the plants are scattered by animals because of the burs.

Hound's Tongue (*Cynoglossum officinale* L.).

Description.—A coarse biennial herb, clothed with short, soft hairs; lower leaves oblong or oblong-lanceolate, the upper closely sessile with a slightly heart-shaped base; racemes nearly bractless, elongated in fruit; divisions of the calyx ovate, lanceolate, acute; corolla reddish purple, rarely white; nutlets flat on the broad upper face, splitting away at maturity.

Distribution.—In fields and waste places, especially westward from New England to Quebec, Ontario, Minnesota, Manitoba and Kansas.

Extermination.—This weed should be cut a few inches below the surface of the ground. It is easily killed. The "seeds" are, however, widely scattered by animals; stray plants should be looked for.

Fig. 147. Hound's Tongue (*Cynoglossum officinale*). In pastures. The burs are scattered by sheep.
(Photographed by Colburn.)

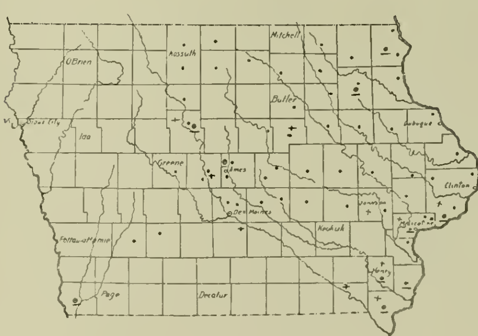


Fig. 147-A. Distribution of Hound's Tongue.

7

Wild Comfrey (*Cynoglossum virginianum* L.).

Description.—Perennial hirsute herb with simple stem 2-3 ft. high, leafless above; stem leaves lanceolate-oblong, clasping by a heart-shaped base; flowers on long peduncles, pale blue, small; fruit broad, nutlets not margined, convex on the upper surface.

Distribution.—Common in woods of the central Mississippi valley, New Brunswick to Ontario, Florida, Louisiana to Texas. Common in eastern to central Iowa near woods.

Extermination.—Sometimes persistent in newly made fields in the northern states. Cultivation for a few seasons will remove the weed.

Fig. 148. Wild Comfrey (*Cynoglossum virginianum*). Woodland pastures. (Photographed by Colburn.)

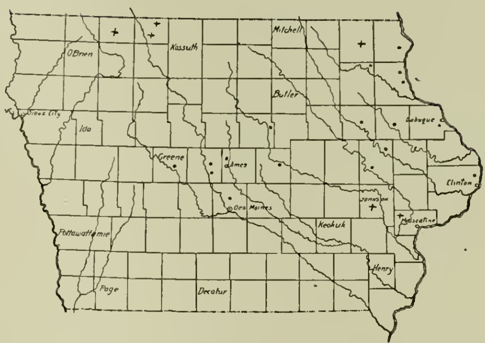


Fig. 148-A. Distribution of Wild Comfrey.

Beggar's Lice (*Lappula virginiana* L.).

Description.—A coarse, pubescent biennial 2-4 ft. high; lower leaves ovate, orbicular, cordate, long-petioled; stem leaves ovate-

Fig. 149. Beggar's Lice (*Lappula virginiana*). Common in woodland pastures. (Photographed by Colburn.)

oblong or oval; flowers nearly white; globose nutlets which are flattened and barbed on the back.

Distribution.—Common especially in woods northward, from New Brunswick to Wisconsin and Minnesota, also from Kansas to Louisiana. Common on borders of woods and in wooded pastures in Iowa.

Extermination.—Cut the plant the first season a few inches below the surface of the ground. When the plants shoot up the second season give the same treatment. The plants are disseminated by animals. Stray plants along fences should be looked for and destroyed.

Stickseed (*Lappula echinata* Gilibert).

Description.—An erect annual 1-2 ft. high; pale, leafy, hispid with erect branches; leaves linear or linear-oblong; racemes 1-sided; bracteolate; calyx segments lanceolate; corolla blue; nutlets rough-granulate or tuberculate on the back, the margins with a double row of slender prickles.

Distribution.—Abundant in waste places along roadsides from eastern Canada and New England to Minnesota, Kansas and British Columbia. Weedy in Europe, where it is native. Common along roadsides and gravelly places in eastern Iowa.

Extermination.—Destroy the plant before the seeds form, by cutting off below the surface of the ground.

Fig. 150. Stickseed, Bur Seed (*Lappula echinata*). Along roadsides. (From Mich. Agr. Coll. Exp. Sta. Bull.)

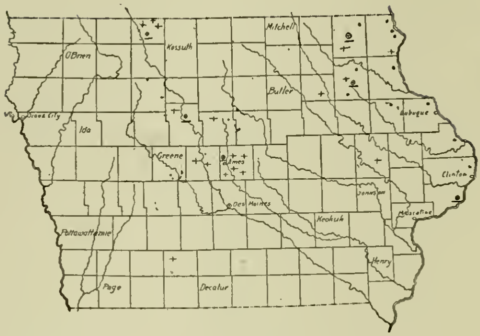


Fig. 150-A. Distribution of Stickseed.

Corn Gromwell (*Lithospermum arvense* L.).

Description.—A pubescent annual with stems 6-12 in. high, with bright green, lanceolate, linear, or oblong, sessile leaves;

Fig. 151. Corn Gromwell or Puccoon (*Lithospermum arvense*). A common roadside and field weed of Europe. Southern Iowa and Missouri. Small white flowers.

(Photographed by Colburn.)

flowers sessile or nearly so, white; calyx segments longer than the corolla tube; corolla funnel-form; nutlets smooth.

Distribution.—Common weed in fields in the east; may be looked for in southeastern Iowa. One of the most common weeds in grain fields in Europe.

Extermination.—The plants are easily destroyed. The seeds probably retain their vitality for some time as the coat is hard.

VERBENACEAE, VERBENA FAMILY.

The common cultivated verbena and lemon verbena belong to this family.

Blue Vervain (*Verbena hastata* L.).

Description.—A tall perennial 4-6 ft. high; leaves lanceolate, coming to a point, cut-serrate, lower leaves often lobed; flowers in erect, linear, corymbed spikes, violet-blue or rarely pink; trichomes simple, long, acuminate.

Fig. 152. Vervain (*Verbena hastata*). Common in low pastures and meadows. *a* Trichome.
(Photographed by Quade. *a* drawn by Charlotte M. King.)

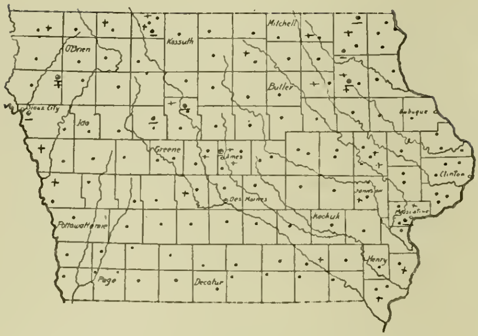


Fig. 152-A. Distribution of Vervain.

Distribution.—In damp situations in every county in the state of Iowa; also to the Atlantic coast and westward and southward.

Extermination.—This weed, though abundant in low grounds, seldom gives trouble where the field is drained and thorough cultivation is given. Spreads chiefly by the seed.

Hoary Vervain (*Verbena stricta* Vent.).

Description.—A soft, pubescent, perennial 1-3 ft. high; leaves downy, ovate or oblong, serrate and sessile; large blue flowers borne in a dense sessile spike, 6 in.-1 ft. long; trichomes several-celled, thick-walled, pitted.

The white vervain (*V. urticaefolia*) grows much taller than *V. stricta* and has very small white flowers on elongated spikes. It is a weed of thickets and waste grounds.

Distribution.—In dry soil, prairies of Ohio to South Daktoa and Wyoming, New Mexico and Texas. Commonly naturalized eastward. A common weed in every part of Iowa; frequent in pastures.

Extermination.—Easily destroyed by cultivation; rarely found in cultivated fields for that reason.

Fig. 153. Hoary Vervain (*Verbena stricta*). Common in pastures. Plant with blue flowers. Plant hair, trichome, to the right.
(General aspect photographed by Colburn. *a*, drawn by Charlotte M. King.)

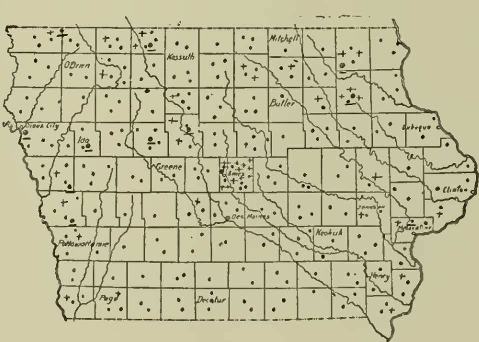


Fig. 153-A. Distribution of Hoary Vervain.

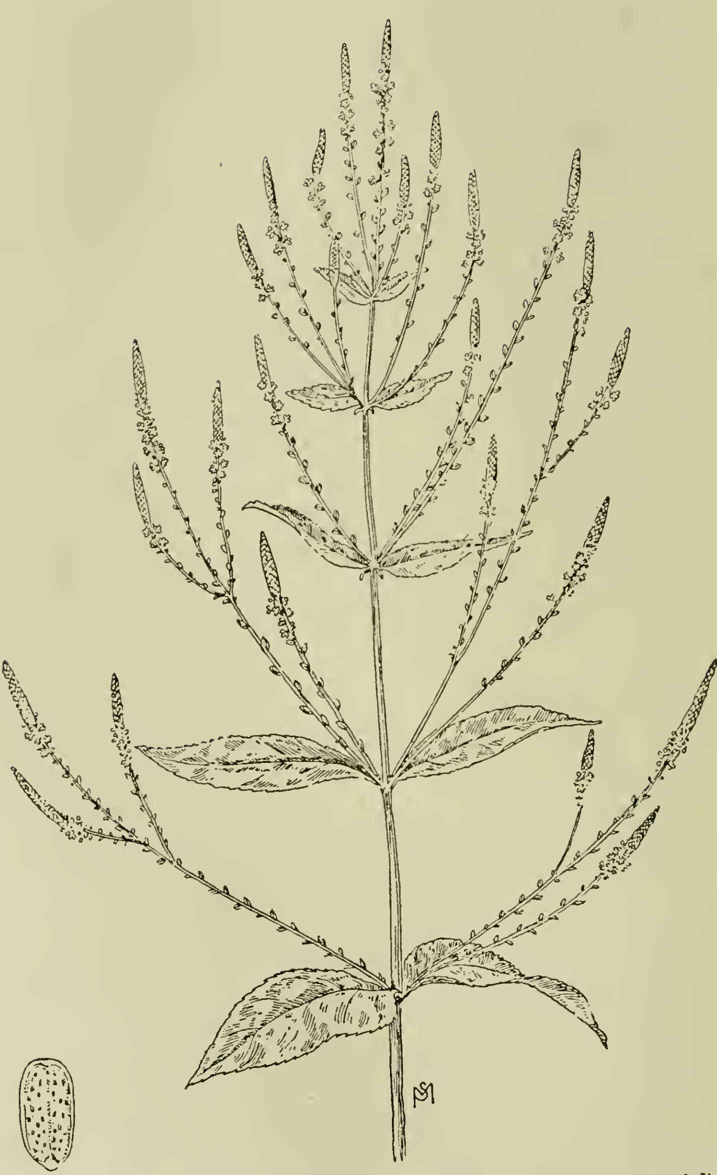


Fig. 153-B. White Vervain, Nettle-leaved Vervain (*Verbena urticaefolia*). (Mich. Agr. Exp. Sta.)

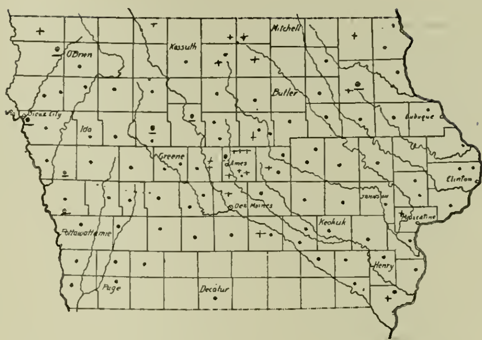


Fig. 153-C. Distribution of White Vervain.

Common Vervain (*Verbena bracteosa* Michx.).

Description.—A widely spreading, hairy annual; leaves wedge-lanceolate, cut-pinnatifid or sometimes 3-cleft; flowers in spikes,

Fig. 154. Prostrate Vervain (*Verbena bracteosa*). *a*, Plant hair or trichome. Common along roadsides, streets, and gravelly places; small, blue flowers. (General aspect photographed by Quade. *a* drawn by Charlotte M. King.)

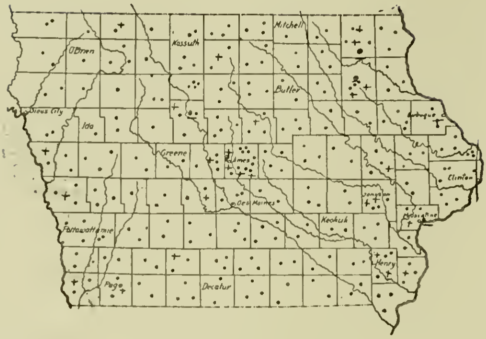


Fig. 154-A. Distribution of Prostrate Vervain.

with large bracts, small, purple; trichomes few-celled from a broad several-celled base.

Distribution.—Common in waste places, roadsides, walks, gravelly and sandy fields from Virginia to Wisconsin and Minnesota and southward.

Extermination.—It is easily exterminated by cultivation.

LABIATAE, MINT FAMILY.

The common pepperment, scarlet sage, catnip, pennyroyal, thyme and basil belong to this family. All are aromatic plants.

Mint (*Mentha arvensis* L.).

Description.—This perennial weed has freely branching stems 1-1½ ft. high, retrorsely pubescent, leaves oblong to ovate, rounded at the base, minutely pubescent, closely serrate, petioled or nearly sessile; flowers white, pink or violet. The varity *canadensis* has lanceolate to oblong-lanceolate, pubescent leaves and is the common form in Iowa in low grounds. Several other species occur in Iowa, namely: peppermint (*Mentha piperita*) along brooks, a smooth and pungent-tasting herb with ovate-oblong leaves and running root-stocks, and spearmint (*Mentha spicata*) with oblong or ovate-lanceolate unequally-serrate leaves.

Distribution.—This Eurasian species occurs from Newfoundland to Nebraska and the Pacific coast.

Extermination.—Easily exterminated by giving thorough cultivation and dragging the soil to bring the root-stocks to the surface of the ground.

Fig. 155. Mint (*Mentha arvensis* var. *canadensis*). Common in low meadows; whitish flowers. Plant with odor of peppermint. (Photographed by Colburn.)

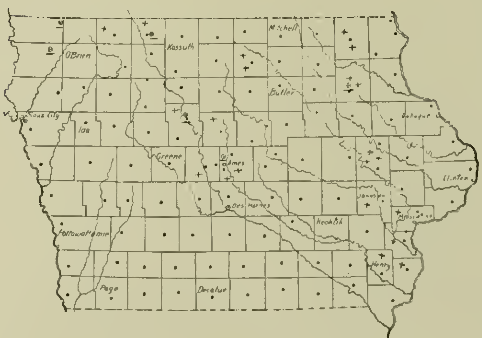


Fig. 155-A. Distribution of Mint.

Fig. 155-B. Peppermint (*Mentha piperita*). In some gardens. (Photographed by Colburn.)

Carpenter Weed, Self-heal (*Prunella vulgaris* L.).

Description.—A low, perennial weed with ovate-oblong, entire or toothed leaves, hairy or smooth; flowers collected in heads of 3-flowered clusters, corolla violet or flesh-color, or rarely pale in color, longer than the purplish calyx which is tubular bell-shaped.

Distribution.—Widely distributed in northern United States, west across the continent in clay soils and woods, also from Newfoundland to Florida.

Extermination.—This weed is not difficult to exterminate by giving cultivation with a cultivator and hoe. The weed is mainly spread by seed. The seed of this is not uncommon in clover seed.

Fig. 156. Self-heal (*Prunella vulgaris*). Common along roadsides, wooded pastures.
(Photographed by Quade.)

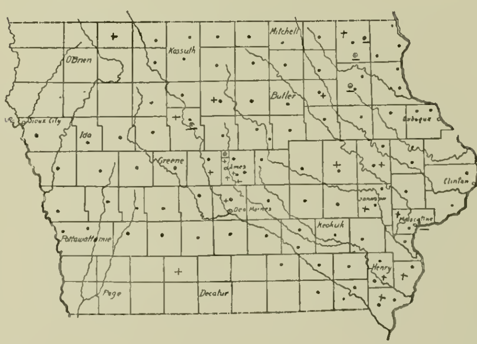


Fig. 156-A. Distribution of Self-heal.

American Germander (*Teucrium canadense* L.).

Description.—A perennial, downy, erect herb 1-3 ft. high with running root-stocks; leaves pubescent, short-petioled, downy beneath, ovate, lanceolate, serrate with a rounded base; floral leaves small; flowers in ample wandlike spikes; calyx 5-toothed, the upper lobes obtuse; corolla purple, rose or whitish.

Distribution.—From New England to Mexico and northwest to Manitoba. Common in Iowa alluvial grounds in pastures, meadows, grain fields, etc.

Extermination.—A very troublesome weed in the north. It is, however, an excellent bee-plant. Should have the same treatment as quack grass. The root-stocks should be exposed and allowed to dry. After plowing the field follow with a disc and harrow once a week after the small grain crop is removed.

Fig. 157. Germander or Wood Sage (*Teuchrium canadense*). Common in fields and woods.
(Photographed by Colburn.)

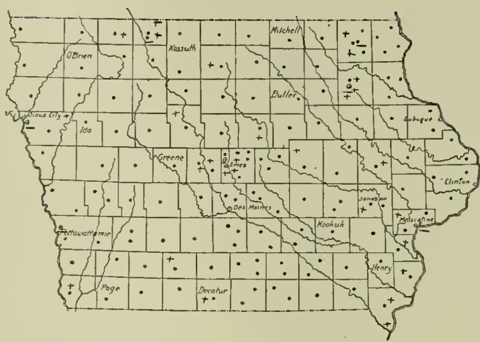


Fig. 157-A. Distribution of Germander.

L. H. Pammel in the Weekly Register says: "Germander is a troublesome weed found in many parts of northern Iowa. It produces root-stock very much like mint and quack grass. Each severed portion produces a new plant, and for this reason it is somewhat difficult to destroy. The only way to exterminate this weed is by thorough cultivation. Plowing in the fall during the dry season, then plowing again in the spring and giving thorough cultivation during the growing season should destroy the weed without difficulty."

Catnip (*Nepeta cataria* L.).

Description.—A perennial, erect herb, 1-3 ft. high; leaves ovate, cordate, coarsely serrate, petiolate, whitish, downy underneath; flowers in cymose clusters; corolla whitish, dotted with purple; trichomes several-celled, rough, thick-walled.

Distribution.—Native to Europe; widely naturalized in the northern states.

Extermination.—Give the same treatment as to motherwort.

Chemical Composition.—According to the University of Minnesota*, it is as follows:—

Dry Matter	Crude Protein	Ether Extract	Nitrogen free Extract and Fiber	Ash
94.30	22.25	2.66	63.07	12.77

*Snyder: Bull. Univ. Minn. Agr. Exp., 101.

Fig. 158. Catnip (*Nepeta cataria*). Trichome or plant hair at the right. Common in waste places.
(Photographed by Colburn. Drawing of hair by Charlotte M. King.)

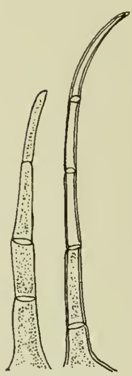


Figure 158A

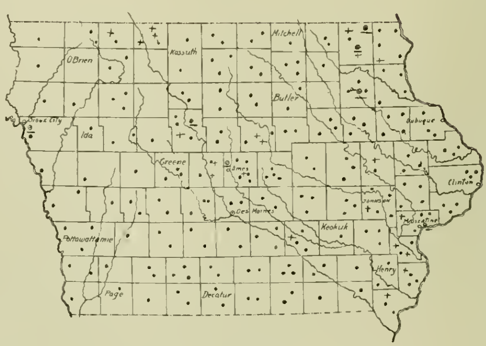


Figure 158B

Fig. 158-A. Plant hair or trichome from leaf of catnip.
(Drawing by Charlotte M. King.)

Fig. 158-B. Distribution of Catnip.

Ground Ivy (*Nepeta hederacea* (L.) Trevisan).

Description.—A creeping, trailing perennial, with leaves all alike, petioled, round, kidney-shaped, crenate, smooth, green on both sides; flowers light blue in axillary whorls of about 6, appearing in early spring and summer.

Distribution.—Native to Europe, widely naturalized in the northern states, especially in shady places. Common everywhere in Iowa.

Extermination.—Somewhat difficult to exterminate in lawns, but thorough cultivation will destroy the weed.

Fig. 159. Ground Ivy or Creeping Charley (*Nepeta hederacca*). Common in some gardens.
(Photographed by Colburn.)

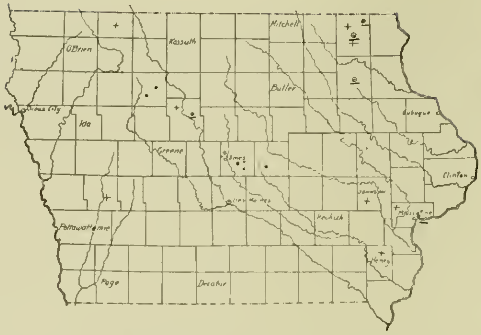


Fig. 159-A. Distribution of Ground Ivy.

Motherwort (*Leonurus cardiaca* L.).

Description.—Tall perennial herb with erect stem, 2-6 ft. high; leaves long-pointed, the lower round and palmately lobed, the up-

Fig 160. Motherwort (*Leonurus cardiaca*). A common weed in waste places and gardens.
(Photographed by Colburn.)

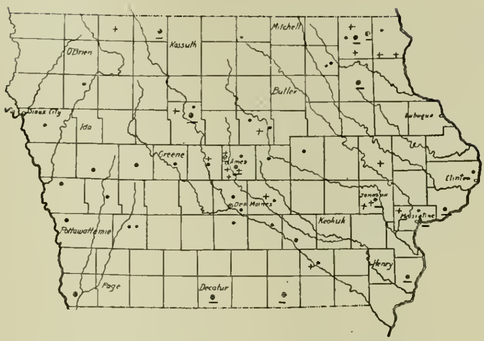


Fig. 160-A. Distribution of Motherwort.

per crenate at the base, 3-cleft; flowers pale purple, in close axillary whorls; corolla bearded.

Distribution.—Native to Europe, widely naturalized in the northern states.

Extermination.—This perennial weed can be exterminated by plowing the field with frequent cultivation subsequently.

Blue Sage (*Salvia lanceaefolia* Poir.).

Description.—A slightly pubescent or nearly smooth annual, 1-2½ ft. high; leaves petiolate, lanceolate serrate or nearly entire; flowers in interrupted, erect spikelike clusters; calyx bilabiate, upper entire, the lower 2-cleft; corolla, blue, slightly exserted; stamens with long connective, attached to a sterile anther which blocks the throat of the corolla; pistil 1, deeply 4-lobed. Plant related to the cultivated garden salvias.

Distribution.—Chiefly west of Missouri river, Kansas, Nebraska, Texas, and Arizona, Missouri and Indiana, introduced in Ohio. Common in Pottawattamie, Fremont, Monona and Woodbury counties, less common in Story, Boone, Polk and Muscatine counties.

Extermination.—This weed is easily exterminated by cultivation. Do not allow the plant to produce seeds.

SOLANACEAE, NIGHTSHADE FAMILY.

Potato, tomato, tobacco, ground cherry, jimson weed, flowering tobacco and black henbane, belong to this family.

FIG. 161. Lance-leaved Salvia, Blue Sage (*Salvia lanceaefolia*).

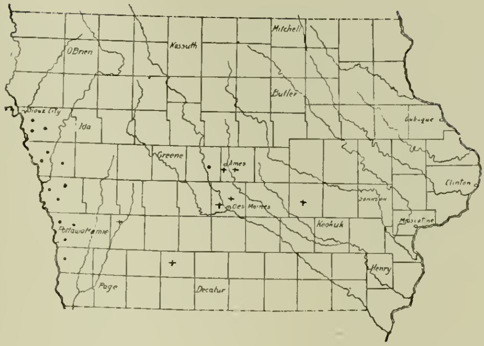


Fig. 161-A. Distribution of Lance-leaved Salvia.

Ground Cherry (*Physalis lanceolata* Michx.).

Description.—A hirsute perennial with short, stiff hairs, sometimes nearly smooth; forms short and stout underground stems; leaves oblong-ovate to lanceolate, sparingly angulate-toothed or more often entire; flowers in axillary peduncles, calyx hirsute, corolla yellowish with a dark eye; berry reddish. The *P. virginiana* Mill., is also an erect perennial with narrowly ovate acutish leaves or acutish or rounded teeth, corolla pale yellow. The *P. subglabrata* MacKenzie and Bush, has ovate or ovate-oblong leaves, oblique at the base, entire or repand, and brownish corolla; berry, large, reddish or purple. The *P. heterophylla* is perennial, leaves obtuse repand, or obtusely toothed; trichomes several-celled, glandular and non-glandular.

Distribution.—The *P. lanceolata* in southern Iowa and southward, the *P. virginiana* common everywhere in Iowa, in dry gravelly soil, from Connecticut to Iowa and southward; the *P. subglabrata* from Rhode Island to Minnesota and southward.

Extermination.—All of the perennial ground cherries are difficult to destroy because of the strong underground root-stocks which freely spread the weed. These plants are also scattered by seed. To exterminate the perennial weeds plow shallowly and expose the plants to the sun; give frequent cultivation.

Fig. 162. Ground Cherry (*Physalis lanceolata*). Common in gravelly and sandy soils; waste places and gardens. 1, leaf; 2, flower. (Photographed by Quade. Drawing by Charlotte M. King.)

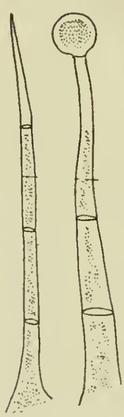


Fig. 162A

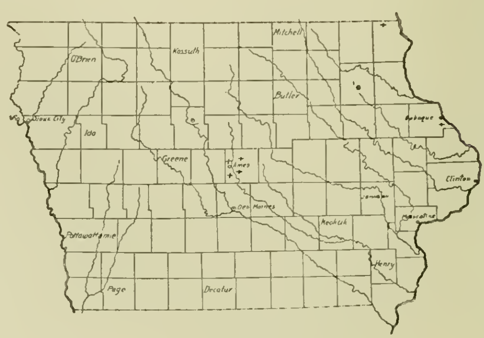


Figure 162B

Fig. 162-A. Trichome or plant hair from leaf of Ground Cherry (*Physalis heterophylla*).
(Drawing by Charlotte M. King.)
Fig. 162-B. Distribution of Ground Cherry.

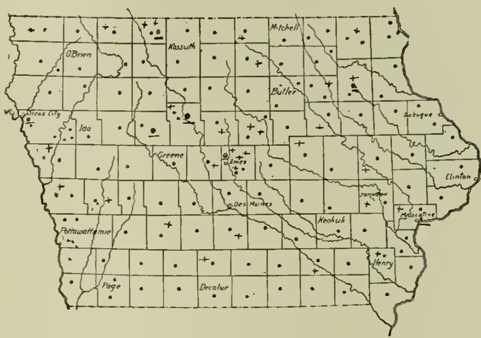


Fig. 162-C. Distribution of Virginia Ground Cherry (*Physalis virginiana*).

Common Nightshade or Stubbleberry (*Solanum nigrum* L.).

Description.—Annual, low-branched and often spreading; glabrous or hairy, hairs roughened on the angles; leaves ovate, petioled,

Fig. 163. Black Nightshade (*Solanum nigrum*). Shady places, gardens and fields.
(Photographed by Colburn.)

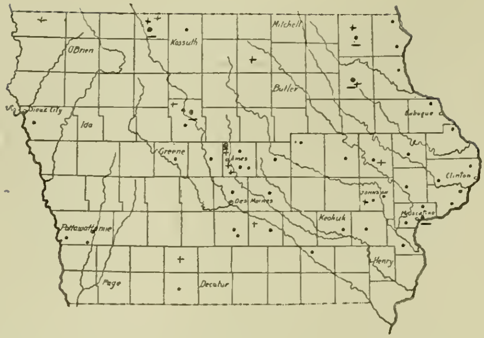


Fig. 163-A. Distribution of Black Nightshade.

Fig. 163-B. Black Nightshade (*Solanum nigrum*).

flowers white in small, umbel-like, drooping, lateral clusters; calyx spreading, the lobes obtuse, much shorter than the white corolla; berries glabrous, globose, black; occasionally large.

Distribution.—Found in northern United States; abundant everywhere in Iowa in shady grounds and fields. A cosmopolitan weed.

Horse Nettle (*Solanum carolinense* L.).

Description.—A deep-rooting perennial, propagating freely by its underground root-stocks, the running roots often being 3 ft. long; stem 1-2 ft. high, somewhat straggling, half shrubby at the base; stem hairy or merely roughish with minute hairs which are star-shaped, also armed with numerous stout, subulate, yellowish prickles; leaves oblong or sometimes ovate, obtusely sinuate-toothed or lobed, or deeply cut, 2-4 in. long; flowers borne in one-sided racemes; calyx consists of slender lobes, corolla light blue or white, an inch or less in diameter; flowers followed by yellow globose berries ½-¾ in. in diameter; small yellowish seeds, a little less than $^1/_{12}$ in. long, minutely roughened. Flowers and yellow berries resemble those of the potato. The spiny character of the leaves and the further resemblance of the flower to the potato should render it easy of detection.

Distribution.—Horse nettle is indigenous to the southern states, but now occurs from Connecticut to northern Iowa. This weed is most abundant in southern Iowa and has been reported from Floyd, Story, Boone and Linn counties; in the north half of the state, however, it is a recent introduction.

Extermination.—There are two methods of propagation; one by seeds, the other by perennial roots. It is so exceedingly tenacious a weed, that it is almost impossible to remove it when fully established. The following very suggestive methods have been given.

Smothering. This is an effective method of removing the plant. For this purpose probably rape or sorghum is the most suitable crop. If the soil is not already rich, a liberal dressing of barnyard manure should be applied during the winter or spring. The soil should be harrowed or cultivated frequently until the time of seeding, which may be any time during the months of May or June. This cultivation will prevent the weed growth, and will also assist in the retention of moisture. If the rape is sown in drills about two pounds of seed per acre is sufficient quantity and three pounds if sown broadcast. When the crop has attained a rank growth it may be pastured or removed and fed to stock. Where land is lacking in vegetable matter it is good practice to plow the crop under when it is properly manured. The latter is not necessary when the object is to destroy the nettle, as the rank growth of the crop is very effective in completely smothering the weed.

Hoed crops. Planting of corn or roots is a method much in vogue for the destruction of this vile intruder. As in the previous method the plant should be kept down before seeding time. When the crop appears above the ground the use of horse and hand hoe should not be sparing. When the welfare of the crop prohibits the use of the horse hoe, the hand hoe should be used at intervals until the crop is removed; even after this, it is sometimes necessary to give attention to the pest. There is no question about this mode of treatment being effective if properly carried out, but often failure results from negligence during the latter part of the season.

The Iowa Homestead suggests the following treatment: "Corn land that has grown up to horse nettles this year should be burned over, if possible, next spring, as this will destroy many of the seeds. Afterwards the land should be plowed lightly and kept cultivated at intervals until somewhat late in the season. A surface cultivator will be all that is necessary, and this need not be run deeper than two or three inches, just enough to effectively cut the plants off below the surface. By checking the growth several times before planting corn the root system becomes much weakened, so that ordinary cultivation the remaining part of the season will often keep them completely in check. Where nettles have been going to seed for a number of years it may require considerable time to free the land because these will germinate as they are brought near the surface by the various plowings. However, it should be kept in mind that any perennial root system may be killed outright in one season if it is not allowed to develop roots or stems."

Buffalo Bur (*Solanum rostratum* Dunal.).

Description.—Herbaceous; woody when old, somewhat hoary or yellowish, 8 in.-2 ft. high, covered with copious stellate pubescence; branches and main stems, when it begins to branch, covered with sharp yellow prickles; leaves somewhat melon-like, 1-3 times pin-

Fig. 164. Horse Nettle (*Solanum carolinense*). Deep rooted perennial, roots sometimes extend 3-4 feet in the soil. Flowers and berries somewhat like the potato. Common in southern Iowa.
(Photographed by Colburn.)

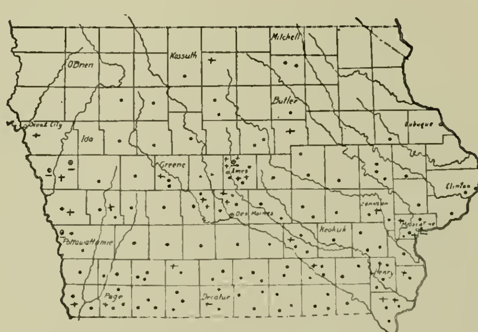


Fig. 164-A. Distribution of Horse Nettle.

Fig. 165. Buffalo Bur (*Solanum rostratum*). Pastures, gardens, railways, etc. (Photographed by Colburn.)

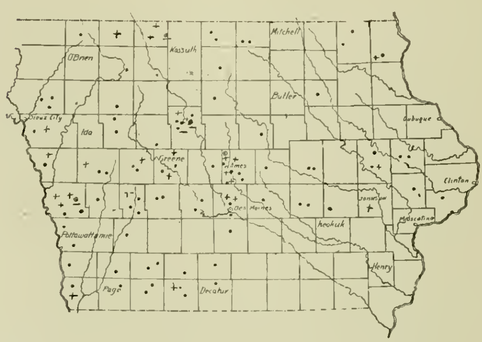


Fig. 165-A. Distribution of Buffalo Bur.

natifid, lobes roundish or obtuse and repand, covered with soft pubescence; hairs stellate, flowers yellow, corolla gamopetalous, about an inch in diameter, nearly regular, the sharp lobes of the corolla broadly ovate; stamens 5, declined, anthers tapering upward, linear-lanceolate, dissimilar, the lowest much larger and longer, with an incurved beak, hence the technical name *rostratum;* style much declined; fruit a berry but enclosed by the close-fitting or prickly calyx, which has suggested the common name buffalo bur; pedicels in fruit erect; seeds thick, irregular, round or somewhat longer than broad, wrinkled, showing numerous small pits and surrounded by a gelatinous substance.

Fig. 165-B. Buffalo Bur (*Solanum rostratum*); *a*, general sketch showing habit of plant; *b*, flower; *d*, seed natural size; *c*, seed enlarged. (After Dewey, U. S. Dept. of Agr.)

Distribution.—Buffalo bur is originally native of the plains region, between the Missouri river and the Rocky mountains. It has spread eastward in the northern states and extensively in Texas, Mississippi and Arkansas. It is not infrequent from Tennessee to New York. It has been found in Germany. This weed is widely scattered in small patches in many parts of the state of Iowa.

Extermination.—Inasmuch as this weed is an annual, it can be easily exterminated by cutting off the young plants below the ground and this should be done before the pods are formed. If plants are older they should be cut off and burned.

The Iowa Homestead says concerning this weed: "On account of the fact that the buffalo bur is an annual its destruction or eradication is simply a matter of preventing it from maturing its seed. Corn fields that are badly infested may need but little attention after the regular time for laying the corn by, for which purpose the one horse cultivator may be pressed into use."

Dr. C. E. Bessey in Breeder's Gazette recommends as follows: "To get rid of it the best thing is first not to allow the weed to get a good start, as its deep roots are hard to get out. Second, if it has a good start, the plants must be cut down frequently so as to prevent their seeding and thus starting new plants. In the third place, the deep roots must be killed by digging out or by smothering. This can be done by using a very heavy dense crop like some of the sorghums, or by covering the patch with wet manure. Of course constant stirring of the soil will kill them. It will pay to watch this weed wherever it appears."

Purple Thorn-apple, Purple Stramonium, or Jimson Weed (*Datura tatula* L.).

Description.—A glabrous annual from a few inches to 5 feet high; stem purplish; leaves thin, ovate, acute or acuminate; flowers consisting of a 5-toothed calyx and a 5-lobed funnel form corolla, with stamens included; filiform filaments inserted below the middle of the corolla tube; capsule globular, prickly, 4-valved and 2-celled. The common thorn-apple (*Datura stramonium*) is a glabrous annual with green stem, sinuate-toothed leaves and white corolla.

Fig. 166. Purple Jimson Weed (*Datura tatula*). Barnyards, roadsides. (Photographed by Colburn.)

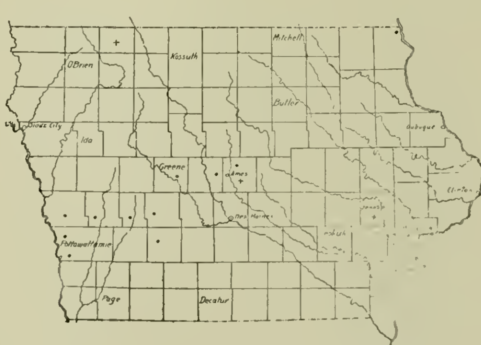


Fig. 166-A. Distribution of Jimson Weed.

Distribution.—Both species abundant in field and waste places from New England to North Dakota and Texas and naturalized from Europe; originally native to India.

Fig. 166-B. Jimson Weed or Thorn-apple (*Datura stramonium*). *a*, flowering spray; *b*, fruiting capsule.
(U. S. Dept. Agr.)

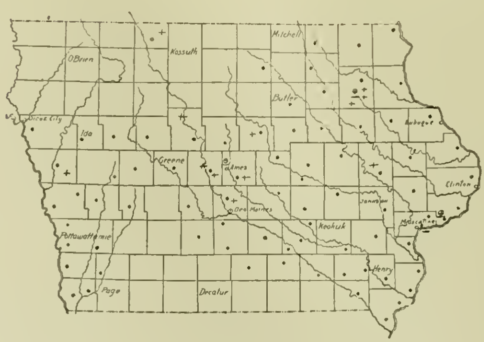


Fig. 166-C. Distribution of Thorn-apple.

Extermination.—Both of the jimson weeds are easily destroyed by cultivation. They produce an enormous amount of seed which probably retains its vitality for a considerable length of time. How long, however, has not been determined.

SCROPHULARIACEAE, MULLEIN FAMILY.

Snapdragon and Simpson honey plant belong to this family.

Mullein (*Verbascum thapsus* L.).

Description.—A tall, densely woolly annual or biennial herb 2-6 ft. high; leaves oblong, thick, covered with branched hairs, the basal leaves margined, petioled; flowers in long dense spikes; corolla

Fig. 167. Mullein (*Verbascum thapsus*). A hairy biennial, common roadside weed; gravel hills along Mississippi river, old fields. (Photographed by Colburn.)

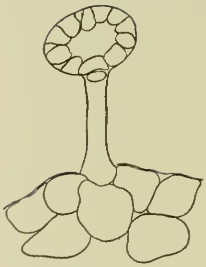


Figure 167A

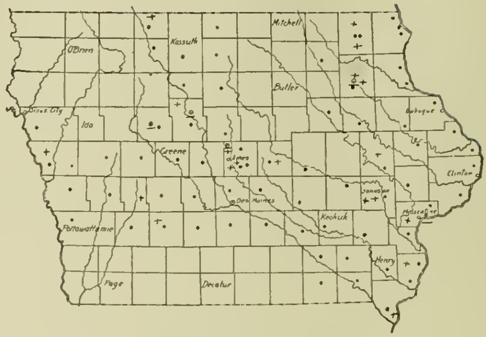


Figure 167B

Fig. 167-A. Glandular trichome from viscid pod of Moth Mullein (*Verbascum blattaria*).
(Drawing L. H. Pammel and Charlotte M. King.)

Fig. 167-B. Distribution of Mullein.

rotate, yellow or rarely white; stamens unequal, the 3 upper shorter, woolly, with short anthers; the 2 lower smooth with larger anthers; trichomes many-celled, branched with central axis.

Distribution.—From Nova Scotia west across the continent. Southwest to Missouri and Kansas and Utah. Common in waste places, especially in eastern Iowa.

Extermination.—Mullein is easily destroyed by cutting the plant off a few inches below the surface of the ground. This may be done in the autumn after the appearance of the root leaves, or in the second season when the plant shoots up.

Toadflax (*Linaria vulgaris* Hill.).

Description.—Persistent, deep-rooted perennial, 1½-2½ ft. high, with erect, slender stem; leaves smooth, sessile, crowded, alternate-linear, somewhat fleshy; flowers in racemes, showy, pale yellow and orange lips; corolla 2-lobed, closed; seeds small, dark brown to black and roughened; flowers from June to October.

Distribution.—Introduced from Europe first as a cultivated plant from whence it has spread to roadsides, meadows, and waste places. Somewhat widely distributed in this state, but particularly common in Clayton, Allamakee and Winneshiek counties; local in Story county.

Fig. 168. Toadflax or Butter and Eggs (*Linaria vulgaris*). Roadsides, gardens, etc.
(After Clark and Fletcher.)

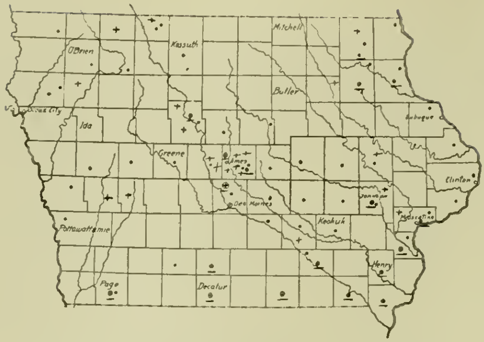


Fig. 168-A. Distribution of Toadflax.

Extermination.—Fletcher and Clark recommend as follows: "Short rotation of crops with deep, thorough cultivation in spring and fall will suppress it. Hand-pulling when the soil is wet is effective in pasture lands that cannot be cultivated. Badly infested meadows or pasture lands should be brought under cultivation by plowing in July, summer-fallowing until autumn, and planting with hoed crop the following spring."

Simpson Honey Plant (*Scrophularia marilandica* L.).

Description.—A glabrous, somewhat glandular, pubescent perennial, 3-5 ft. high; stems 4-angled; leaves thin, ovate, or ovate-lanceolate, sharply serrate; flowers cymose; calyx lobes ovate, about the length of the tube, corolla brownish purple; capsule subglobular; seeds small, numerous.

Distribution.—Common in woods and thickets from Maine to the Rocky mountains. Abundant in woods and adjacent fields.

Extermination.—Simpson honey plant produces a large number of small seeds. However, but little is known of their vitality. The weed is easily killed by cultivation and easily crowded out by clover and small cereals.

The *Scrophularia leporella* Bicknell, is similar as regards the foliage, the rudimentary stamen is, however, yellowish-green instead of brownish-purple as in the *S. marilandica.*

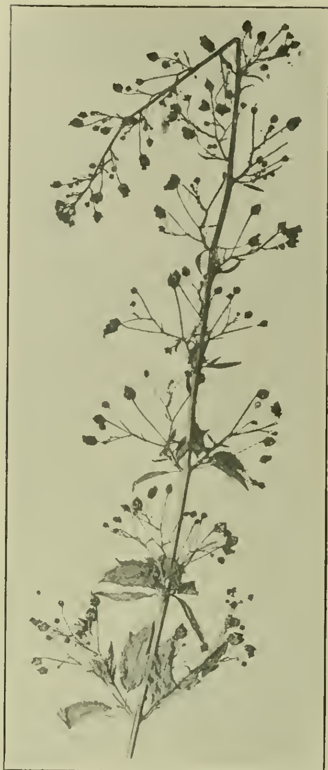


Fig. 169. Simpson Honey Plant (*Scrophularia marilandica*). Woods and waste places.
(Photographed by Colburn.)

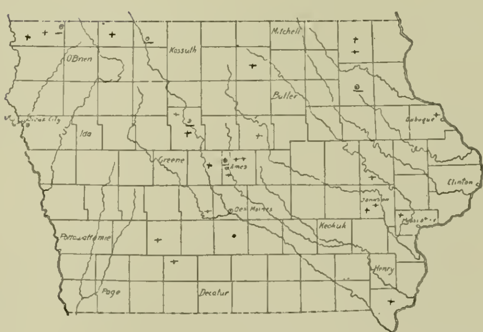


Fig. 169-A. Distribution of Simpson Honey Plant.

Purslane Speedwell, Neckweed (*Veronica peregrina* L.).

Description.—A glabrous, glandular, or nearly smooth, branching annual 4-9 in. high; leaves petioled, upper oblong, linear and entire; floral leaves like those of the stem but reduced; flowers axillary and solitary, white; capsule orbicular.

Distribution.—A common weed in fields in Iowa and in eastern North America from Nova Scotia southward; also west to Texas and the Pacific coast. Found in South America and in Europe; cosmopolitan.

Extermination.—The seeds are produced abundantly, but young as well as older plants are easily killed by cultivation.

Fig. 170. Speedwell (*Veronica peregrina*). Common in gardens and fields in early spring.
(Photographed by Quade.)

PLANTAGINACEAE, PLANTAIN FAMILY.

The family contains few plants of economic importance. The seeds of a few species are used as medicine.

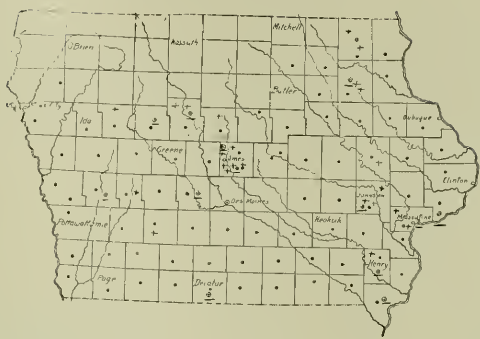


Fig. 170-A. Distribution of Speedwell.

Common Plantain (*Plantago major* L.).

Description.—A smooth, glabrous perennial with short rootstocks; leaves with a long channeled petiole, ovate, oblong or oval; spike long, linear, cylindrical, capsule circumscissile near the middle; flowers proterogynous; seed smooth, angled, reticulated; trichomes short, several-celled, from a broad base.

Distribution.—Common plantain is widely distributed in North America from the Atlantic to the Pacific. Perhaps native far northward; probably naturalized in Iowa. It is found in every county in the state; frequent in dooryards, fields and pastures.

Extermination.—Usually not a difficult weed to exterminate in cultivated fields.

Clark and Fletcher recommend the following treatment: "Hoed crops every four years will keep this weed in check. Working with a broad-shared cultivator, followed by a harrow, to drag the plants with their fibrous roots to the surface, is recommended for spring cultivation. Plantain in lawns may be weeded out when the soil is firm by forcing a small implement like a chisel, with a half-round blade having a point like the tip of a spoon, between the soil and the fleshy crown of the weed to a depth sufficient to break the plant away from its fibrous roots without disfiguring the turf. A teaspoonful of salt applied to the crown of small plants in hot dry weather will kill them without seriously injuring the grass."

Fig. 171. Common Plantain (*Plantago major*). Common in dooryards, waste places, etc.
(After Clark and Fletcher.)

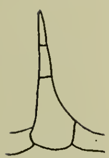


Fig. 171A

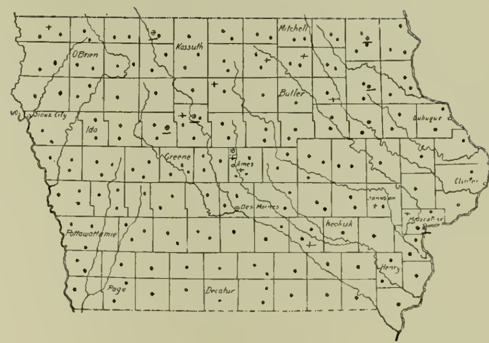


Figure 171B

Fig. 171-A. Hairs of Common Plantain.
(Drawing by L. H. Pammel and Charlotte M. King.)

Fig. 171-B. Distribution of Common Plantain.

Chemical Composition.—According to the report of the Bussey Institution* the chemical composition is as follows:

FRESH OR AIR DRY MATERIAL.

Water	Ash	Protein	Fiber	Nitrogen free Extract	Fat
81.44	2.16	2.65	2.09	11.19	0.47
WATER FREE SUBSTANCE.					
	11.7	14.3	11.3	60.2	.25

Rugel's Plantain (*Plantago Rugelii* Dec.).

Description.—Perennial, much like the preceding, but leaves and petioles commonly purplish; spikes less dense; sepals oblong; capsule about twice as long as the sepals; circumscissile much below the middle; flowers proterogynous; seed oval or oblong, not reticulated.

Distribution.—Common in fields and waste places from Maine to Texas, South Dakota and Ontario. Common in Iowa.

Extermination.—This weed may be exterminated in the same manner as the preceding species.

*Bull. 1877:117, Jenkins & Winton. Office of Experiment Stations, Bull 11

Fig. 172. Rugel's plantain (*Plantago rugelii* Decne.)
(Mich. Agr. Exp. Sta.)

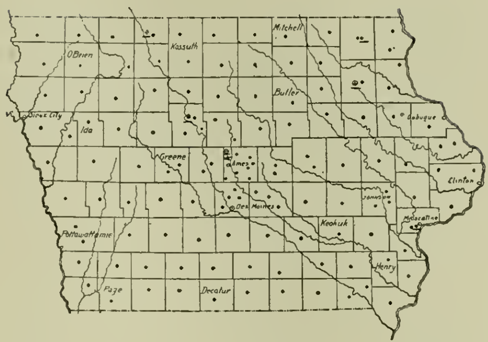


Fig. 172-A. Distribution of Rugel's Plantain.

Rib Grass (*Plantago lanceolata* L.).

Description.—A hairy, scapose, perennial with flowering heads, 1-2½ ft. high; leaves lanceolate or lance-oblong; spike thick, at first capitate, becoming cylindrical; bracts and sepals scarious; seed smooth, brownish, hollowed on the face; trichomes simple, long, slender-pointed.

Distribution.—Buckhorn or rib grass is native to Europe and has long been known as a troublesome weed in the eastern states; it is particularly abundant in Ohio and New York and is frequent in the east; in the Rocky mountains and on the Pacific coast. In Iowa it has been distributed widely with clover and will be found in clover meadows in many parts of the state.

Extermination.—This weed is a persistent perennial in fields, lawns and clover meadows. Nothing but thorough cultivation will destroy it. In seeding to clover use only pure and clean seed.

Clark and Fletcher recommend as follows: "Sow clean seed. In common with other species of plantain, this weed is easily suppressed by hoed crop and short rotation. It is prevalent almost exclusively in clover crops, in which it increases rapidly by the distribution of its seeds with commercial clover seed, the market value of which is depreciated by this impurity. Farmers who use only first quality red clover seed and who pull the first plants of this weed that occur in the clover seed crop will soon rid their farms of this pest."

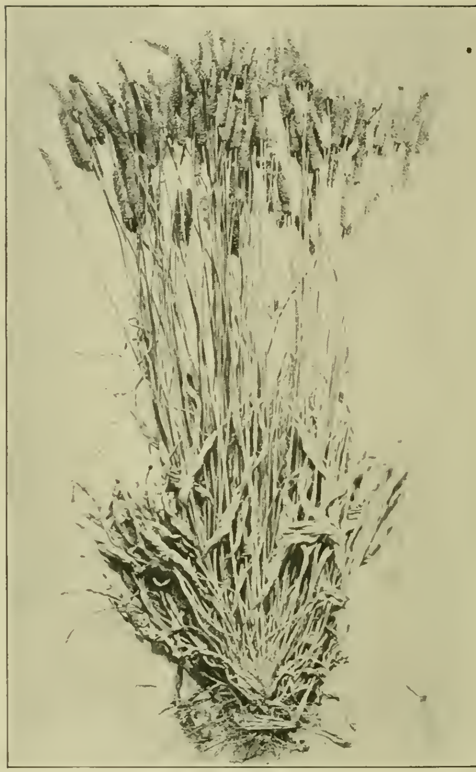


Fig. 173. Buckhorn (*Plantago lanceolata*). Common in clover meadows. (Photographed by Colburn.)

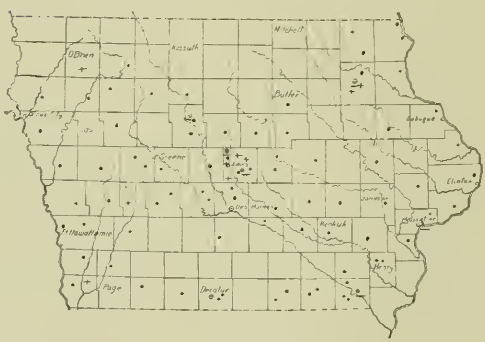


Fig. 173-A. Distribution of Buckhorn.

Chemical Composition.—The chemical composition of rib grass, grown in New Hampshire, according to Rept. U. S. Dept. Agr., 1879, p. 121, is as follows:*

FRESH OR AIR DRY MATERIAL.

Water	Ash	Protein	Fiber	Nitrogen free Extract	Fat
7.85	6.90	9.80	20.24	51.10	4.11

WATER FREE SUBSTANCE.

	7.4	10.7	21.9	55.5	4.5

Prairie Plantain (*Plantago purshii* R. & S.).

Description.—A silky, green annual with slender scapes; leaves linear, acute, with marginal petioles; spikes usually cylindrical, villous with rigid bracts; flowers of two kinds on different plants; most of them cleistogamous; sepals oblong, obtuse; corolla lobes broadly ovate; stamens 4; capsule oblong, obtuse, circumscissile at about the middle; seeds convex on the back, deeply concave on the face.

Distribution.—Common westward from Ontario and Illinois to British Columbia, Texas and Mexico. Sometimes a troublesome weed in Missouri and Nebraska. Found along railways in Iowa.

Extermination.—This little plantain is not likely to give much trouble unless the seeds are able to retain their vitality for a considerable length of time. The plant is easily destroyed by cultivation.

*Jenkins and Winton. Bull. Off. Exp. Sta. 11:79.

Fig. 174. Prairie Plantain (*Plantago purshii*).
(Drawing by Ada Hayden.)

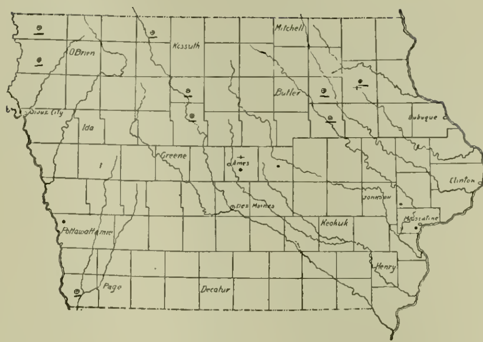


Fig. 174-A. Distribution of Prairie Plantain.

Bracted Plantain (*Plantago aristata* Michx.).

Description.—A loosely hairy, green annual, becoming glabrous with age, leaves 1-3-nerved, oblong, linear, or filiform; spike slender, cylindrical, with narrow linear bracts, much longer than the flowers. Flowers of two kinds with reference to the length of anthers and filaments on different plants, mostly cleistogamous; corolla lobes broad and rounded; seeds 2, smooth, light brown, with a ring on the hollowed portion. The *P. purshii* is much like bracted plantain except that its leaves are silky villous and slender; spike dense.

Distribution.—The bracted plantain is common in southern Iowa and is spreading to many other parts of the state with clover seed; on prairies, Illinois to Louisiana, naturalized eastward. The *P. purshii* is found chiefly along railroads where it has been introduced; common; native from western Minnesota and Iowa to the Pacific coast.

Extermination.—Only clean clover seed should be used. Easily exterminated by cultivation. Practice rotation of crops, oats, corn and clover.

Wallaces' Farmer says concerning its extermination: "The entire southern country seems to be infested with bracted or lance-leaved plantain, and seed coming from the south should always be regarded with suspicion. It is one of the worst weeds that can get on the farm. Cut the hay, plow up the land, put it in wheat, and don't undertake to take a crop of clover seed from that land

Fig. 175. Bracted Plantain (*Plantago aristata*). A common weed in clover fields in southern Iowa and in waste places.
(Photographed by Colburn.)

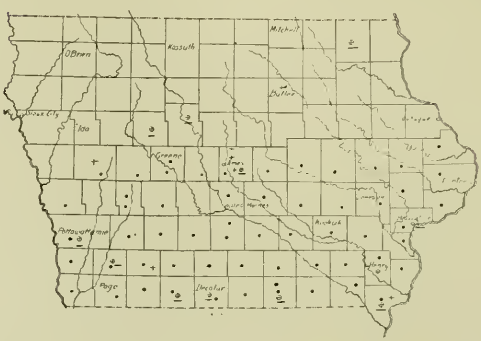


Fig. 175-A. Distribution of Bracted Plantain.

When this weed grows over the whole field the only thing to do is to put it through a course of rotation. Where there is only a stalk here and there it may be taken out with a 'spud,' which is simply a two-inch chisel with a handle, by means of which the farmer can cut out rapidly many of these weeds, but where it is scattered over the field the only way is to put it through a course of rotation."

CAPRIFOLIACEAE, WOODBINE FAMILY.

Contains a number of cultivated ornamental plants like the coral honeysuckle, bush honeysuckle, elder, etc.

Indian Currant, Coralberry (*Symphoricarpos orbiculatus* Moench.).

Description—A shrub 2-4 feet high; purplish, usually pubescent branches; leaves oval or ovate, entire or undulate, nearly glabrous above, pubescent underneath; flowers in short axillary clusters; corolla bell-shaped, sparingly bearded, pinkish, stamens included; fruit a purplish berry.

Distribution.—Rocky woods and along streams; from New Jersey, Illinois, South Dakota, Nebraska to Texas and Georgia. This weed is common throughout the southern part of the state of Iowa and is often most troublesome.

Extermination.—Fields that are infested with this weed must be broken up with a breaking plow and subsequently disked so that the roots may be brought to the surface and exposed to the sun. It may be necessary to disk once or twice more before planting the crop.

COMPOSITAE, SUNFLOWER FAMILY.

Includes comparatively few economic plants, such as lettuce, artichoke, pyrethrum, sunflower; quite a number such as gumweed (Grindelia), tansy and absinth, are used in medicine; several, like daisy, cosmos, coreopsis, aster and goldenrod, are ornamental.

Fig. 176. Indian Currant (*Symphoricarpus orbiculatus*).

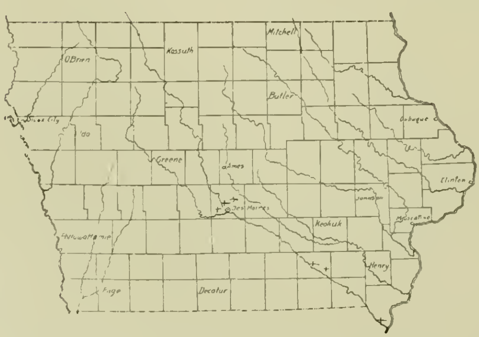


Fig. 176. Distribution of Indian Currant.

Ironweed (*Veronia baldwini* Torr.).

Description.—A roughish, pubescent, perennial 3-5 ft. tall; leaves lance-oblong or ovate, denticulate; heads in open, cymose clusters, about 25-flowered; involucre hairy-tomentose; bracts squarrose, purplish or greenish; involucre acuminate.

Distribution.—Common from Maine to Missouri and southward. It is found in central Iowa, from Webster county southward and along Missouri river to Council Bluffs.

Extermination.—Frequently a troublesome weed. Usually not difficult to exterminate in cultivated fields.

Fig. 177. Ironweed (*Vernonia baldwini*). Common in low pastures. Flowers in heads.
(Photographed by Colburn.)

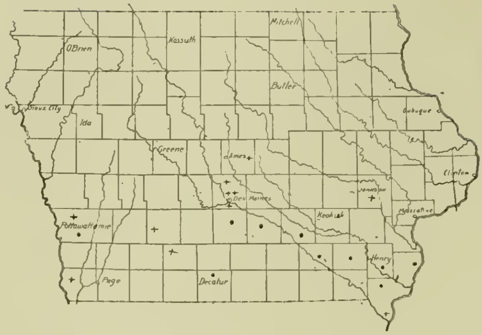


Fig. 177-A. Distribution of Ironweed.

Western Ironweed (*Vernonia fasciculata* Michx.).

Description.—A bushy perennial 3-5 ft. high; leaves linear to oblong-lanceolate, long, acuminate, smooth or nearly so, denticulate; heads short-peduncled, 20-30-flowered, bracts of the involucre appressed, ovate or oval, acute, ciliate, the uppermost somewhat mucronate.

Distribution.—Common in the Mississippi valley, especially on low, alluvial grounds from Ohio to North Dakota, south to Kentucky and Texas; frequent in all parts of Iowa.

Extermination.—This perennial weed, though abundant in pastures and low meadows, soon succumbs to cultivation.

Wallaces' Farmer says concerning its destruction: "An occasional cutting of ironweed is useless. If you are to keep it down by strangulation, then you must keep at it until the weed is strangled.

"If we had some permanent pasture that was covered with ironweed, we would try sheep. There are a few weeds that sheep will not eat. They will probably not make a very good living on ironweed alone, although we recently saw some sheep that apparently had nothing else to live on trimming up ironweed alone. But sheep will eat almost any weed that grows out of the ground, barring thistles, mullein and buffalo berry. It requires about two years of sheep pasturing to get rid of ironweed. We know of no other way in which it can be done so easily."

Fig. 178. Common or Western Ironweed (*Vernonia fasciculata*). A perennial weed with purple flowers. In low pastures and meadows. (Photographed by Colburn.)

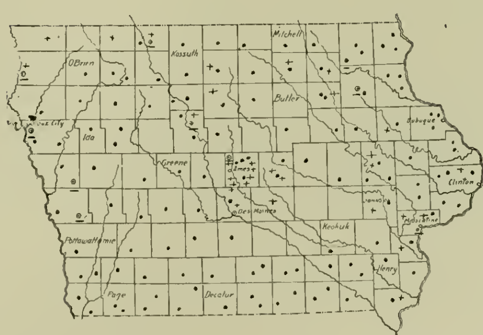


Fig. 178-A. Distribution of Western Ironweed.

White Snakeroot (*Eupatorium urticaefolium* Riech.).

Description.—Perennial, with smooth, branching stem 15-40 in. high; broad, ovate, coarsely and sharply toothed, pointed, long-petioled leaves; flowers in compound, cymose clusters, white.

Distribution.—Pennsylvania, Virginia, westward; reported from many places in Iowa.

Extermination.—This perennial weed is easily killed by cultivation. It is common in woodlands. It is mentioned here because of its supposed poisonous nature.

Fig. 179. Boneset or White Snakeroot (*Eupatorium urticaefolium*). Woodland pastures.
(Photographed by Quade.)

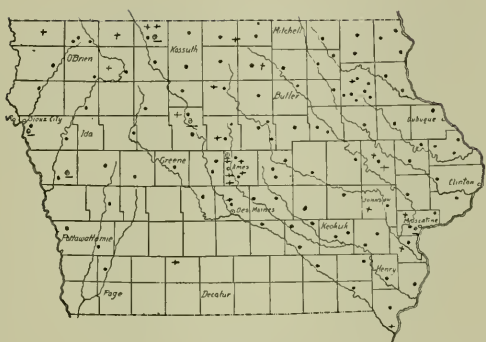


Figure 179A

Figure 179B

Fig. 179-A. Distribution of White Snakeroot.

Fig. 179-B. Boneset (*Eupatorium rotundifolium*). (Drawing by Lois Pammel.)

Goldenrod (*Solidago canadensis* L.).

Description.—A rough, hairy, pubescent perennial 3-6 ft. high; lanceolate, pointed, sharply serrate leaves, especially pale in color, pubescent beneath and rough above; heads in recurved racemes forming panicles; ray flowers yellow; trichomes several-celled; cells short, walls pitted.

Distribution.—Most widely distributed of the goldenrods from the Atlantic to the Rocky mountains; common in every part of Iowa, especially in Story, Boone, Clinton, Linn, Allamakee, Pottawattamie, Woodbury, Cerro Gordo and Marshall counties.

Extermination.—This weed is quite largely spread by "seeds," but is not difficult to kill by cultivation, although it sometimes persists in fields for some years. Prevent the carrying of "seeds" and give thorough cultivation.

Fig. 180. Canadian Goldenrod (*Solidago canadensis*). Roadsides and woods. *a*, hairs of leaf.
(Photographed by Colburn, *a*, hairs drawn by Charlotte M. King.)

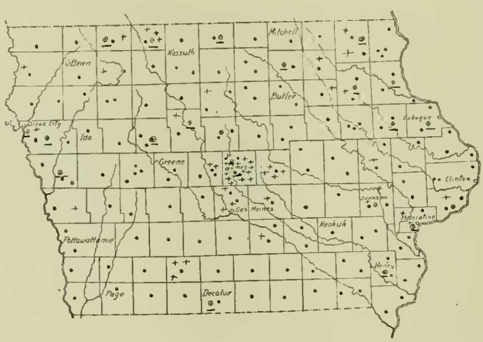


Fig. 180-A. Distribution of Canadian Goldenrod.

Goldenrod (*Solidago serotina* Ait.).

Description.—A tall, stout perennial 4-6 ft. high; often glaucous; leaves smooth on both sides, lanceolate to oblanceolate, taper-pointed, sharply serrate; heads in open panicles, pubescent, bracts linear; ray flowers 7-14, yellow.

Distribution.—Common from New England southward and westward to the Rocky mountains and Colorado; common in all parts of the state of Iowa.

Extermination.—Succumbs readily to cultivation, spreads by its seeds and root-stocks.

Fig. 181. Smooth Goldenrod (*Solidago serotina*). Abundant in low grounds along streams.
(Photographed by Colburn.)

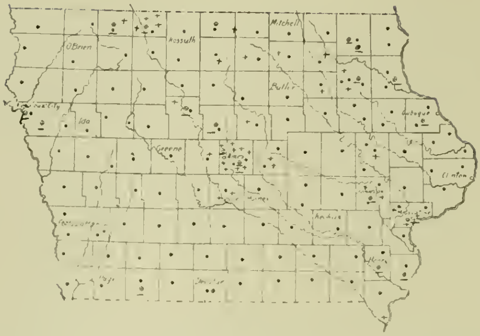


Fig. 181-A. Distribution of Smooth Goldenrod.

Large Yellow-flowered Goldenrod (*Solidago rigida* L.).

Description.—A rough and somewhat hoary perennial, minutely pubescent; stems stout, 2-5 ft. high, very leafy; leaves oval or ob-

Fig. 182. Large-flowered Goldenrod (*Solidago rigida*). In pastures and roadsides.
(Photographed by Colburn.)

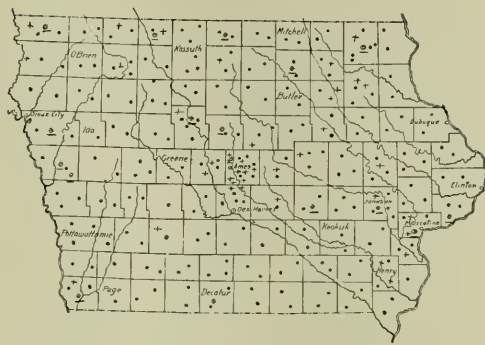


Fig. 182-A. Distribution of Large-flowered Goldenrod.

long, feather-veined, thick and rigid, the upper sessile; heads large, collected in a large compound corymb, terminating the stem.

Distribution.—Abundant in dry soils from New England to Manitoba, Dakota, Nebraska and Missouri; common in pastures in Iowa, in Story, Boone, Polk, Linn, Marshall, Hardin, Cerro Gordo, Winnebago, Emmet and Woodbury counties.

Extermination.—Though it is often a very troublesome weed in pastures it is easily killed by cultivation; spreads largely by "seeds."

Many-flowered Aster (*Aster multiflorus* Ait.).

Description.—A pale or hoary pubescent, branched perennial, 9 in-1½ ft. high; heads on spreading, racemose branches; leaves rigid, crowded, spreading, with ciliate margins; ray flowers white, small.

Distribution.—Common along roadsides and fields, gravelly knolls, etc.

Extermination.—Though abundant in fields readily succumbs to cultivation.

Fig. 183. White or Many-flowered Aster (*Aster multiflorus*). Common on roadsides.
(Photographed by Quade.)

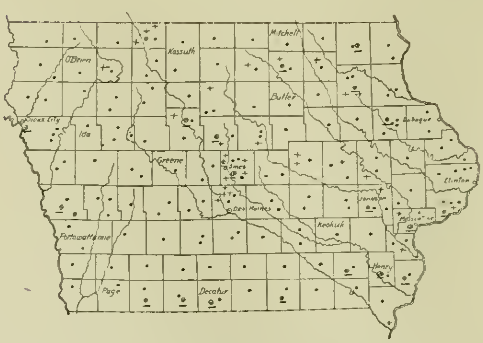


Fig. 183-A. Distribution of White Aster.

Willow-leaved Aster (*Aster salicifolius* Ait.).

Description.—A branched, leafy perennial 2-8 ft. high; leaves oblong to narrowly lanceolate, pointed, entire, or slightly serrate, firm, often scabrous; heads racemose, clustered; ray flowers purplish.

Distribution.—Common in low grounds, thickets or borders of fields from New England to Wisconsin and Minnesota. An allied species, *A. paniculatus* Lam., is much like *A. salicifolius* except that the leaves are more pointed, serrate and less scabrous. It is a very variable species, with distribution similar to that of *A. multiflorus.*

Extermination.—Easily exterminated by cultivation.

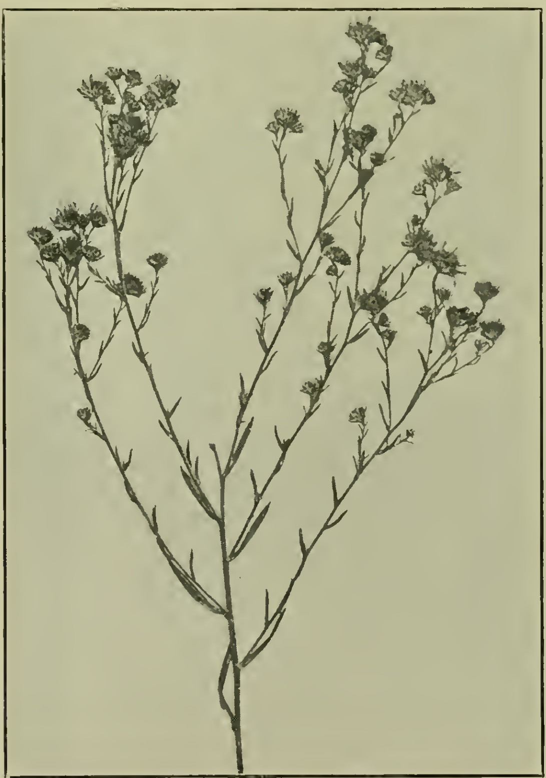


Fig. 184. Willow-leaved Aster (*Aster salicifolius*). Common in low grounds. (Photographed by Quade.)

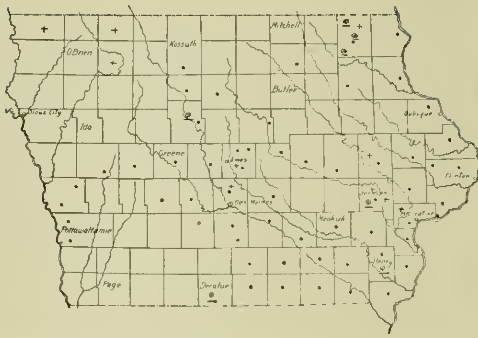


Fig. 184-A. Distribution of Willow-leaved Aster.

Fig. 185. *Aster paniculatus.* *a,* Plant Hair. Common in low grounds everywhere in Iowa. White ray flowers, sometimes purplish. (Photographed by Colburn. Drawing by Charlotte M. King.)

The *Aster tradescanti* L., is closely related to *A. paniculatus,* but has smaller leaves and shorter rays. The leaves are lanceolate to linear. The bracts are linear or acutish.

Whiteweed or Fleabane (*Erigeron annuus* Pers.).

Description.—A sparingly pubescent annual 3-5 ft. high; leaves thin, coarsely and sharply toothed, the lower one ovate, or ovate-lanceolate, acute, and entire on both ends; heads corymbed; rays white, tinged with purple.

Distribution.—This weed occurs from New England to Texas. Common in the Mississippi valley. Common throughout the state of Iowa, particularly in timothy and clover meadows. This weed is also naturalized in Europe.

Extermination.—Both this and *E. ramosus* are easily exterminated by thorough cultivation. They are seldom troublesome outside of meadows, though in some parts of Iowa the meadows and pastures are white with flowers of these species.

Fig. 186. Whiteweed or Daisy Fleabane (*Erigeron annuus*). Common in clover and timothy meadows.
(Photographed by Colburn. Drawings *a* and *b* by Charlotte M. King.)

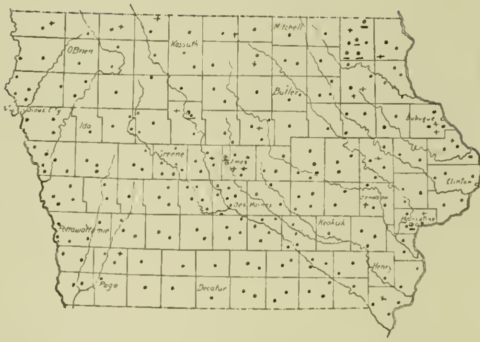


Fig. 186-A. Distribution of Whiteweed.

Wallace's Farmer states concerning its eradication: "One of the worst enemies of the meadow, and especially the timothy meadow in the west, is a peculiar form of daisy to which farmers give the name of whiteweed. It may be seen in full bloom about the time timothy heads out, and if not dealt with on its first appearance in the timothy field it is only a question of time when the hay will be from one-fourth to one-half whiteweed. If the farmer is vigilant and goes through and pulls out these weeds on their first appearance, he can protect his timothy meadows. If he fails to do this, it is only a question of time when he will have to plow them up."

Daisy Fleabane (*Erigeron ramosus* (Walt.) B S P).

Description.—This resembles the preceding species except that the stem and leaves are somewhat more hirsute and hairy; leaves roughish, entire or nearly so, the upper lanceolate, the lowest oblong or spatulate; flowers white and smaller than in the preceding species.

Distribution.—Daisy fleabane is native from New England to Arkansas. Common in Iowa, particularly in drier situations, clover meadows and timothy fields.

Extermination.—This weed is common in timothy and clover meadows. The seed is often found in clover and timothy seed. Care should be used to sow only clover and timothy seed that does

Fig. 187. Daisy Fleabane (*Erigeron ramosus*).
(Mich. Agr. Coll. Exp. Sta. Bull.)

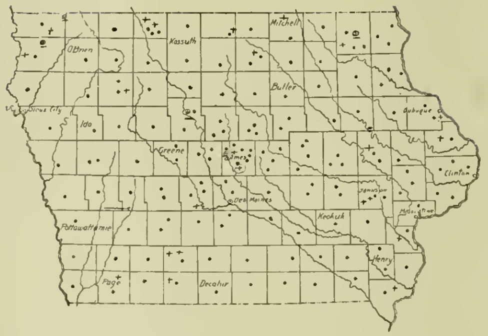


Fig. 187-A. Distribution of Daisy Fleabane.

not contain these weed seeds. This weed is easily destroyed by cultivation. The meadows are sown from seed coming from the neighboring roadside or field. The weeds should, therefore, be cut in waste places.

Horseweed (*Erigeron canadensis* L.).

Description.—Bristly, hairy, or sometimes glabrate stem, 1-6 ft. high, simple or paniculately branched; leaves usually pubescent or ciliate, the lower spatulate, incised or entire, obtuse or acutish, the upper generally linear and entire; heads numerous, with inconspicuous white ray flowers shorter than the pappus; pappus simple; trichomes several-celled, straight with long cells, curved with short cells.

Distribution.—Horseweed is common throughout eastern North America; naturalized in Europe, the Rocky mountains and along the Pacific coast. Everywhere in Iowa in waste places and in cultivated fields.

Extermination.—This weed is an annual and is very easily destroyed. Cutting off just below the surface of the ground will exterminate it, provided, of course, that the new seeds are not permitted to re-seed the soil. The weed is common everywhere and the fact that it is so easily blown by the wind makes it difficult to keep it in check.

Fig. 188. Horseweed (*Erigeron canadensis*). In fields and waste places. (Mich. Agr. Exp. Sta.)

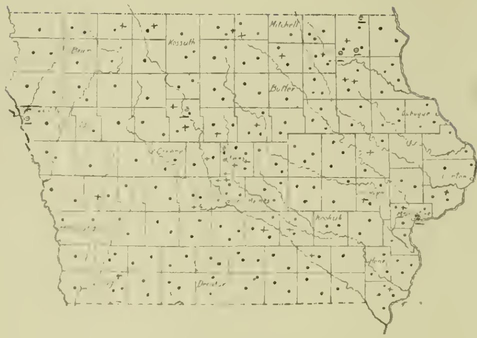


Fig. 188-A. Distribution of Horseweed.

Great Ragweed (*Ambrosia trifida* L.).

Description.—A stout, scabrous, hispid or nearly glabrous annual, 3-12 ft. high; leaves all opposite and petioled, 3-nerved, deeply 3-5-lobed; lobes ovate-lanceolate and serrate, upper leaf sometimes ovate and undivided; flowers monoecious, staminate, borne in spikes surrounded by the larger bract-like leaves; involucre turbinate to obovoid, 5-7-ribbed, beaked, each rib bearing a tubercle near the summit; involucre enclosing a single oily seed.

Distribution.—This North American weed is most abundant in the Mississippi valley from Texas to Minnesota and in the Dakotas; however, it also occurs east from New England to Quebec. It is abundant in every part of Iowa, especially along highways, in grain fields and corn fields.

Extermination.—It is certain that cultivating the young plants followed by three or four other similar treatments will remove the weed in a single season.

Fig. 189. Greater Ragweed (*Ambrosia trifida*), sometimes, but incorrectly, called Ironweed. Common in fields, along roadsides, etc. (Photographed by Colburn.)

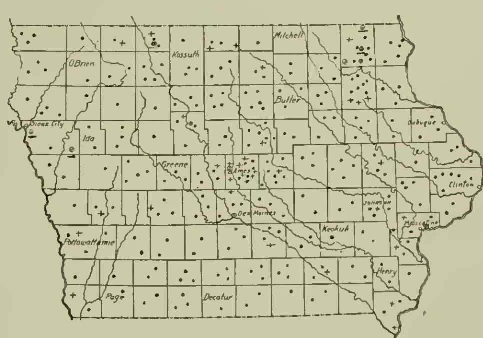


Fig. 189-A. Distribution of Greater Ragweed.

Smaller Ragweed (*Ambrosia artemisiifolia* L.).

Description.—A puberulent or hirsute annual, branched, 1-3 ft. high; leaves thin, 1-2 pinnatifid; upper leaves alternate, lower usually opposite, pale or canescent beneath; flowers monoecious, staminate above and pisillate in lower axils of the leaves; fertile heads obovoid or globose; short-beaked, 4-6 spined; trichomes several-celled, cells short or long.

Distribution.—Ragweed or hogweed is originally from Europe but is common throughout eastern North America; also found in the Rocky mountains, the Pacific northwest, and in Mexico, West Indies and South America. It is common throughout the state of Iowa in gardens and fields and is abundant in pastures.

Extermination.—This weed is too common in pastures, along roadsides and in waste places. The weed is easily exterminated by cutting the plants off below the surface of the soil. The commonly used cultivator will destroy most of the young plants in a corn field.

Clark and Fletcher recommend the following treatment: "Sow clean red clover seed. Stubble lands where this weed is prevalent should be shallow plowed directly after harvest, or, if seeded, the autumn growth should be closely cut with a mowing machine within two weeks after the grain crop is cut."

Wallaces' Farmer says concerning this serious pest of the pasture: "We suggested that the reason why the ragweed grows in the blue grass pastures is because for some reason the stand of grass has been weakened and thus the ragweed seeds, which are present in all cultivated soils in the west in great abundance, have a chance to grow. We suggested further that the stand of grass may have been weakened by overpasturing in a dry time, thus giving the sun opportunity to burn the roots and lower their vitality. We suggested also that it may have been weakened by the ravages of larvæ of the various insects known as the white grub worms. We suggested still further that blue grass, not being able to obtain nitrogen from the atmosphere, was nitrogen hungry, and therefore weak.

To meet all these various suggestions we proposed that farmers who have blue grass pastures of long standing should re-seed them next year with one or other of the various kinds of clover, filling

Fig. 190. Small Ragweed or Hogweed (*Ambrosia artemisiifolia*). In pastures, waste places, gardens and clover meadows.
(After Clark and Fletcher.)

Figure 190A

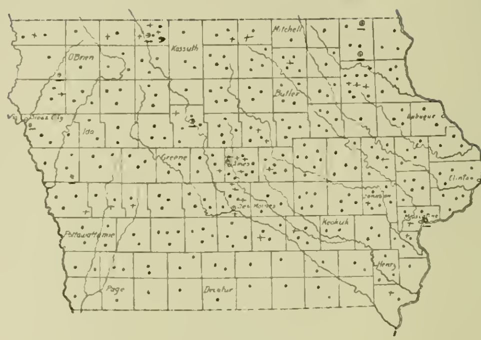


Figure 190B

Fig. 190-A. Plant hairs or trichomes of ragweed.
(Drawing by Charlotte M. King.)

Fig. 190-B. Distribution of Small Ragweed.

up the land with a preferred food for stock and at the same time restoring the nitrogen content to the soil, enabling the blue grass to make more rapid growth.

Fig. 191. A weedy Iowa field; Ragweed, Foxtail, Barnyard Grass, etc. The seeds are sown in the field for next year.
(Photographed by Pammel.)

We did try it on a neighbor's farm under the most disadvantageous circumstances imaginable. The field was a pasture of blue grass and wool grass with a very little white clover. The ground was dry; as dry as we have ever seen it at that time of the year. We found it easy even under these hard conditions to drill in clover on this tough sod and cover it from an inch to an inch and a half, using a Hoosier drill with two horses.

We found that the clover was dropped in the very bottom of the slit made by the disk, a seed every two or three inches, using six pounds to the acre. It lay there until the 23d of May, apparently as dry as it came out of the drill, except in some of the lower spots, where it had sprouted. The 23d of May there was a two-inch rain on that field, and at once the clovers began to grow."

Perennial Ragweed (*Ambrosia psilostachya* D C.).

Description.—A branched hairy and rough perennial with slender running root-stock, 2-3 ft. high; leaves once pinnatifid, acute lobes, lower leaves incised; monoecious flowers, staminate flowers with flattish involucres, involucre of fertile flowers, obovoid, tubercles absent or very small.

Distribution.—Common on gravel hills and sandy plains from Illinois, Wisconsin to the Saskatchewan to the Rocky mountains, common gravel knolls and sandy plains; Clinton, Muscatine, Carroll, Kossuth, Pottawattamie counties.

Extermination.—Succumbs readily to cultivation.

Fig. 192. Perennial Ragweed (*Ambrosia psilostachya*). Pastures, drift soils, roadsides.
(Photographed by Quade.)

Marsh Elder (*Iva xanthifolia* Nutt.).

Description.—An annual 1-8 ft. high; stem frequently pubescent when young; leaves opposite, rhombic, ovate, or lowest heart-shaped, doubly serrate, or cut-toothed, obscurely lobed; upper surface minutely scabrous, canescent beneath, especially when young; petiole frequently ciliate at its upper end; flowers borne in spikelike clusters forming a compound panicle; heads small, crowded; outer bracts of the involucre broadly ovate, greenish; inner membranaceous; achenes glabrate. This plant is also known botanically as *Cyclachaena xanthifolia* Fr.

Distribution.—Common in the eastern Rockies, to Saskatchewan and western Wisconsin, most abundant in Iowa along Missouri river where it is troublesome in fields, along highways, and in

Fig. 193. Halfbreed Weed, Marsh Elder (*Iva xanthifolia*). Common in western Iowa, fields and roadsides.
(Photographed by Colburn.)

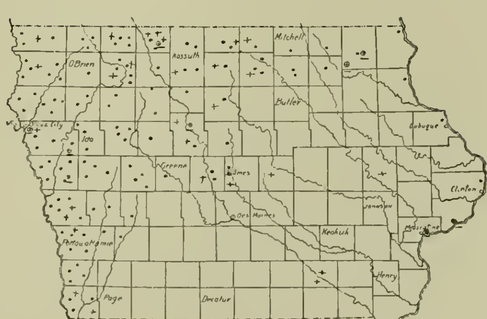


Fig. 193-A. Distribution of Marsh Elder.

yards, spreading into north and northeastern Iowa, Mason City and Allamakee county and also in central Iowa, in Boone and Story counties.

Extermination.—Marsh elder is an annual and hence thorough cultivation for a single season will destroy it, provided it is not allowed to form seeds.

Cocklebur (*Xanthium canadense* Mill.).

Description.—A coarse, rough annual from 1-2 ft. high, stem marked with brown punctate spots; leaves alternate, cordate or ovate, 3-nerved, long petioled; flowers monoecious, staminate and pistillate flowers in different heads, the pistillate clustered below; involucre of staminate flowers somewhat flat, of separate scales; receptacles cylindrical; scales of the fertile involucre closed; fruit 2-beaked, containing 2 achenes; bur densely prickly and hispid, achenes oblong, without pappus.

The spiny clotbur *X. spinosum* has spines in the axils of the lanceolate leaves.

Distribution.—Common in Mississippi valley from Texas to Minnesota and eastward. Common in fields in many parts of the state, but more common in southern than in northern Iowa.

Extermination.—The best method of combating this weed is the rotation of crops and clean culture. Where a field is in corn, the field should be thoroughly cultivated and none of the plants allowed to mature seed. If they cannot be caught by the cultivator, it may pay to kill the remaining plants with a hoe, or to pull them by hand. The corn should be followed with winter rye, and then oats, using the oats as a nurse crop for clover and timothy. Leave the field in meadow for at least two years and then if possible turn it into pasture.

Mr. E. B. Watson found in soil badly infested with cocklebur that clover seed would not germinate as well, and it is rather difficult to get clover to start in fields of this kind.

The Homestead says concerning the eradication of cocklebur: "Needless to say there is no easy way of eradicating the pest. Where the winter wheat can be grown the following plan can be depended upon. Start on fields that have been in small grain and plow the land as soon as the crop is removed. Harrow as often

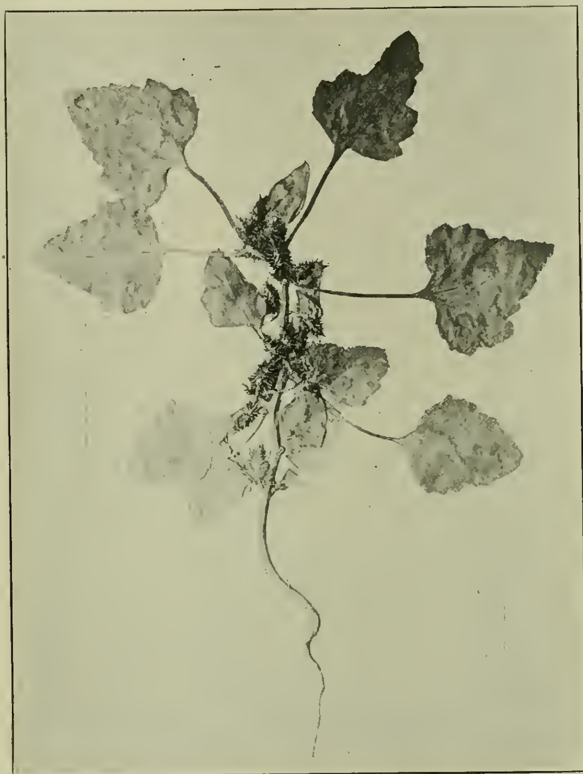


Fig. 194. Cocklebur (*Xanthium canadense*). Corn fields, roadsides, alluvial bottoms.
(Photographed by Colburn.)

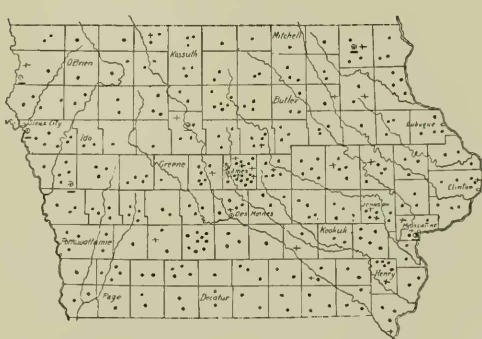


Fig. 194-A.* Distribution of Cocklebur.

as necessary to kill weeds and put in wheat when the time comes. The next season as soon as the wheat is harvested remove from the field and go on with the mower. This will clip all or most all of the young cocklebur plants, as well as other weeds, and following this operation the stubble should be plowed as rapidly as possible and prepared for another crop of wheat. Another season's treatment of this sort will generally reduce the burs to such an extent that very few will be left and these can be pulled by hand.

Fig. 195. Spiny Clotbur (*Xanthium spinosum*). Waste places from Maine to Kansas. Perhaps in southern Iowa.
(Photographed by Colburn.)

"One of our Nebraska subscribers, Mr. J. J. Bishop, stated some time ago that he succeeded in almost clearing out a badly infested field of cockleburs in two years by employing the following method: Just as soon as the removal of the oat crop the soil was plowed and prepared for winter wheat, this crop being sown at the proper time. Mr. Bishop stated that before plowing this ground after removing the oats the surface was covered with burs just about as thick as they could grow. After harvesting the first crop of winter wheat the soil was again plowed and seeded for the second time to winter wheat. After this it was followed by corn and other crops, with the result that even in the corn crop a very short time spent in pulling burs freed the field entirely of these pests.''

Mr. Albert Wiltz says in Wallaces' Farmer: ''When I moved to this farm nine years ago the land was very badly infested with cockleburs, and farmers told me that each bur had two seeds, one growing one year and the other one the next year. I left a patch of ground where the cockleburs were lying thick without a crop, plowed in June once, and again in August. That settled the cockleburs. That year was a good corn year, with plenty of moisture. Now, would not that way be the cheapest way to deal with them—to put three years, yes, sometimes ten years' fighting into one year? That is, take a field one year to fight cocklburs, and finish it; next year take another, and so on, if the farmer is a renter on a long term lease or owns the land.''

Wallaces' Farmer states concerning the extermination of cocklebur: ''If it is desirable to put some of this kind of land in alfalfa, we would not put it in corn, but disk it every week or two during the summer to sprout the burs, and then kill them by subsequent disking, and keep on that way all summer, missing the crop for the first year. Then in the fall, when the ground has sufficient moisture, say in August or in the first part of September, seed it to alfalfa alone, we would not sow alfalfa in the spring on that kind of land; but by continuous summer cultivation it can be gotten in shape to grow alfalfa and thus avoid not only cockleburs but also crabgrass, another great foe to alfalfa in that part of the country.

''Speaking now on the subject of cockleburs generally. Where the land is not so badly infested with them as this farm seems to be, and it is not desirable to grow spring grains and seed to clover, we would make the stand of grain rather thin, put in a good seeding of clover, put the clover deep enough to insure germination, use as early a variety of grain as possible, get it off the land as soon as possible, and then keep the cockleburs mowed down by clipping the clover until a good stand is secured.''

Ox-eye (*Heliopsis scabra* Dunal.).

Description.—A rough, pubescent, perennial with opposite, petioled, triple-nerved leaves; heads large, peduncled; scales of involucre in 2-3 rows, nearly equal; ray flowers yellow, 10 or more, fertile; achenes smooth, thick, 4-angled, truncate; pappus chaffy or 2-3-toothed.

Distribution.—From New York west to Wisconsin, Minnesota and British Columbia and southwest to Missouri, Kansas and Arkansas.

Extermination.—Though this weed is perennial, it is rather easily destroyed by cultivation.

Fig 196. Ox-eye (*Heliopsis scabra*). *a*, plant hair or trichome. Common in orchards, waste places. Rather large yellow heads, and rough, opposite leaves.

(Photograph by Colburn. *a*, drawing by Charlotte M. King.)

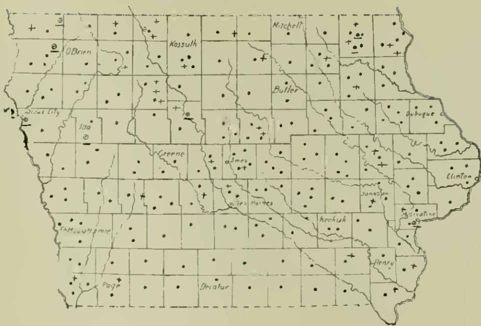


Fig. 196-A. Distribution of Ox-eye.

Black-eyed Susan, Nigger-head, Cone-flower (*Rudbeckia hirta* L.).

Description.—A rough, hairy biennial 1-2 ft. high with stems simple, or branched, bearing a long pedunculate head; leaves nearly entire, the upper sessile, oblong or lanceolate, the lower

Fig. 197. Black-eyed Susan (*Rudbeckia hirta*). Common in sandy fields. (Photographed by Colburn.)

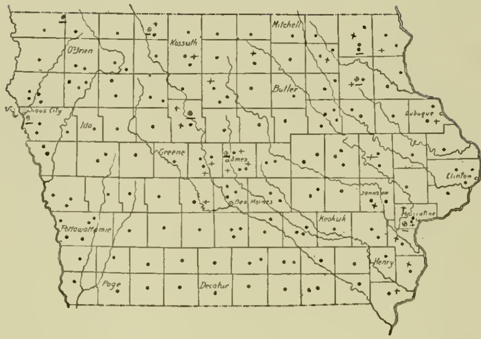


Fig. 197-A. Distribution of Black-eyed Susan.

petioled and spatulate; heads many-flowered, radiate, neutral; receptacle columnar or conical; chaff hairy at tip, acutish; ray flowers yellow, disk dull brown; achenes 4-angled; pappus none.

Distribution.—This weed is indigenous to the northern Mississippi valley but has been naturalized eastward; is common throughout the state of Iowa, occuring not only in meadows but in somewhat sandy fields in Linn and Muscatine counties.

Extermination.—This weed succumbs to cultivation but care should be used in the sowing of clover seed as seed of this weed is sometimes found with it. It is largely in this way that it has been spread in the east.

Common Sunflower (*Helianthus annuus* L.).

Description.—A tall, rough annual, 6-8 ft. high, leaves 3-ribbed, ovate or the lower cordate, serrate; large heads with yellow ray flowers, disk flowers brownish.

Distribution.—Widely distributed west of Missouri river from Saskatchewan to Texas, California and Mexico. Common in western Iowa, from Woodbury to Fremont county, occurring in fields along highways, meadows, vacant lots and corn fields; widely scattered, but not abundant in many other sections of the state, as Boone, Story, Polk, Cerro Gordo, Webster, Lyon, Linn and Muscatine counties.

Extermination.—The seeds of this plant do not retain their vitality very long. The young plants are easily destroyed by cultivation. The plant should not be permitted to go to seed.

Fig. 198. Common Sunflower (*Helianthus annuus*). Common in western Iowa fields, roadsides.
(Photographed by Colburn.)

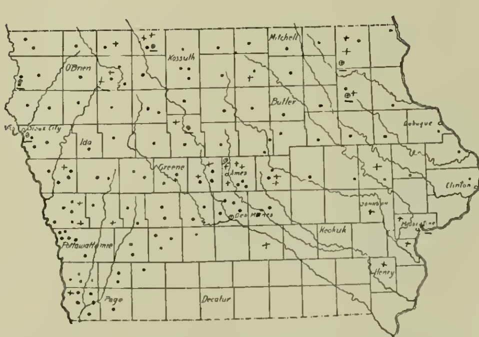


Fig. 198-A. Distribution of Common Sunflower.

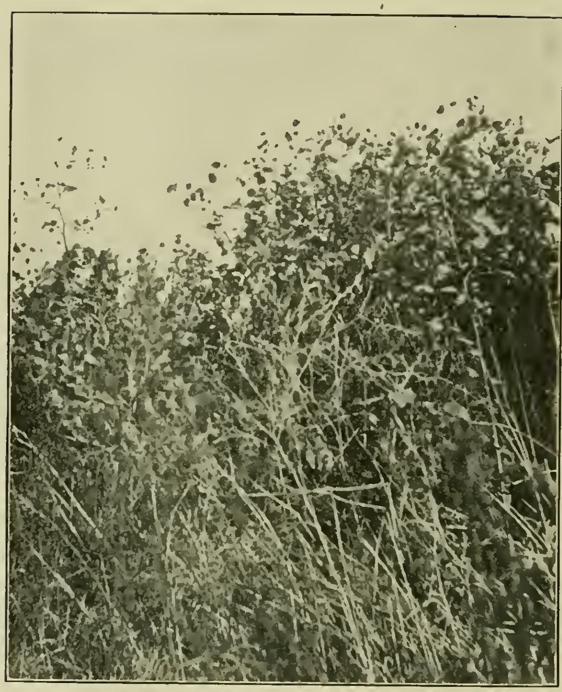


Fig. 198-B. A patch of Wild Sunflowers (*Helianthus annuus*). Common in western Iowa.
(Photographed by Pammel.)

Prairie Sunflower (*Helianthus petiolaris* Nutt.).

Description.—The prairie sunflower is an annual 1-3 ft. high; lower branches rough; stem leaves 1-3 in. long, oblong to ovate-lanceolate, sparingly toothed, lower leaves abruptly contracted into a long slender petiole; ray flowers yellow, disk flowers brownish; bracts lanceolate or oblong-lanceolate, usually not ciliate; head flowers smaller than in common sunflower; flowers half an inch or more in diameter.

Distribution.—Prairie sunflower is most abundant in dry prairies from Minnesota to the northwest territory and Oregon and south to Missouri. It has become naturalized more or less in Iowa. It is not uncommon from Council Bluffs to Sioux City and around Muscatine.

Extermination.—This weed is easily exterminated by cultivation.

Fig. 199. Prairie or Western Sunflower (*Helianthus petiolaris*). In Muscatine Island and western Iowa. Similar to large Sunflower. (Photographed by Colburn.)

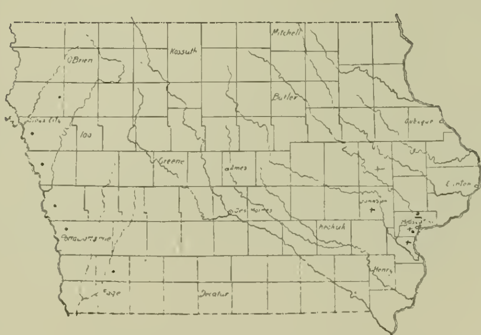


Fig. 199-A. Distribution of Prairie Sunflower.

Meadow or Saw-toothed Sunflower (*Helianthus grosseserratus* Martens).

Description.—A tall, glabrous perennial 6-10 ft. high, bearing numerous short peduncled heads; lower stem leaves 8-10 in. long and petiole 1-2 in. long; leaves opposite or alternate with a slender petiole, oblong, lanceolate, acuminate with sharp teeth, or the upper merely denticulate, somewhat scabrous above, whitish below; heads ½ in. high with deep yellow rays about an inch long; bracts of the involucre slender.

Distribution.—Common in the central states and northward, also westward to Texas. Abundant throughout the state of Iowa in corn fields, low swales and roadsides, particularly in northern Iowa.

Fig. 200. Meadow Sunflower (*Helianthus grosseserratus*). Common in meadows, pastures and fields.
(Photographed by Colburn.)

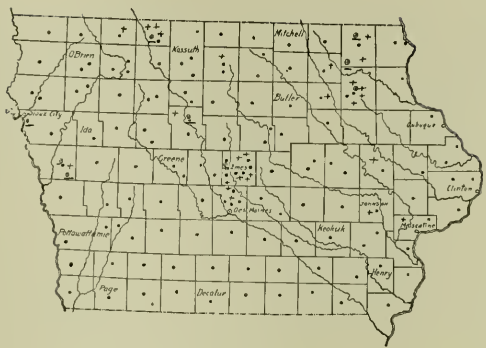


Fig. 200-A. Distribution of Meadow Sunflower.

Fig. 200-B. Meadow Sunflower (*Helianthus grosseserratus*). In meadows and fields.
(Photographed by Pammel.)

Extermination.—It is certain that cultivating the young plants followed by three or four other similar treatments will remove the weed in one or at most two seasons. It would be well to use clover, planted as a rotation after the field had had clean cultivation.

Artichoke (*Helianthus tuberosus* L.).

Description.—A pubescent or hirsute perennial with tuberous underground stems; leaves oblong-lanceolate or ovate-acuminate, scabrous, minutely pubescent; flowers yellowish, large.

Distribution.—Common from New York to Minnesota; in Iowa most abundant in the northern counties; particularly troublesome in Mitchell, Howard and Cerro Gordo counties. However, it is not infrequent along highways and fields in many other parts of the state.

Fig. 201. Artichoke (*Helianthus tuberosus*). Common in corn fields, roadsides, etc., north Iowa.
(Photographed by Colburn.)

Fig. 202. Artichoke (*Helianthus tuberosus*). In grain fields, roadsides and waste places.

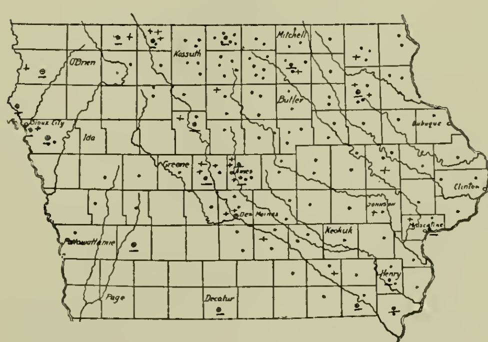


Fig. 202-A. Distribution of Artichoke.

Extermination.—This is a most troublesome weed in corn and smaller grain fields of northern Iowa. The somewhat thickened underground stems spread the plant freely by cultivation. The small-grain field should be plowed after the grain is removed, then dragged so as to expose the "roots" to the sun. Before planting corn in the spring run a disk over the field, then harrow, plant to corn, and give thorough cultivation. When the weed is very bad it may be well to get the field into meadow or pasture.

Maximilian's Sunflower (*Helianthus maximiliani* Schrad.).

Description.—Stem seabrous and hispid, 2-12 ft. high, the latter height being obtained in alluvial bottoms; leaves usually alternate, thick, becoming rigid, scabrous above, hairy beneath, lanceolate,

Fig. 203. Maximilian's Sunflower. (*Helianthus maximiliani*). Common in meadows and fields of northern Iowa. Yellow flowers, hairy elongated leaves.

(Photographed by Colburn.)

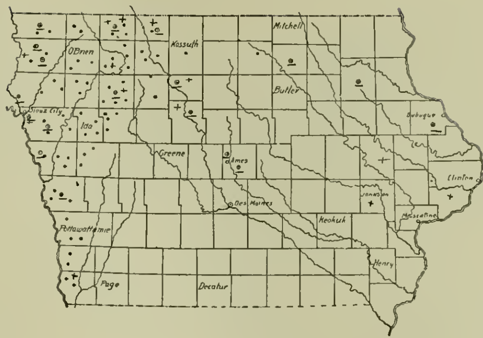


Fig. 203-A. Distribution of Maximilian's Sunflower.

narrowing at both ends, nearly sessile, entirely or sparingly denticulate; heads large, ½-¾ in. high; short peduncle terminating the simple stem and later appearing in the axils of lower leaves; involucre consisting of rigid bracts about 1½ in. long; ray flowers golden yellow, disk flowers brownish, flowering in late summer and early autumn.

Distribution.—This weed is common in places from Alberta and Manitoba to Texas. In Iowa it is most abundant in the northwestern and western counties, in the alluvial bottoms of Missouri river and on high prairies of Pocahontas, Dickinson, Emmet and Palo Alto counties; also found east in Worth, Howard and Cerro Gordo counties.

Extermination.—This perennial weed has the habit of the artichoke. The more or less thickened underground stems freely propagate the plants. Give the field a shallow plowing then drag and expose the roots to the sun for a few days. This will destroy the most of the plants. If the field is put into corn give thorough cultivation and follow corn with a small-grain crop and then clover.

Boot-jack (*Bidens discoidea* (T. & G.) Britton).

Description.—A diffusely branched annual with alternate, divided leaves and slender petioles; leaflets ovate-lanceolate, pointed, coarsely serrate, small heads of yellow flowers surrounded by a double involucre, the outer of 4 bracts; achenes linear, wedge-shaped, smooth or tuberculate, bearing a pair of short, upwardly barbed awns.

Fig. 204. Tall Boot-jack or Spanish Needle (*Bidens discoidea*). Common in corn fields, pastures, and meadows.
(Photographed by Colburn.)

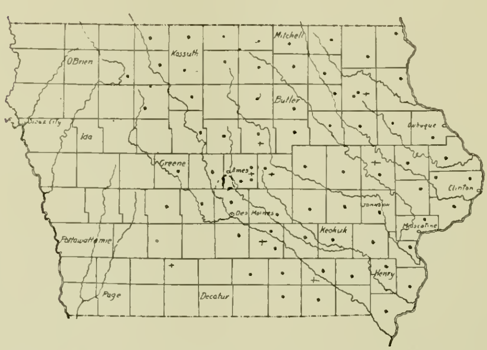


Fig. 204-A. Distribution of Tall Boot-jack.

Distribution.—Moist situations from New England to Missouri. Common in southern Iowa.

Extermination.—This annual is most abundant in low fields. It succumbs readily to cultivation. The plants should not be allowed to go to seed as the seed is scattered by animals; its spreading, therefore, can be prevented by cutting the plant off close to the surface of the ground when it begins to blossom.

Beggar-ticks, Stick-tight, Boot-jack (*Bidens frondosa* L.).

Description.—A branching, hairy or smooth annual 2-6 ft. high; leaves petioled, 3-5-divided, terminal leaflet long-stalked, pointed, coarsely toothed, frequently divided again; rays small, yellow invo-

Fig. 205. Boot-jack, Spanish Needle, (*Bidens frondosa*). Common in gardens. The "seeds", more properly achenes, are scattered by animals. (Photographed by Colburn.)

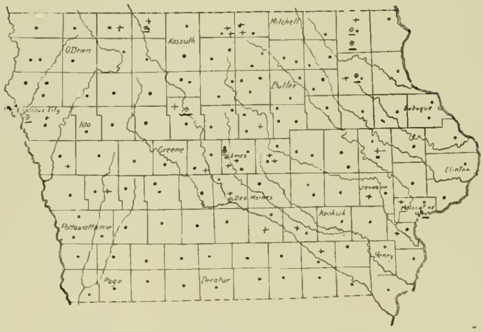


Fig. 205-A. Distribution of Boot-jack.

lucre double, the outer foliaceous; bracts ciliate, longer than the head; receptacle flattish with deciduous chaff; achenes narrowly acuminate, 2-awned, the awns downwardly barbed.

Distribution.—Widely distributed in moist places throughout the northern states; often a very troublesome weed in gardens. It is widely scattered because of the "seeds" adhering to clothing, pelts of animals, etc.

Extermination.—Boot-jack is easily exterminated by cultivation. The weed is disseminated by animals and man. It would be well to cut off the plant close to the surface of the ground when in flower.

Tickseed (*Bidens aristosa* (Michx.) Britton).

Description.—A smoothish, slightly pubescent, annual 2-4 feet high; leaves 1-2-pinnately, 5-7-divided, petioled; leaflets lanceolate, cut-toothed or pinnatifid; heads panicled-corymbose; scales of the involucre in 2 series, the outer about as long as the inner, ciliate; ray flowers conspicuous, yellow; achenes obovate with ciliate margins, usually with 2 divergent teeth; a somewhat showy plant with yellow flowers.

Distribution.—From Michigan and southern Iowa to Kansas and Texas. Abundant in Missouri; probably indigenous to southern Iowa; in recent years has made its appearance in Wapello, (Pammel) Marion, (Pammel) Polk (Bakke) and Decatur (Anderson) counties.

Fig. 206. Tickseed (*Bidens aristosa*).
(Mich. Agr. Exp. Sta.)

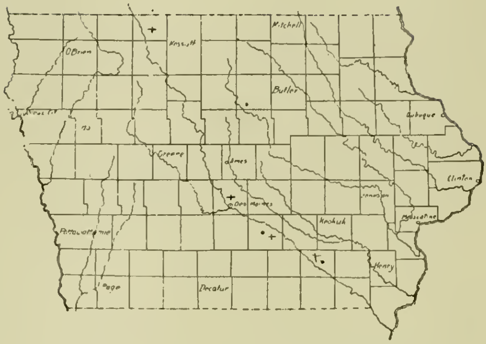


Fig. 206-A. Distribution of Tickseed.

Extermination.—This weed is easily exterminated by cultivation. Do not permit seeds to mature.

Sneezeweed (*Helenium autumnale* L.).

Description.—A smooth, angular, branching perennial, 1-5 ft. high; mostly toothed, lanceolate-ovate oblong; heads yellow, appearing in autumn; involucre of the head or flower consists of small reflexed scales; ray and disk flowers yellow and fertile; seeds top-shaped and ribbed; pappus consisting of 5-8 thin, 1-nerved, chaffy scales.

Distribution.—Native to the northern states, particularly from Missouri and Illinois to Wisconsin and Minnesota; in the Dakotas as well as in the Rocky mountains, Utah and the northwest.

Extermination.—This weed occurs only in low grounds. The soil should be drained. Then sow to some useful leguminous crop like alsike clover. The weed succumbs readily to cultivation.

FIG. 207. Sneezeweed (*Helenium autumnale*). Common in low grounds, pastures and along streams.
(Photographed by Colburn.)

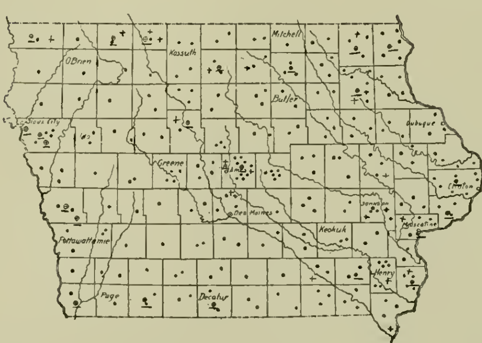


FIG. 207-A. Distribution of Sneezeweed

FIG. 207-B. Sneezeweed (*Helenium autumnale*).

Fetid Marigold (*Dyssodia papposa* (Vent.) Hitch.).

Description.—A nearly smooth or somewhat pubescent, branched annual with strong odor, 6 in.-2 ft. high; leaves opposite, sessile, pinnately parted, bristly-toothed, with large pellucid glands; heads many-flowered; disk and ray flowers small, yellow; involucre with a few scales at the base, one row of scales united to form a cup; achenes slender, 4-angled, pappus a row of chaffy scales finely divided into numerous rough bristles.

Distribution.—Common from western Iowa and Minnesota to Illinois and to the southwest. Common in western Iowa along right of ways, streets, barnyards and fields.

Extermination.—This weed is not difficult to destroy by cultivation. It sometimes occurs in clover seed and alfalfa seed.

FIG. 208. Fetid Marigold (*Dyssodia papposa*). Pungent smelling herb. Roadsides, fields, waste places, etc. Especially in western Iowa. (Photographed by Hart.)

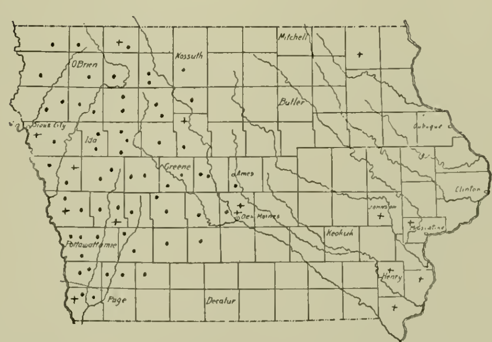


FIG. 208-A. Distribution of Fetid Marigold.

FIG. 209. Fetid Marigold (*Dyssodia papposa*).
(Drawing by Charlotte M. King.)

Yarrow (*Achillea millefolium* L.).

Description.—A perennial with simple stem 1-2½ feet high; leaves twice-pinnately parted, the divisions linear; 3-5-cleft flowers in corymbose heads, flat-topped ray flowers usually white, 4-5, sometimes pink; plant with a somewhat pungent odor.

Distribution.—Widely distributed in fields, especially gravelly knolls and drift soils through the state; particularly common in northeastern Iowa, found from the Atlantic to the Pacific, also in Europe and Asia.

Extermination.—The weed is not difficult to destroy by cultivation. It is not uncommon in clover seed. Practice rotation of crops; when in the pasture where it is apt to be very common cut

Fig. 210. Yarrow (*Achillea millefolium*). Common in pastures, especially northwestern Iowa. "White flowers."

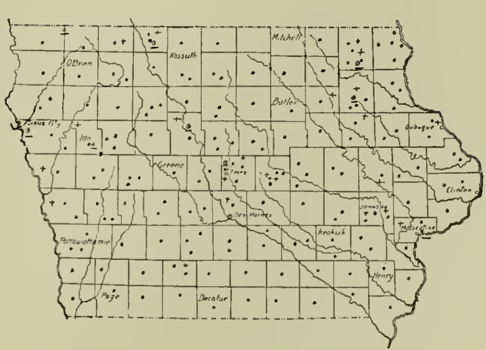


Fig. 210-A. Distribution of Yarrow.

the roots off with a small spade. This will effectually destroy the plant. In Europe, it is sometimes recommended as a forage plant but it is of doubtful value.

Mayweed or Dog Fennel (*Anthemis cotula* L.).

Description.—An acrid, branching, strong-scented perennial, white ray flowers; plants 1-2 feet high; leaves pinnately dissected; solitary and many-flowered, outer ray flowers pistillate, fertile, or neutral; disk flowers yellow, small, and tubular; involucre of numerous, small, dry scarious scales; achenes small, tuberculate; pappus roughened, none, or merely a minute crown.

Distribution.—This weed is native to Europe; early introduced in the United States, now common from the Atlantic to the Pacific. In Iowa more common in northeastern part than westward; especially abundant in some gardens and along roadsides.

Extermination.—A weed easily exterminated by cultivation. It is especially common in clover seed in eastern United States.

Clark and Fletcher recommend as follows: ''Clean up the waste places about the farmyards and seed to permanent grass that will take full possession of the soil to the exclusion of this and other weeds. This plant is usually prevalent in gardens fertilized with manure from city stables.''

FIG. 211. Mayweed or Dog Fennel (*Anthemis cotula*). Barnyards, roadsides, etc. (After Clark and Fletcher.)

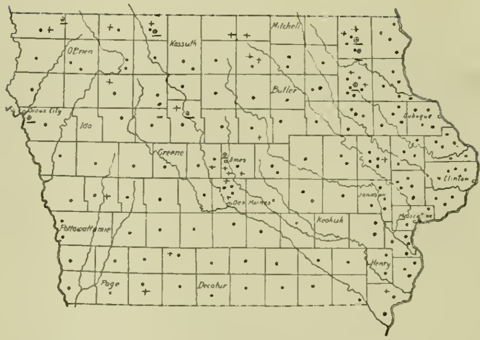


FIG. 211-A. Distribution of Mayweed.

Ox-eye Daisy (*Chrysanthemum leucanthemum* L. var. *pinnatifidum* (Lecoq) Lamotte).

Description.—A perennial herb with erect stem; spatulate, petioled, root leaves, those of the stem partially clasping, all leaves cut or pinnatifid-toothed; nearly simple stem bearing a large, many-flowered head with numerous white rays; scales of involucre with scarious margins, both disk and ray flowers producing achenes, marked with longitudinal lines; pappus absent.

Distribution.—This European weed has long been known as a troublesome weed in New England and the central states. It is not abundant in Iowa except in a few places.

Extermination.—This weed is not troublesome as yet in Iowa. There is much danger, however, that it may be introduced with clover seed, as it frequently occurs in eastern and European grown clover seed. *Sow only clean clover seed.* It succumbs quite readily to cultivation.

Clark and Fletcher make the following recommendations: "Shallow plowing of sod in August, with thorough cultivation from time to time until frost, will suppress it. This pest does not give trouble on lands worked under a short rotation of crops. Clover for hay in which this weed is plentiful should be cut early."

FIG. 212. Ox-eye Daisy. (*Chrysanthemum leucanthemum* var. *pinnatifidum*).
Pastures occasionally.
(After Clark and Fletcher.)

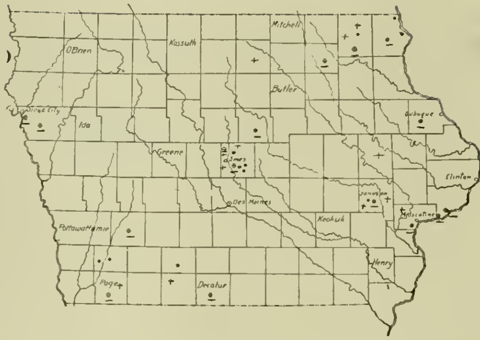


FIG. 212-A. Distribution of Ox-eye Daisy.

Chemical Composition.—Its chemical composition according to Me. Bull. Agr. Ex. Sta. 26:6 (1888), is as follows.*

FRESH OR AIR DRY MATERIAL.

Water	Ash	Protein	Fiber	Nitrogen free Extract	Fat
9.63	6.85	8.44	29.00	51.72	4.36

WATER FREE SUBSTANCE.

	7.6	9.3	32.1	46.2	4.8

Tansy (*Tanacetum vulgare* L.).

Description.—A bitter, acrid, strongly scented, poisonous herb or branched perennial 2-4 ft. high; leaves pinnately divided into linear-pinnatifid divisions, lobes serrate; heads many-flowered, few ray flowers, disk yellow; marginal flowers fertile; scales of the involucre in several series; receptacle flat or convex, naked; branches of the style brush-like at the summit; achenes 5-angled or 5-ribbed, truncate or obtuse; pappus none or a short crown.

Distribution.—Common throughout the southern states from the Atlantic to the Pacific but more common in eastern North America. Common in many parts of the state of Iowa, especially in some communities, in gardens and along roadsides.

Extermination.—Easily exterminated by cultivation.

*Compiled by Jenkins and Winton; Bull. Off. Exp. Sta. 11:78.

FIG. 213. Tansy (*Tanacetum vulgare*) Common in old gardens, roadsides, etc. (Photographed by Colburn.)

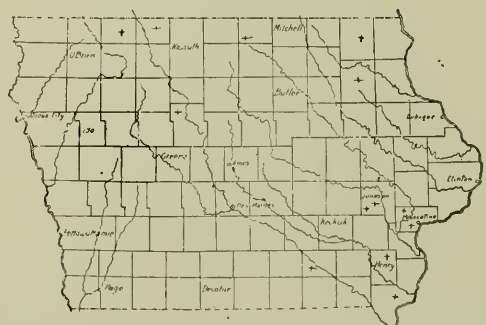


FIG. 213-A. Distribution of Tansy.

Western Mugwort (*Artemisia ludoviciana* Nutt.).

Description.—A branching perennial with inconspicuous flowers; leaves and stems white, woolly; leaves lanceolate, the upper usually entire, the lower cut-toothed; heads in narrow panicles, ray flowers absent; involucre of dry scarious scales; receptacle naked; flowers small, yellowish; achenes obovoid; no pappus; trichomes long, simple, cylindrical, tortuous.

Distribution.—This weed is common from Illinois north to Saskatchewan, southwest to Texas, and west to Utah. It is quite widely distributed in the state of Iowa.

Extermination.—This weed is easily exterminated by cultivation. After the crop has been removed the field should be plowed thus leaving the soil in good condition.

FIG. 214. Western Mugwort, or White Wormwood (*Artemisia ludoviciana*). Common in gravelly places, fields and pastures. *a*, plant hairs. (Photographed by Colburn. *a*. Drawn by Charlotte M. King.)

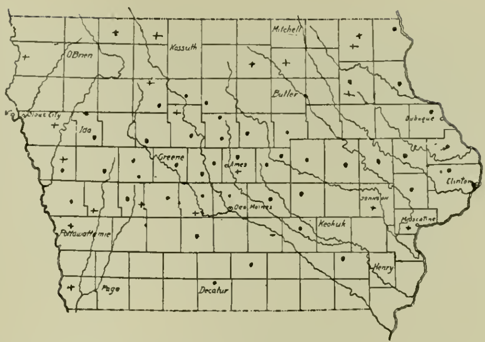


FIG. 214-A. Distribution of Western Mugwort.

Wormwood (*Artemisia biennis* Willd.).

Description.—An aromatic, somewhat bitter, smooth annual, or biennial herb, 1-3 ft. high, with leafy stems and erect branches;

FIG. 215. Biennial Wormwood. (*Artemisia biennis*). Pungent smelling herb, fields, woods, etc.
(Photographed by Colburn.)

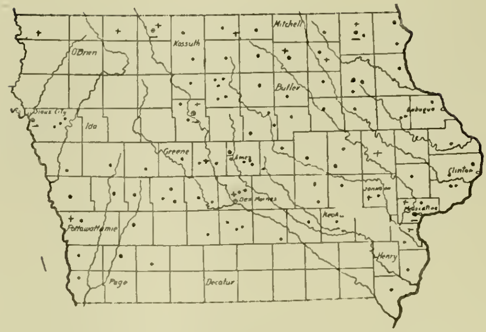


FIG. 215-A. Distribution of Biennial Wormwood.

lower leaves twice pinnately parted, the upper pinnatifid, the lobes linear or linear-oblong, serrate or cut-toothed; inconspicuous flowers; ray flowers absent; heads numerous in short axillary spikes; bracts of involucre green, scarious, margined.

Distribution.—Common in the northern Mississippi valley; now widely scattered east to Nova Scotia and south to Kentucky. It occurs in many parts of the state of Iowa.

Extermination.—Readily succumbs to cultivation. The plant should be cut off close to the surface of the ground.

Fireweed (*Erechtites hieracifolia* L. Raf.).

Description.—A coarse, annual weed of rank odor and grooved, often hairy stem; leaves simple, lanceolate or oblong, acute, cut-toothed, the upper with auricled base; heads many-flowered; receptacle naked; flowers tubular and perfect; achenes oblong, tapering; soft, white, capillary bristles.

Distribution.—This weed is common in moist woods; in the north especially in recent clearings which have been burned over, hence the common name fireweed; also occurs in the Rockies, and Kansas; common in many parts of Iowa, especially along streams.

Extermination.—Easily exterminated by cultivation. Plants should be cut off close to the surface of the ground.

FIG. 216. Fireweed (*Erechtites hieracifolia*). Common in clearings, woodland pastures.
(Photographed by Colburn.)

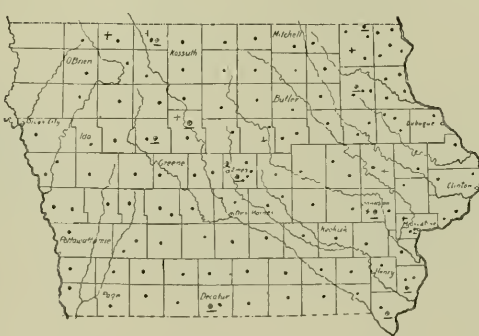


FIG. 216-A. Distribution of Fireweed.

Burdock (*Arctium lappa* L.).

Description.—A coarse, branched biennial 1-3 ft. high; hairy; leaves large, roundish or heart-shaped, thin, obtuse, entire or dentate, floccose, tomentose beneath; petioles deeply furrowed, heads of purplish or whitish flowers, clustered or somewhat corymbose; involucre surrounding the flowers lengthened into hooked tips, glabrous or slightly cottony; trichomes simple, long, twisted.

Distribution.—Burdock has long been known as a troublesome weed in the northern states and in Europe. Quite common from New Brunswick to Alabama and the Rocky mountains, the Great Basin country and on to the Pacific coast. Common in grain fields and waste places in many parts of the state.

FIG. 217. Burdock (*Arctium lappa*). Common in waste places. A biennial weed; "seeds" scattered by animals.
(Photographed by Gardner.)

Figure 217A

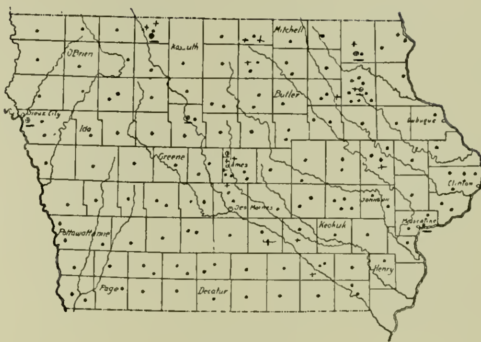


Figure 217B

FIG. 217-A. Trichome or plant hair from leaf of Burdock. (Drawing by Charlotte M. King.)

FIG. 217-B. Distribution of Burdock.

Extermination.—Burdock is easily destroyed. Since it is a biennial, cut off below the crown during spring or summer. If it comes up again, cut off once more, or as often as may be necessary.

Dr. Vasey says: "It may also be killed by being mowed when the seed has fully formed, and the tops burned."

Prof. Shaw says: "Farmers who go over their fields twice a year with the spade will soon have no burdock."

Prof. Goff says: "During the first year of growth the plant is readily destroyed by pulling out by the roots when the ground is very wet."

The important thing is not to allow it to go to seed; it will then die if left to itself. But we may always expect an abundance of the weed as long as it is allowed to grow in waste places. Then add to this its excellent means of dispersal and no wonder it is constantly coming up in out-of-the-way places.

Bull Thistle (*Cirsium lanceolatum* (L.) Hill).

Description.—Branching biennial, 3-4 ft. high, tomentose, becoming dark green and villous or hirsute with age, branchlets bearing large heads; leaves lanceolate, decurrent on the stem with prickly wings deeply pinnatifid, the lobes with rigid prickly points, upper face roughened with short hairs, lower face with a cottony tomentum; heads 1¾-2 in. high; bracts of the involucre lanceolate, rigid when young, more flexible with age, long-attenuated, prickly, pointed, spreading tips, wholly arachnoid; flower hermaphrodite; tube of the corolla 10 lines long; anther tips acute, filaments pubescent; achenes smooth, 1½ in. long; pappus of numerous plumose bristles.

Distribution.—Bull thistle is native and indigenous to Europe. It has long been an inhabitant of the northern states and now extends across the continent. In Iowa it is abundant in every county, frequently found in fields and particularly in pastures and woodlots.

Extermination.—This weed should be treated like all other biennials. The most important point is to prevent the seeds from forming. For this purpose the plant should be cut off in early spring below the surface of the ground. The seeds germinate in the spring and during the first season produce a flattened mass of leaves. The second season, a flowering stem shoots up rapidly; early in August the flowers begin to appear and these are continued till frost.

The only method of treating is to cut down and remove all the "roots" as far as it is possible to do so. If this is done frequently and thoroughly the weed can be exterminated. If the patch is a small one, cutting off the parts as soon as they appear above the ground, several times during the season, will certainly destroy this thistle. In larger patches, plow the ground, harrow and remove the thistle, either burn the material, or put into compost heaps. This should be done five or six times during the season or as often as occasion may require.

FIG. 218. Bull Thistle (*Cirsium lanceolatum*). Common in woodland pastures, roadsides and waste places.
(Photographed by Colburn.)

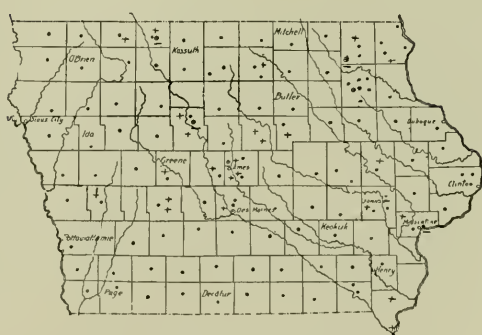


FIG. 218-A. Distribution of Bull Thistle.

Woolly Thistle (*Cirsium canescens* Nutt.).

Description.—Branching perennial, 2-4 ft. high, woolly throughout, branches bearing single, medium-sized heads; stem angled, white-woolly; leaves, radical, 8 in.-1 ft. long, the division usually 2-lobed, prominently ribbed, ending in stout spines; stem leaves, except the lower, 1-4 inches long, pinnatifid, the upper sessile, slightly roughened, with a slight cottony down, the lower white-woolly; heads 1½-2 in. high; bracts of the involucre somewhat arachnoid; lower scales with a broad base, glutinous ridge, and ending in a minutely serrated spine, inner scales long, attenuated, tips straw-colored; flowers purple.

Distribution.—This species is distributed from Mason City and southwestern Minnesota, west to the Rocky mountains. It was collected by Chas. A. Geyer in 1839 and described by Nuttall. The

FIG. 219. Woolly Thistle (*Cirsium canescens*). Common in western Iowa fields and roadsides.
(Photographed by Quade.)

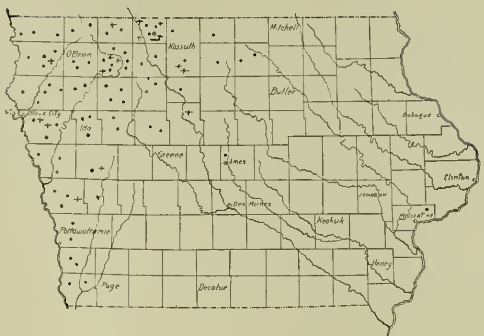


FIG. 219-A. Distribution of Woolly Thistle.

writer has seen it very abundant in both Wyoming and Colorado. The species occurs in Emmet, Dickinson, Sioux, Plymouth, Woodbury, Cerro Gordo, Worth, Ida and Carroll counties in Iowa.

FIG. 220. Woolly Thistle (*Cirsium canescens*). In pastures and fields of northwestern and western Iowa.
(Photographed by Pammel.)

Extermination.—Correspondents sending this weed frequently refer it to Canada thistle. It occurs not only in pastures and meadows, but also in corn and grain fields. It grows in patches like the Canada thistle. These patches increase in size from year to year. It was described as a doubtful perennial by early botanical writers and so far as I have been able to determine, it is a perennial. It may be exterminated by thorough cultivation, plowing well and then following with the cultivator.

Prairie Thistle (*Cirsium discolor* (Muhl.) Spreng.).

Dcscription.—Tall, branching, leafy biennial, 5-7 ft. high, with heads larger than in Canada thistle; stem striate, slightly hirsute; leaves radical, 12-14 in. long, deeply pinnatifid, the divisions frequently divided, prickly-toothed, the upper surface smoothish, and the lower white; woolly single heads terminating the branches, with

FIG. 221. Prairie or Wood Thistle (*Cirsium discolor*). Common border of woods, etc.
(Photographed by Colburn.)

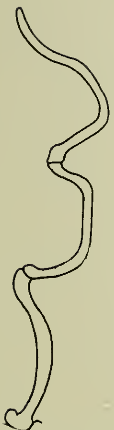


Fig. 221A

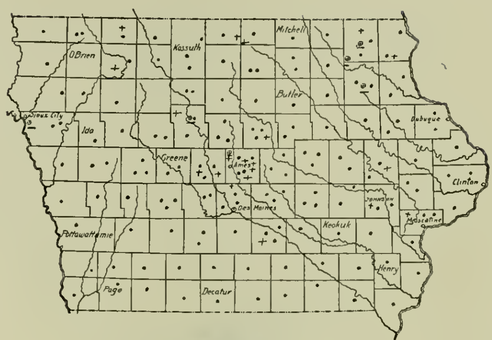


Figure 221B

FIG. 221-A. Trichomes or plant hairs of wood thistle.
FIG. 221-B. Distribution of Prairie Thistle.

purple flowers; heads 1-1½ in. long; bracts of the globose involucre somewhat suppressed, slightly arachnoid, lower bracts ovate with a broad base and a weak prickly recurved bristle, slight dorsal gland, inner linear-lanceolate with a nearly colorless entire appendage; flowers purple, tube of the corolla 11-12 lines long, lobes of the corolla terminating in clavate tips; anther tips acute, filaments pubescent; bristles of pappus plumose; achene 22 lines long, smooth, upper part yellow.

Distribution.—Common in many portions of Iowa; Marshall, Johnson, Winnebago, Lee, Winneshiek, Allamakee, Greene, and Emmet counties; at Keokuk, Muscatine, Ames, Cedar Rapids, Carroll, Des Moines, Polk City, Steamboat Rock, Mason City, Belle Plaine and Iowa City.

Extermination.—This field thistle should be treated like all other biennial weeds. The flattened masses in the spring should be cut off below the ground and none of the plants allowed to go to seed. We have received numerous inquiries in regard to this weed from western and northwestern Iowa.

Iowa Thistle (*Cirsium iowense* (Pammel) Fernald).

Description.—Biennial with downy, branching stem; leaves roughly hairy above but white-woolly beneath, oblong-ovate to narrowly lanceolate, sinuate-toothed, or somewhat pinnatifid, lobes or

Fig. 222. Iowa Thistle (*Cirsium iowense*). Common in pastures and meadows. (Photographed by Colburn.)

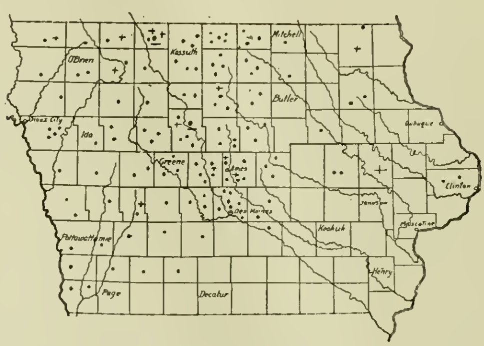


Fig. 222-A. Distribution of Iowa Thistle.

teeth with weak prickles; rather large heads; involucre 1-1½ in. long; bracts with broad glandular back, the inner with a somewhat attenuated colorless tip.

Distribution.—Common in borders of woods and in fields. From Iowa to South Dakota and Kansas. In Story, Emmet, Kossuth, Marshall, Boone, Linn, Clinton, Webster and Carroll counties in prairie meadows.

Extermination.—This biennial is readily destroyed by cutting the plants off below the surface of the ground. When left to flower it dies but in meadows where cut off above the surface of the ground it acts like a perennial.

Canada Thistle (*Cirsium arvense* (L.) Scop.).

Description.—Smooth perennial, spreading by roots and rootstocks, 1-3 ft. high, corymbosely branched at the top; stem smooth; leaves lanceolate, sessile, and deeply pinnatifid, lobes and margins of leaf with spiny teeth; heads small, ¾-1 in. high, bracts appressed, the outer with a broad base, inner narrow, all with an acute, never spiny, tip; somewhat arachnoid flowers purple, dioecious; in staminate plant, flowers exserted with abortive pistils, in pistillate less so, scarcely exceeding the bracts; tube of the corolla 6 lines long; stamens with abortive anthers, anther tips acute, filaments minutely pubescent; young achene pubescent; all of the bristles of the pappus plumose; trichomes simple, long, floccose.

Distribution.—This European weed is widely distributed in Canada to the Pacific coast; found in Iowa in many counties, more common in northern counties than in the southern. It is more or less abundant in Hardin, Pocahontas, Clinton, and Worth counties, frequently in clover meadows and in pastures.

Extermination.—The Canada thistle can be treated with sodium arsenite. No other chemicals, so far as our experiments extend, will entirely destroy this weed. Carbolic acid only partially destroys the roots and the plants shoot up again from below the point of injury, but by repeating the process the Canada thistle can ultimately be exterminated. A good method of eradicating the weed is to plow shallow and cultivate frequently during the summer. The roots of the Canada thistle extend deeply down into the soil, hence for this reason deep cultivation will be of no avail. After

FIG. 223. Canada Thistle (*Cirsium arvense*). Common and widely distributed in Iowa.
(After Clark and Fletcher.)

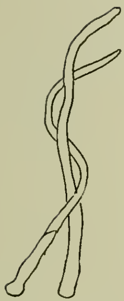


Figure 223A

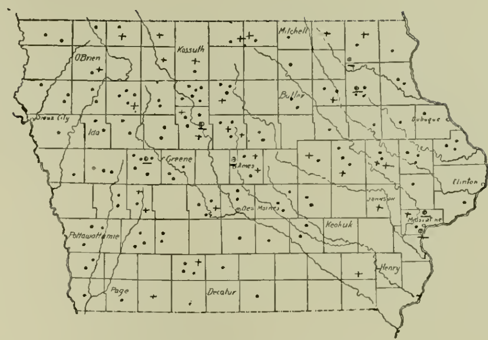


Figure 223B

FIG. 223-A. Trichome or plant hair from leaf of Canada Thistle. (Drawing by Charlotte M. King.)

FIG. 223-B. Distribution of Canada Thistle.

plowing, the soil should be dragged and the roots exposed to the sun and removed, when possible. It may be necessary to run over the field with a hoe to cut off the stray plants which appear. This method was tried on a patch several years ago and no Canada thistles have since made their appearance in this place. Various crops, such as clover and sorghum, are said to be effective in subduing the thistles.

Of the various chemicals which have been used to exterminate Canada thistles none are more effective than sodium arsenite. It is applied at the rate of 1½-2 pounds to 52 gallows of water.

Carbolic acid at the rate of one part to one part water destroys the root when it comes in contact with the mixture, and for a little distance beyond. This is not an effective method, as the roots sprout out from below.

In response to circulars of inquiry sent out by the Iowa Experiment Station, the majority of correspondents recommend shallow plowing, disking, and harrowing; and continuing cultivation and hoeing as long as the thistles make their appearance. Some report successful treatment with salt when scattered thickly about the thistles, especially if cattle or sheep are given access to it. Some report success with carbolic acid when it is applied directly to the stem. Tarred paper in a few cases gave success, as did also the method where the thistle was covered thickly with straw or manure. The depth of covering was not, however, given.

Clark and Fletcher recommend the following treatment: "The chief safeguard against the Canada thistle and all similar deep-rooted perennials is undoubtedly a regular short rotation. A three-year rotation, including two cuttings of early red clover for the first year, followed by a deep fall plowing for hoed crops with clean cultivation, and a cereal crop for the third year, will suppress it."

A correspondent in The Prairie Farmer on the resisting qualities of Canada thistle says: "I have been debating in my mind and endeavoring to determine whether or not root-stocks or portions thereof have to some extent the hibernating qualities of the seed. For instance, take two seeds of the cocklebur—one hibernates for one season and the other for two seasons, with growth always present. Now the question is may not a Canada thistle with its root-stock or a portion of it lie dormant for a season or more? If this be true, then some of the best known methods of extermination are useless."

To this Prof. R. A. Moore says: "In regard to Canada thistle roots hibernating and retaining their vitality for several years, will say, that I think your correspondent's version seems reasonable, and it is quite conclusive from this fact that the eradication of the pest is all the more difficult. It seems that many of the seeds and plants are given this power of remaining dormant when subjected to adverse conditions. In the lower order of plants, many of the species of bacteria when subjected to adverse environments are transformed into resistant spores and will not vegetate until the conditions are favorable."

Wallace's Farmer says concerning its eradication: "We believe if we had a quarter of an acre of Canada thistles we would let them alone until August, when the thistle will put forth its utmost efforts to produce seed. While the thistles are in full blossom we would mow them, rake them up and burn them, and then plow the ground about eight inches deep, throwing the furrow flat. Letting them put forth their full strength to produce seed and thwarting that by mowing and burning would weaken the roots materially. Then by plowing them under eight inches deep, if possible, you would attack them at their weakest point.

Knapweed (*Centaurea solstitialis* L.).

Description.—Annual erect, branched, cottony stem; lower leaves lyrate, deeply pinnatifid, upper leaves, linear, entire or nearly so, decurrent wings on the stem; outer bracts, with long spreading spines, those at base few and smaller; flowers yellow, with soft pappus.

FIG. 224. Knapweed, Star Thistle (*Centaurea solstitialis*). In alfalfa fields. (Mich. Agr. Exp. Sta.)

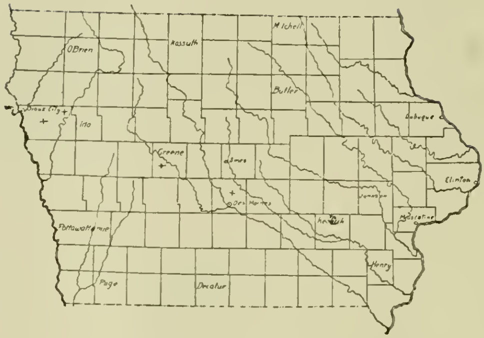


FIG. 224-A. Distribution of Knapweed.

Distribution.—Massachusetts to Ontario and Iowa; introduced with alfalfa seed into other western states.

Extermination.—This annual weed has been introduced largely with alfalfa seed. *Sow clean seed.* Use seed coming from the Rocky mountains or Kansas where the weed is not common. It is an extremely objectionable weed because of the spiny heads. It is easily killed by cultivation.

Chicory or Succory (*Cichorium intybus* L.).

Description.—A branching perennial with deep roots, alternate leaves; blue flowers, or sometimes pink or purple; basal leaves spreading on the ground; stem leaves oblong or lanceolate, partly clasping.

Distribution.—It is common along roadsides in fields and waste places from New England to Canada to Nebraska, especially common where chicory has been cultivated; it has become a troublesome weed in Wisconsin and Minnesota. It is allied to endive, cultivated as a salad plant.

Extermination.—Chicory is not difficult to destroy where rotation of crops is practiced. Though a perennial, the roots are easily killed by repeated cultivation.

Clark and Fletcher recommend the following treatment: "A short rotation of crops will soon suppress it. Chicory is not often seen in good farming districts except as a wayside weed. Individual plants may be destroyed by close cutting and applying salt to the root in hot, dry weather."

FIG. 225. Chicory (*Cichorium intybus*). In clover and alfalfa fields, sometimes in waste places.
(After Clark and Fletcher.)

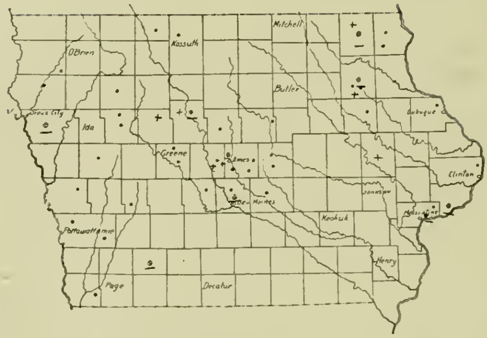


FIG. 225-A. Distribution of Chicory.

Dandelion (*Taraxacum officinale* Weber).

Description.—A smooth, or at first pubescent, biennial or perennial; the many-flowered head borne on a slender hollow scape; root leaves pinnatifid or runcinate; involucre double, the outer of

FIG. 226. Dandelion (*Taraxacum officinale*). Long root, sometimes to a depth of three and one-half feet in the soil.
(Photographed by Gardner.)

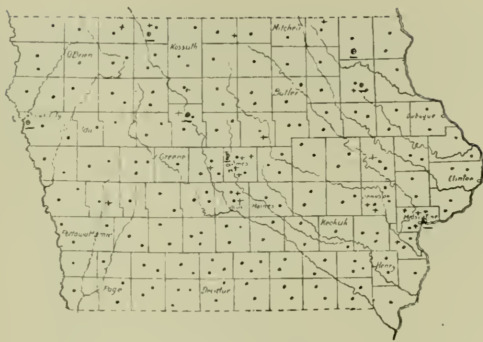


FIG. 226-A. Distribution of Dandelion.

short scales, the inner of long, linear, erect scales in a single row; after flowering the inner involucre closes, the fruit is ripened close to the ground, and when ripe the hollow scape elongates and the whole involucre is reflexed permitting the wind to scatter the "seeds;" "seeds" oblong, long-beaked, the beak being 2 or 3 times as long as the remainder of the achene, bearing at the end the pappus.

FIG. 226-B. A patch of Dandelion in a lawn, early in June. (Photographed by Charlotte M. King.)

Distribution.—The dandelion is cosmopolitan. It is quite as common in Europe as in the United States, being common and abundant at high elevations, as in the Rocky mountains. Found everywhere in Iowa on lawns and pastures.

FIG. 227. Common Dandelion (*Taraxacum officinale*). A weed common in lawns, pastures, etc.
(Photographed by Colburn.)

Extermination.—The dandelions are not difficult to exterminate in cultivated fields but in garden crops it is more difficult to do so, especially in strawberry beds. As the dandelions are perennial herbs, seed formation should be prevented. Where they occur in small patches a spud may be used successfully. Where they are abundant in lawns it is only necessary to keep the lawn closely cropped and dig them up with a small spud to prevent seeding. Blue grass and clover, especially the latter, will crowd them out. It is rare that dandelions give trouble after the middle of June.

FIG. 227-A. Common Dandelion (*Taraxacum officinale*). *1*, head; *2*, single flower; *3*, achene; *4*, receptacle and seed with pappus.

Experiments have been made with herbicides and the one most commonly used is iron sulphate which is usually applied at the rate of 100 pounds to one barrel of water. The weed where properly sprayed will be destroyed, but owing to the fact that the dandelion possesses a long perennial root, sometimes 4 feet long, it will sprout again. The spraying must be kept up until fall.

Chemical Composition.—According to the report of the Bussey Institution the chemical composition of the dandelion is as follows:

FRESH OR AIR DRY MATERIAL.

Water	Ash	Protein	Fiber	Nitrogen free Extract	Fat
85.54	1.99	2.81	1.52	7.45	0.69

WATER FREE SUBSTANCE.

	13.8	19.4	10.5	51.5	4.8

*Bull. 1877. Compiled by Jenkins and Winton; Bull. 11, Off. Exp. Sta., U. S. Dept. Agr.

Red-seeded Dandelion (*Taraxacum erythrospermum* Andrz.).

Description.—A perennial weed with long root; leaves deeply runcinate-pinnatifid or pinnately divided into narrow segments; heads somewhat smaller than in common dandelion, sulphur yellow; involucre glaucous, the inner bracts corniculate, appendaged at tip; the outer short, spreading or ascending; achene reddish, tuberculate above.

Distribution.—Red-seeded dandelion is a much more recent introduction than common dandelion. It occurs from Maine to Kansas. Naturalized from Europe, in similar situations to common dandelion in Iowa; sometimes less abundant and sometimes more abundant than the latter.

Extermination.—May be exterminated in the same way as the common dandelion.

FIG. 228. Red-seeded dandelion (*Taraxacum erythrospermum*). Common in lawns.
(Photographed by Colburn.)

Clark and Fletcher recommend the following treatment: "It is important to prevent dandelions from seeding in lands adjacent to lawns. Though entailing much labor, the most satisfactory way to deal with them, when deeply rooted in lawns, is to loosen the soil with a digging fork and pull them up. The use of the fork may not be necessary in some wet and soft soils. The application of kerosene to the crown of the plant, in the centre of the rosette of leaves, is recommended. Sulphate of ammonia or sulphate of iron in excess is also recommended. A small tablespoonful of salt applied in the morning of a hot day, when the soil is dry, will kill them.

Annual Sow-thistle (*Sonchus oleraceus* L.).

Description.—Annual, succulent herb with leafy, smooth stems, and pale yellow flowers in corymbose or umbellate clusters; leaves of stem dentate, runcinate-pinnatifid, terminal with a large segment; heads numerous; blossoms in late summer and fall.

Distribution.—This weed is common in fields and waste places throughout North America, especially in the north. It is common in Europe and also occurs in Mexico and South America.

Extermination.—Sow thistle is easily exterminated by cultivation. It can also be exterminated by the use of iron sulphate at the rate of 100 pounds to a barrel of water; where it is abundant it may be necessary to make two or three applications.

Clark and Fletcher recommend as follows: "Prevent them from seeding in waste places by cleaning them up and seeding them to permanent, vigorous grasses. This annual weed, with its relatively small, pale yellow flowers, when compared with perennial species is not difficult to control by ordinary methods of cultivation and alternation of crops. Sheep, if sufficient in numbers, will prevent sow thistles from seeding in pasture lands."

The Iowa Homestead says concerning its eradication: "We have seen the sow thistle take complete possession of a soil, growing so thickly that other crops were entirely choked out. Necessarily the best way to destroy it is to cultivate freely. If it makes its appearance in stubble ground we would advise plowing as early as possible after harvest and the cultivation of surface at intervals during the late summer and fall in order to keep the thistles below the ground.

FIG. 229. Common Sow Thistle (*Sonchus oleraceus*). Waste places. (After Clark and Fletcher.)

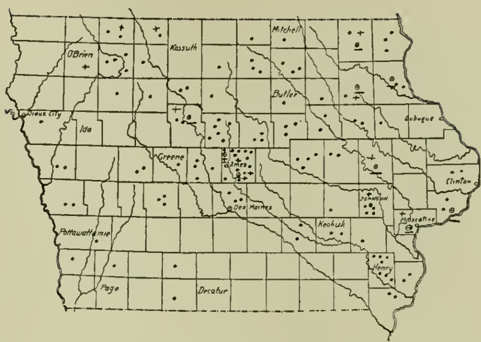


FIG. 229-A. Distribution of Annual Sow Thistle.

Sow Thistle (*Sonchus asper* (L.) Hill).

Description.—Like the preceding species except that stem leaves are less divided and more spiny-toothed, with auricles of the

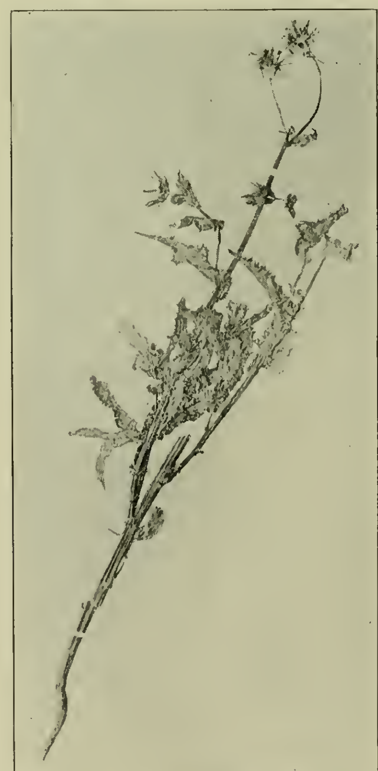


FIG. 230. Sow Thistle (*Sonchus asper*). Waste places, yellow flowers and milky juice.
(Photographed by Colburn.)

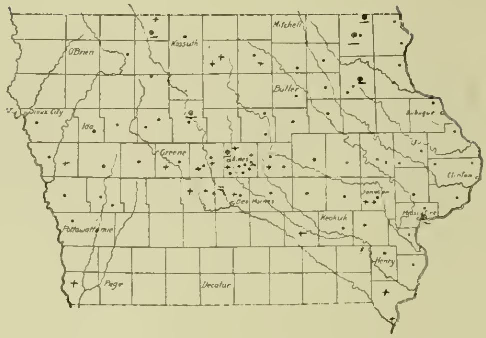


FIG. 230-A. Distribution of Sow Thistle.

clasping base rounded; achenes 3-nerved on each side and margined, smooth.

Distribution.—Common with the preceding species, in waste places.

Extermination.—This annual is not difficult to exterminate by giving thorough cultivation.

Perennial Sow Thistle (*Sonchus arvensis* L.).

Description.—A perennial with creeping root-stock, and milky juice; leaves runcinate, pinnatifid and spiny toothed, heart-shaped base; flowers yellow; peduncle and involucre bristly; achenes ob-compressed, wrinkled on the ribs.

Distribution.—Common from Nova Scotia west to Saskatchewan, North Dakota, Minnesota, occasional in Iowa to New Jersey and New England.

Extermination.—A most difficult weed to exterminate and should be treated like the Canada thistle. Summer fallow with frequent cultivation is the only successful method. Clark and Fletcher of Canada, recommend the following:

"Small patches may be eradicated by digging out the roots as thoroughly as possible and destroying them. This may have to be done several times during a season. Great care must be taken not to distribute pieces of the rootstocks over the fields by harrows or other implements. To exterminate Perennial Sow Thistle, some system must be adopted which will prevent the development of leaves for a period sufficiently long to kill the roots by smothering

FIG. 231. Perennial Sow Thistle (*Sonchus arvensis*). Plants with bright yellow flowers, milky juice. Not common in Iowa. A difficult weed to exterminate.

(Photographed by Colburn.)

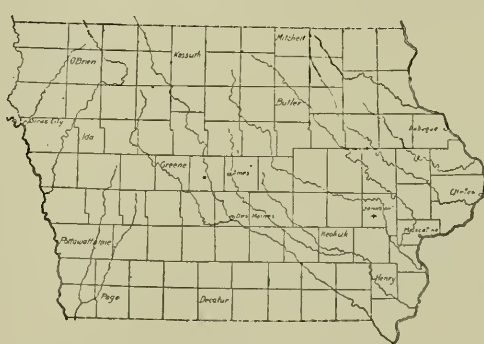


FIG. 231-A. Distribution of Perennial Sow Thistle.

them. When a field is badly infested it requires special treatment for a season and close attention for a number of years. One of the most effective methods is to plow lightly immediately after the hay or grain crop is removed and follow with frequent use of a broad-shared cultivator. Late in the fall plow again, somewhat deeper. In the spring give frequent cultivation, so as to prevent the development of any leaves and thus weaken the roots to the greatest possible extent. About the middle of June or first of July sow rape in drills at the rate of about 1½ lbs. per acre. Cultivate between the drills as soon as possible and repeat at short intervals until the rape completely covers the ground. Some hand hoeing may be necessary to keep all the thistles down. This should pretty well exterminate the pest but if some plants still remain when the rape is cut or pastured off, the field may be fall plowed and put into hoed crop the next season, when special attention can be given to any small patches that may appear. Buckwheat is sometimes used instead of rape for a smothering crop."

Prickly Lettuce (*Lactuca scariola* L. var. *integrata* Gren. & Godr.).

Description.—Tall, erect herbs, glaucous, green, 2-5 ft. high, simple or branched except the lower part of stem which has stiff bristles; leaves glaucous, green, smooth except the midrib which is beset with weak prickles lanceolate to oblong in outline, with spinulose, denticulate margins, occasionally sinuate-toothed; flowers pale yellow. The leaves of *L. scariola* are pinnatifid and more prickly; trichomes multicellular.

Distribution.—Prickly lettuce was introduced into Massachusetts about 1863 from Europe. It is quite widely distributed in northern Africa and Europe and has become frequent throughout the northern Mississippi valley to the Pacific coast. It is common everywhere in Iowa particularly along roadsides, highways and in gardens. The *L. scariola* is becoming more frequent in Iowa, in Ames, Des Moines, Boone, etc.

Extermination.—The weed is easily exterminated from cultivated fields and in waste places by cutting off young plants below the ground. Where the stem is cut off below the surface of the ground it will give no trouble, but in meadows and lawns where the plants are cut off above the ground the weed will continually reappear, producing from 3-6 branches. The following excellent suggestions are made by L. H. Dewey:

FIG. 232. Prickly Lettuce (*Lactuca scariola* var. *integrata*). Common roadsides and gardens.
(After Clark and Fletcher.)

Figure 232A

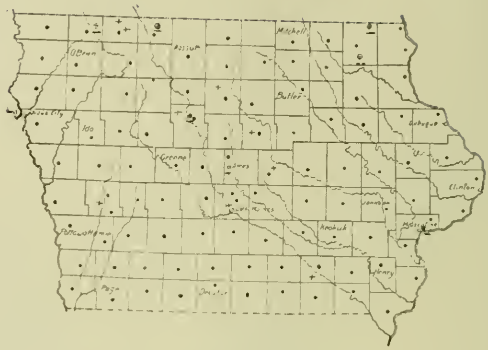


Figure 232B

Fig. 232-A. Bristles on Prickly Lettuce (*integrata*). (Drawing by Charlotte M. King.)
Fig. 232-B. Distribution of Prickly Lettuce.

"Sheep and sometimes cattle will eat the young prickly lettuce, and in some localities their services have been found very effective in keeping it down, especially in recently cleared land where cultivation is impossible. Repeatedly mowing the plants as they first begin to blossom will prevent seeding and eventually subdue them. Thorough cultivation with a hoed crop, by means of which the seed in the soil may be induced to germinate, will be found most effective. The plowing should be shallow so as not to bury the seeds too deep. Under no circumstances should the mature seed-bearing plants be plowed under, as that would only fill the soil

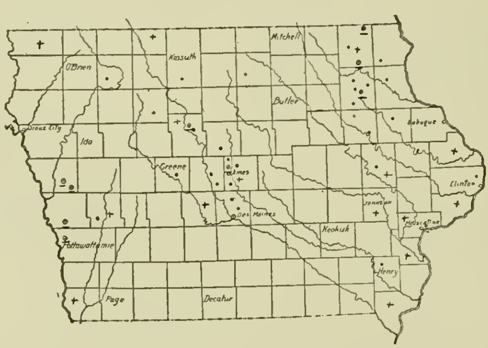


Fig. 232-C. Distribution of Prickly Lettuce (*Lactuca scariola*).

with seeds buried at different depths to be brought under conditions favorable for germination at intervals for several years. Mature plants should be mowed and burned before plowing. The seed appears as an impurity in clover, millet and the heavier grass seeds, and the plant is doubtless most frequently introduced by this means. As the seeds may be carried a long distance by the wind, the plants must be cleared out of the fence rows, waste land and roadsides."

Clark and Fletcher recommend as follows: "The seed is short-lived and if the plant is kept closely cut and prevented from seeding in waste places for two or three years it will soon disappear from cultivated areas. Clean waste lands and seed to permanent vigorous grasses. Ordinary methods of cultivation will suppress it in the fields."

Wild Lettuce (*Lactuca canadensis* L.).

Description.—Stem leafy, glabrous or nearly so, glaucous; lower leaves sinuate, pinnatifid, upper entire; heads numerous, in a rather long, open panicle; flowers yellow.

Distribution.—Nova Scotia to Ontario, Ohio and westward; frequently found in Iowa.

Extermination.—This perennial is not difficult to destroy by cultivation.

FIG. 233. Wild or Canadian Lettuce (*Lactuca canadensis*). Fields, roadsides and meadows.
(Photographed by Quade.)

FIG. 233-A. Wild or Canadian Lettuce (*Lactuca canadensis*). Plant with milky juice and yellow flowers.
(Photographed by Quade.)

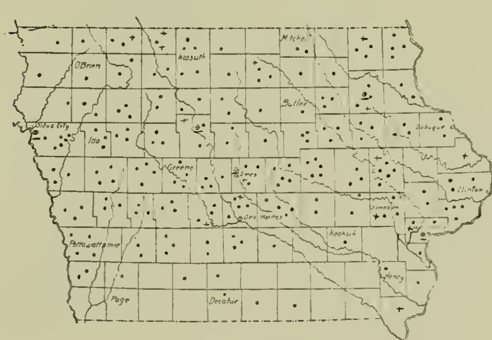


FIG. 233-B. Distribution of Wild Lettuce.

Blue Lettuce (*Lactuca pulchella* (*Pursh.*) DC.).

Description.—Perennial plant, deep-rooted, pale or glaucous; stem simple, about 1 foot high; leaves sessile, oblong or linear-lanceolate, glabrous, entire, or lower leaves somewhat pinnatifid; racemose heads large, erect; peduncles with scaly bracts; bracts of involucre imbricated in 3-4 ranks; flowers blue.

Distribution.—Northern Michigan and Ontario southward; reported from several localities in Iowa.

Extermination.—Prevent from distributing seed by continued cutting before flowering. If it becomes established in a field, try thorough summer fallow with deep cultivation so as to check growth of long rootstocks.

FIG. 234. Blue Lettuce (*Lactuca pulchella*). Blue flowered lettuce. Plant with milky juice. Common in western Iowa.
(Photographed by Quade.)

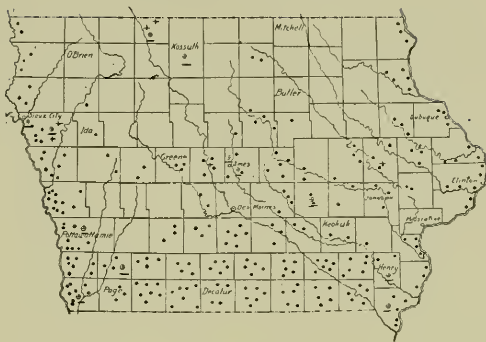


FIG. 234-A. Distribution of Blue Lettuce.

Rushlike Lygodesmia (*Lygodesmia juncea* (Pursh.) D. Don.).

Description.—A tufted, smooth, frequently glaucous perennial a foot or more high, coming from a thick woody root, with copious

FIG. 235. Lygodesmia or Skeleton Weed (*Lygodesmia juncea*). A deep rooted perennial with a yellowish milky juice. (Photographed by Colburn.)

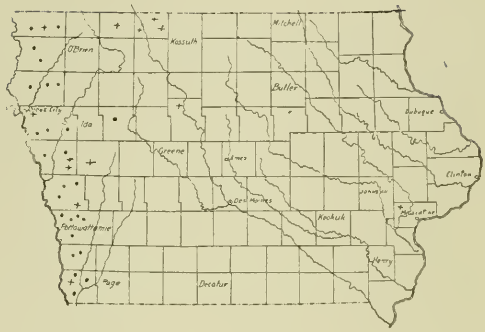


FIG. 235-A. Distribution of Lygodesmia.

yellowish juice; lower leaves rigid, linear-lanceolate, small, entire, the upper scalelike; flowers purple in erect heads; achenes narrow-ribbed, pappus light brown. This weed is sometimes called skeleton weed.

Distribution.—This weed is common from Missouri river to western Montana and east to St. Croix river in Wisconsin. A somewhat troublesome weed in northwestern Iowa; easily recognized by the yellowish juice and rushlike stems.

Extermination.—This plant produces a long root which enables the plant to spread rapidly. It also produces a large number of "seeds." Where the weed is common, plough the field after harvest and disk the plants. It is a good plan to follow up with a hoe, cutting off the plants.

CHAPTER II.

THE GENERAL CHARACTERS OF SEEDS

By

L. H. PAMMEL

and

CHARLOTTE M. KING

CHAPTER II.

CYPERACEAE, SEDGE FAMILY.

Sedge (*Carex vulpinoidea* Mx.).

Achene enclosed by an utricle called the perigynium, hardly 3-angled, somewhat flattened, tipped by lanceolate 2-toothed beak, the persistent base of the flower-style; achene flask-shaped, about

Figure 236A

Figure 236B

FIG. 236. Forms of Sedges. *a, Eleocharis palustris; b, Carex vulpinoidea.* (After Gray.)

one-sixteenth of an inch in length, light brown; surface inconspicuously nerved; whitish, projecting scar.

Spike Rush (*Eleocharis palustris* R. Br.).

Achenes slightly flattened, somewhat lenticular, with 2 or 3 obtuse angles one-twelfth to one-tenth in. long, brown, smooth, shining, minutely cross-striated; seed with persistent tubercle from tip; tubercle conical, triangular, constricted; bristles pale, longer than

FIG. 237. Achenes, "seeds," of common forms of Sedges (*Carex*). (After Hillman, Bull. Nevada Agr. Exp. Sta.)

achene; seed may appear with or without tubercle and bristles. Seed occasionally found in seed of alsike and red clover from wet grounds.

GRAMINEAE, GRASS FAMILY.

Johnson Grass (*Sorghum halepense* (L.) Pers.).

Sessile spikelet broadly lanceolate, acute, 4-6 mm.* long, becoming dark at maturity; callus small, obtuse, shortly and sparsely barbate; first glume coriaceous, slightly pubescent on the flattened back, 5-7 nerved; second similar, equal to first, with hyaline, ciliate,

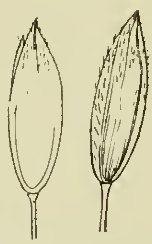


FIG. 238. Spikelet of Johnson Grass (*Sorghum halepense*). (Drawn by Charlotte M. King.)

inflexed margins; the third glume shorter, membranous, faintly 2-nerved, with ciliate, infolded margins; fourth glume broad, obtuse, shorter than second, 2-lobed at apex, ciliate, awned; awn 10-16 mm. long; palea shorter than glumes, without nerves, ciliate.

Smooth Crab Grass (*Digitaria humifusa* Pers.).

Spikelets lanceolate or elliptical, one-twelfth in. in length, acutish; glumes usually present, first glume wanting, sometimes rudimentary, 3-nerved; the first and second, hairy on the margins;

*1 mm. = 0.0394 inch, or nearly one-twenty-fifth inch.

Fig. 239. Seeds of Smooth Crab Grass (*Digitaria humifusa*). A and B, spikelets; A showing the second glume, B showing the third glume. C, D and E, florets; D, bearing a portion of the second glume, E, the inner face, showing the edges of the flowering glume. F, a spikelet of *Digitaria filiformis*, showing the shorter second glume. G, the natural size of both of these species. (After Hillman, Bull. Nevada Agr. Exp. Sta.)

the third, 7-nerved; the fourth, dark purplish brown. Occurrence very frequent in alfalfa clovers and commercial grass seed.

Crab Grass (*Digitaria sanguinalis* (L.) Scop.).

Spikelets one-seventh in. in length with usually persistent scale-like glumes, lanceolate, pedicellate; second glume usually ciliate on margins, short; fourth glume silky-villous along marginal nerves, 5-nerved, color pale. Frequently occurs in red and alsike clover, as well as in timothy.

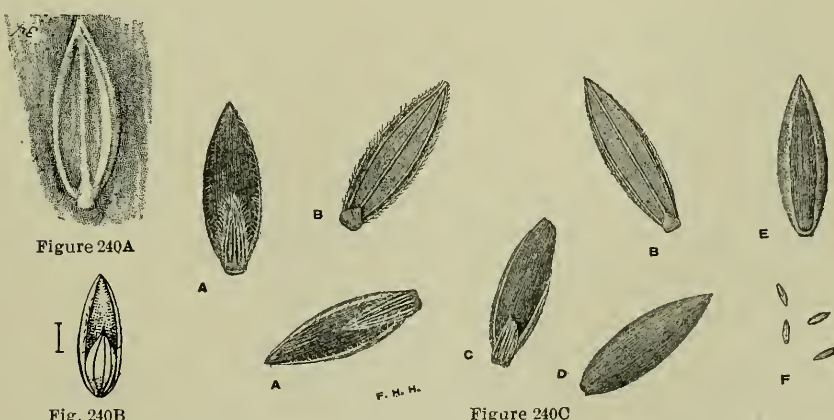


Fig. 240. Common Crab Grass (*Digitaria sanguinalis*). A, an enlarged view of Crab Grass. B, with small glume attached. C. A, spikelets showing the second glume, floret, and edges of the third glume. B, the opposite face, showing the minute first glume and third glume. D and E, the two faces of the floret. F, seeds, natural size.
(A and B, Drawings by C. M. King; C, after Hillman, Bull. Nevada Agr. Exp. Sta.)

Tickle or Hair Grass (*Panicum capillare* L.).

Spikelets small, ovate or acute, one-fifteenth to one-twelfth in. long, acuminate-pointed, smooth, shining; sterile glumes usually absent, when present not shining; first glume 1-3-nerved, obtuse to

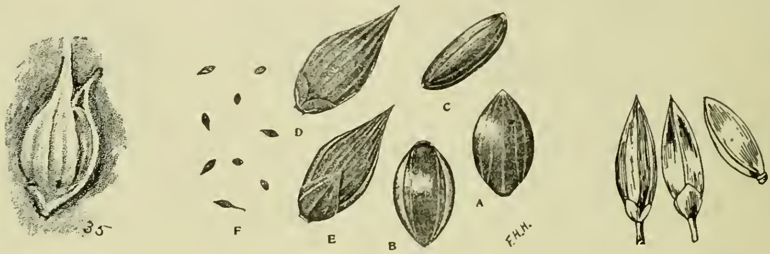


Figure 241A Figure 241A Figure 241B

Fig. 241. A. Tickle or Hair Grass (*Panicum capillare*). At the left a spikelet opened, at the right various views. A, B and C, the outer, inner and edge views, respectively, of a floret. D and E are views of the spikelet, D showing the second glume and the first in part, and E the first and third and the second in part. F, a group showing the natural size of the preceding.

B. Sprouting Crab Grass. Various views of spikelets.

(A, at the left, drawn by C. M. King; A, at the right, after Hillman, Bull. Mich. Agr. Exp. Sta.; B, drawn by C. M. King.)

acute; second and third glumes 5-7-nerved, tips acute; flowering glume shining, smooth, elliptical, obtuse, or subacute. Often found in clovers and in timothy.

Sprouting Crab Grass (*Panicum proliferum* Lam.).

Spikelet lanceolate, ovate, acute, one-tenth in. in length, smooth; lower glume obtuse, nerveless or 1-3-nerved; second and third glume equal, acute, 5-7-nerved; flowering glume smooth and shining; pedicels scabrous. Rarely found in clover.

Switch Grass (*Panicum virgatum* L.).

Spikelets ovate, acuminate, 3-5-nerved; flowering glume shorter than the outer glumes, smooth, shining, minutely striated; with outer glumes removed, the spikelet resembles a small jassid. Rarely found in clovers.

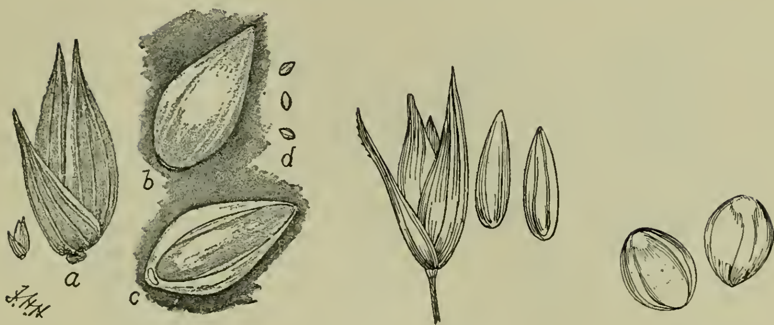


Figure 242A Figure 242B Figure 242C

FIG. 242. A. Switch Grass (*Panicum virgatum*). a, b, c, various views of spikelet; d, "seeds," natural size.
B. A single spikelet.
C. Millet (*Panicum miliaceum*).
(A, after Hillman, Bull. Mich. Agr. Exp. Sta.; B and C, drawings by Charlotte M. King.)

Millet (*Panicum miliaceum* L.).

Spikelets acuminate, one-eighth to one-fifth in. long, lower glume acuminate, 5-7-nerved; third glume subtending the empty palet, 7-13-nerved; flowering glume indurated, obtuse, shining, minutely cross-striated; the hulled seeds ovoid, yellowish. Found in clover and alfalfa seed.

Barnyard Grass (*Echinochloa crusgalli* (L.) Beauv.).

Spikelets with hispid or pubescent nerves; first glume shorter than the third, awned; second awnless or short-awned; third with long rigid awn; flowering glume generally ovate; one-tenth to one-ninth in. longitudinally striate; palet smooth. Not infrequently found in clovers.

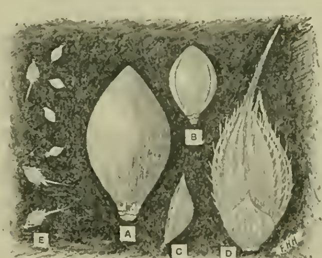


FIG. 243. A. Barnyard Grass (*Echinochloa crusgalli*). A, a floret, back view of the glume. B, front view of floret, showing the palea. C, edge view of the same. D, the spikelet, showing the small first glume, the awned third glume, and the tip of the second. E, a group showing the natural size of the preceding.

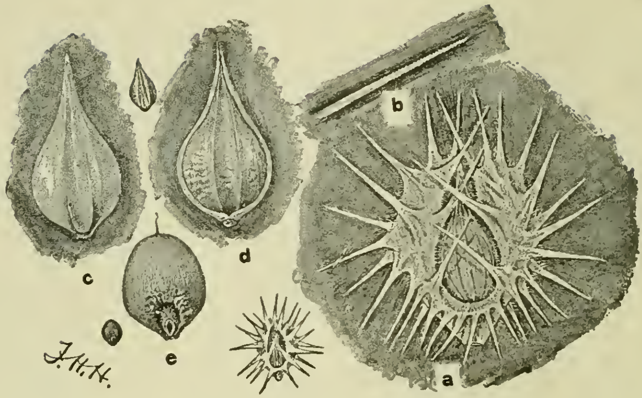


FIG. 243. B. Sandbur (*Cenchrus tribuloides*). a, bur enlarged; b, spine; c and d, spikelet; e, seed.

(After Hillman; A, Bull. Nevada Agr. Exp. Sta., B, Bull. Michigan Agr. Exp. Sta.)

Sandbur (*Cenchrus tribuloides* L.).

Burs with sharp, straight, pubescent prickles; each bur with 6-20 globose spikelets.

Green Foxtail (*Setaria viridis* (L.) Beauv.).

"Seeds" about one-twelfth in. in length, biconvex, color light green, or greenish; with flowering glume rounded, slightly granu-

FIG. 244. A. Green Foxtail (*Setaria viridis*). A and B, views of the floret; A, the back of the glume; B, showing the palea, its shining edges partially covered by the edges of the glume. C, a floret covered by the empty glumes (a spikelet), the figure showing the first and third glumes. D, a group showing the natural size.

B. Slightly enlarged spikelet.

C. Whorled Millet (*Setaria verticillata*).

(A, after Hillman, Bull. Nevada Agr. Exp. Sta.; B and C, drawings by Charlotte M. King.)

lar, striate lengthwise and with cross-ridges; palea shining; commonly brownish or greenish. In alfalfa, clovers and grass seed.

Whorled Millet (*Setaria verticillata* (L.) Beauv.).

Spikelets elliptical-ovate, one-twelfth in. long; first glume triangular-ovate, acute or obtuse, 3-nerved; second glume ovate, obtuse, 5-7-nerved; third glume, 5-7-nerved, bears short palet in its axil; flowering glume about one-fifteenth in. in length, striate, nearly smooth; bristles about the flower, 1 or 2, retrorsely scabrous, one-twelfth to one-third in. long. Found in clover seed.

Yellow Foxtail (*Setaria glauca* (L.) Beauv.).

"Seeds" about one-eighth in. in length, very variable; color, yellowish, brownish, or even pale; perfect flower with flowering glume plano-convex, partially covering edges of palet; back of

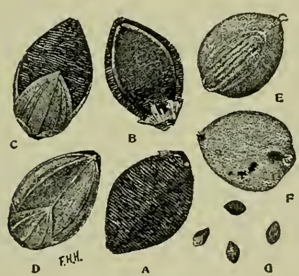


Figure 245A

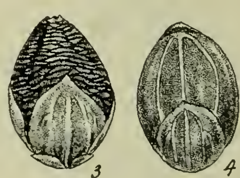


Figure 245B

FIG. 245. Yellow Foxtail or Pigeon Grass (*Setaria glauca*). A and B, the outer and inner faces, respectively, of a floret; B, showing the palea. C and D, the same showing the empty glumes of the spikelet; C, showing the second glume, and the first and third in part; D, showing the first and third glumes and the second slightly. E and F, the grain; E, the convex, embryo-bearing face; F, the plane face. G, a group showing the natural size.
B. Slightly enlarged spikelet.
(A, after Hillman, Nevada Agr. Exp. Sta. Bull.; B, drawing by Charlotte M. King.)

flowering glume with prominent transverse branching ridges; flowering glume minutely granular. In alfalfa, clovers and grass seed.

Mexican Dropseed (*Muhlenbergia mexicana* (L.) Trin.).

Spikelet about one-twelfth in. long, on very short pedicel; empty glumes nearly equal, acuminate; flowering glume lanceolate, 3-nerved, scabrous on keel, pilose near base; sterile and flowering glumes marked by dark, longitudinal lines; seed brown, about one-twelfth in. in length, marked at embryo by darker elliptical area. Occurs in alfalfa and the clovers.

Marsh Muhlenberg (*Muhlenbergia racemosa* (Mx.) B. S. P.).

Spikelets one-sixth to one-quarter in. long; lower glume acuminate-pointed; flowering glume acute, densely bearded at base, minutely pubescent and marked by black lines; seed slender, cylindrical, brown, with black area at one end. Found in timothy and clover seed.

Fig. 246. Dropseed Grasses. A. Seed of Mexican Dropseed Grass (*Muhlenbergia mexicana*). B. Spikelet of Marsh Muhlenberg (*M. racemosa*). C. Nimble Will (*M. schreberi*).
(Drawings by Charlotte M. King.)

Nimble Will (*Muhlenbergia schreberi* J. F. Gmel.).

Spikelet one-twelfth in. in length, as long as or longer than pedicel; empty glume minute; lower sometimes absent; flowering glume lanceolate, slender, awned, scabrous on nerves. Found in clover seed.

Timothy (*Phleum pratense* L.).

Flowering glume or larger scale marked by several veins, truncate at top, shorter scale or palet also prominent; seed usually with flowering glume; one-sixteenth to one-twelfth in. long; color light

Fig. 247A

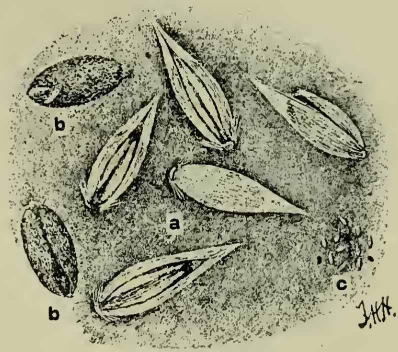


Figure 247B

FIG. 247. A. Timothy (*Phleum pratense*). Hulled and unhulled seed. B. Red Top (*Agrostis alba*).
(A, drawing by Charlotte M. King; B, after Hillman, U. S Dept. Agr.)

gray; seeds somewhat transparent with darker elongated area at lower end, marking the location of the embryo.

Red Top (*Agrostis alba* L.).

Spikelet one-twelfth to one-eighth in. long, empty glumes lanceolate, acute; the first scabrous on the keel; the second a little shorter, and smooth or scabrous near the apex: flowering glume a little shorter than the empty cnes, obtuse or truncate; palet one-half to three-quarters as long as glume; rachilla frequently present in seed, roughened; fruit brownish, ovate.

Wild Oats (*Avena fatua* L.).

Fruit spindle shape, and of a light yellow color on the tip, balance darker yellow to blackish brown; bears one long geniculate awn with lower end twisted; basal scar oval, sloping, with a bunch of soft hairs just above; size 15 mm.

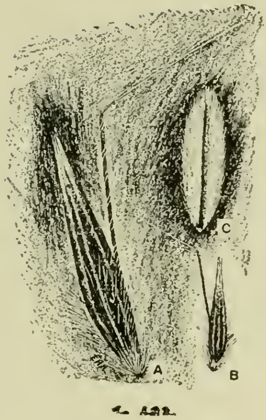


Figure 248A

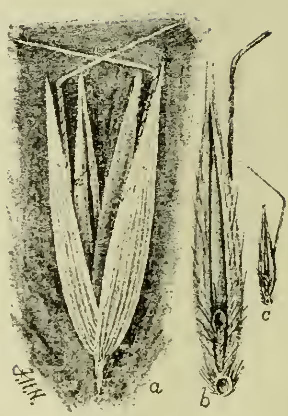


Figure 248B

FIG. 248. Wild Oats (*Avena fatua*). a, spikelet; b, floret; c, natural size. (A, after Hillman, Bull. Nev. Agr. Exp. Sta.; B, Bull. Mich. Agr. Exp. Sta.)

Crowfoot or Goose Grass (*Eleusine indica* Gaertn.).

Spikelets closely imbricated, 1½-2 lines (3¾-5 mm.) long, 3-6-flowered; glumes obtuse, the first small, 1-nerved, the second larger, with flowering glumes 3-5-nerved; seeds rugose, enclosed within a thin, loose pericarp.

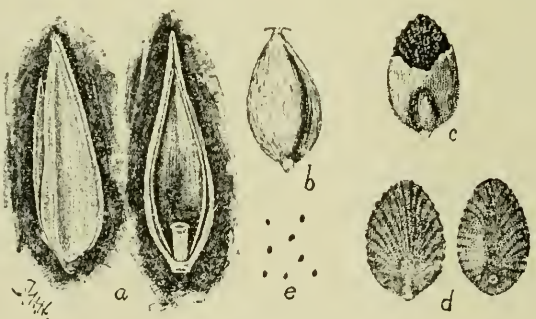


Figure 249A

Figure 249B

Figure 249C

FIG. 249. A. Crowfoot or Goose Grass (*Eleusine indica*). a, florets; b, c, d, views of seed.
B. Tufted Eragrostis (*Eragrostis pilosa*), a, spikelet; b. fruit.
C. Candy Grass (*Eragrostis megastachya*). A. Seeds enlarged. B. Seeds natural size.

Candy Grass (*Eragrostis megastachya* (Koeler) Link.).

Spikelets ovate to linear, many-flowered, one-sixth to two-thirds in. long; empty glumes nearly equal, ovate-lanceolate, one-twelfth in. long, prominently nerved, scabrous on keel; palet ciliate on keel; seed small, ovoid to elliptical, one-thirty-second in. in length, color brown. Found in commercial grass seed and alsike clover.

Southern Spear Grass (*Eragrostis pilosa* (L.) Beauv.).

Spikelet narrow, lanceolate, 3-15-flowered, equaling or exceeding the capillary pedicels, one-sixth to five-twelfths in. long; empty glume ovate, acute, scabrous on keel; flowering glume broadly ovate, obtuse, 3-nerved, scabrous on keel, one-seventh in. in length; palet ciliate on keel; seeds small, elliptical or ovoid; one-twenty-eighth in. in length. Found in commercial grass seed.

Orchard Grass (*Dactylis glomerata* L.).

Spikelets compressed, 3-5-flowered, in crowded, 1-sided clusters; flowering glumes lanceolate, acute or awn-pointed, one-sixth to one-quarter in. in length, ciliate on keel, and otherwise minutely pubescent; callus at base; palet serrate on margin near upper end and minutely pubescent.

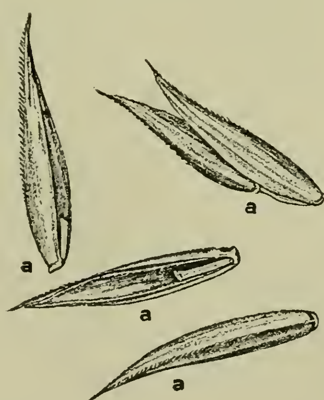


FIG. 250. Orchard Grass (*Dactylis glomerata*). (After Hillman. U. S. Dept. Agr.)

Wire Grass (*Poa compressa* L.).

Spikelets lanceolate, 5-9-flowered, one-sixth to one-quarter in. in length, flowering glumes about one-seventh in. in length, obscurely 5-nerved; marginal teeth of palet continue to extreme apex. Found with seed of Kentucky blue grass and other commercial grass seed.

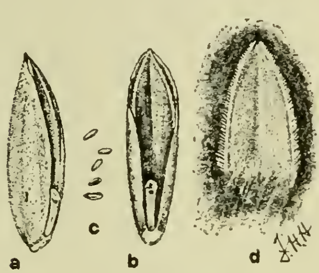


Figure 251A

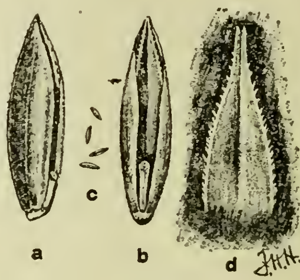


Figure 251B

Fig. 251. A. Wire Grass (*Poa compressa*). a, b, two views of seed; c, natural size; d, upper portion of palet showing marginal spines. B. Kentucky Blue Grass (*Poa pratensis*). a, b, two views of seed; c, natural size; d, upper part of palet showing marginal spines.
(Hillman, Bull. Mich. Agr. Exp. Sta.)

Kentucky Blue Grass (*Poa pratensis* L.).

Spikelet 3-5-flowered, one-sixth in. long, on short scabrous pedicels; empty glumes slightly unequal, lower nearly lanceolate, 1-nerved, upper glume broader, 3-nerved; flowering glume ovate, scarious towards the apex, base cobwebby, rachilla slender; palet with marginal teeth disappearing short of the apex. Found occasionally in fescue grass seed and the commercial grass seed.

Meadow Fescue (*Festuca elatior* L.).

Spikelet lanceolate, 5-10-flowered; empty glume lanceolate, acute, one-quarter in. long, smooth, faintly striate; indistinctly 5-nerved; rachilla slender. Occasionally found in brome grass and rye grass seeds.

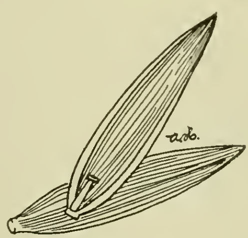


Fig. 252. Meadow Fescue (*Festuca elatior*).
(Drawing by Ada Hayden.)

Soft Chess (*Bromus hordeaceus* L.).

Flowering spikelet 7-9 mm. in length, obtuse and awned; awns 6-8 mm. in length; roughened; glume with 3 nerves on each side; glume bearing numerous hairs upon the surface; caryopsis 5 mm. long, 2 mm. wide, light brown, scar at base, extending one-third length of seed.

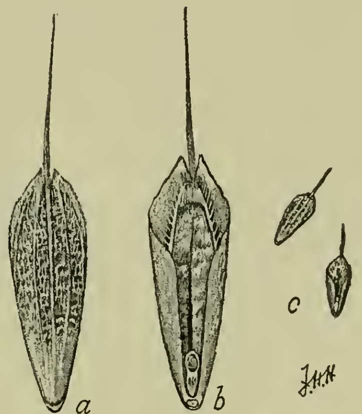


Figure 253A

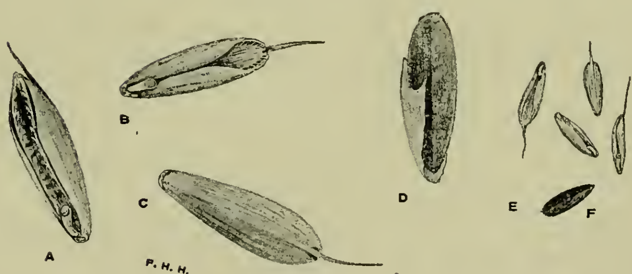


Figure 253B

FIG. 253. A. Soft Chess (*Bromus hordeaceus*). a, b, views of enlarged seed; c, natural size.
B. Chess (*Bromus secalinus*). a, b, c, d, views of seed, enlarged; e, natural size.
(After Hillman.)

Smooth Brome or Hungarian Brome Grass (*Bromus inermis* Leyss.).

Empty glumes unequal; flowering glumes awnless or short-awned, with broad scarious margin at obtuse or emarginate apex; veins of flowering glume conspicuous, roughened; veins of palet roughened; seed flattened, boat-shaped, one-third in. in length, one-twelfth in. in width.

Figure 254B Figure 254A

Fig. 254. A. Smooth Brome (*Bromus inermis*). B. Awned Brome (*Bromus tectorum*).
(A, after Hillman; B, drawn by Ada Hayden.)

Awned Brome Grass (*Bromus tectorum* L.).

Spikelet with unequal, acuminate-pointed, hirsute empty glumes, and rough or hirsute flowering glumes 8-12 mm. long; awn 12-16 mm. long.

Chess (*Bromus secalinus* L.).

Spikelets tinged, 6-12-flowered, pendulous in fruit, one-twelfth to two-fifths in. long; empty glume oblong-lanceolate; flowering glume ovate-oblong, obscurely 7-nerved, nearly awnless, or short-awned from the back of apex; pubescent along margins and toward the apex; palet obtuse, strongly nerved; toothed or fringed with distant bristles; seed brownish. Found in oats and other small grain.

Perennial Rye Grass (*Lolium perenne* L.).

Spikelets about one-half in. in length, 5-12-flowered; empty glume much shorter than the spikelet; flowering glume obscurely nerved, obtuse, cuspidate, or very short awn-pointed, bearing callus at base; palet granulate; serrulate on margin.

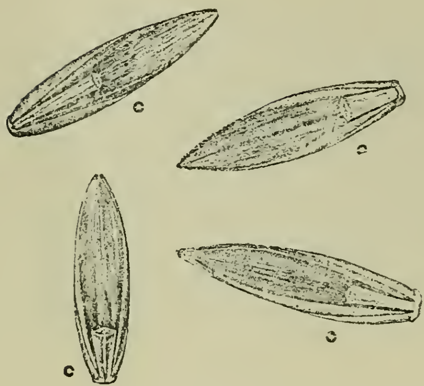


Figure 255A

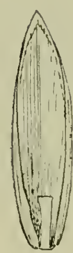


Fig. 255A

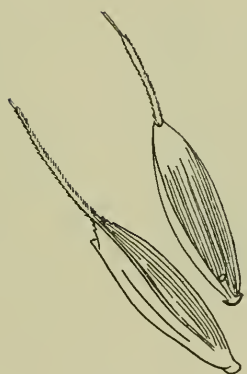


Figure 255B

Fig. 255B

FIG. 255. A. Perennial Rye Grass (*Lolium perenne*). B. Italian Rye-grass (*Lolium italicum*).
(A, after Hillman; B, drawn by C. M. King.)

Italian Rye Grass (*Lolium italicum* A.).

Spikelets two-fifths to three-fifths in. long, 6-15-flowered; flowering glume scabrous near the summit, awned; awn slender, about length of glume; margin of palet serrate.

Quack Grass (*Agropyron repens* (L.) Beauv.).

Spikelets 4-8-flowered; empty glumes 5-7-nerved, obtuse or notched, acute or acuminate; flowering glume awned near apex; two-fifths in. in length; 5-7-nerved above the middle, finely rough-

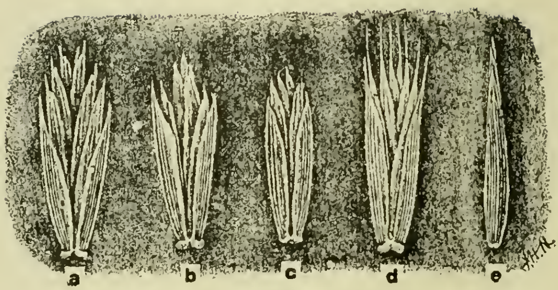


Figure 256A

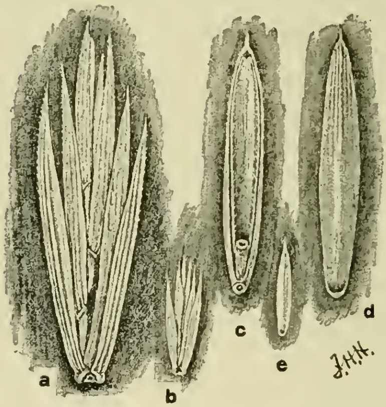


Figure 256B

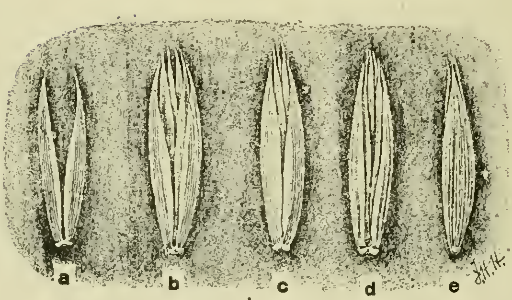


Figure 256C

FIG. 256. A and B. Quack Grass (*Agropyron repens*) showing various forms. C. Slender Wheat Grass (*Agropyron tenerum*).

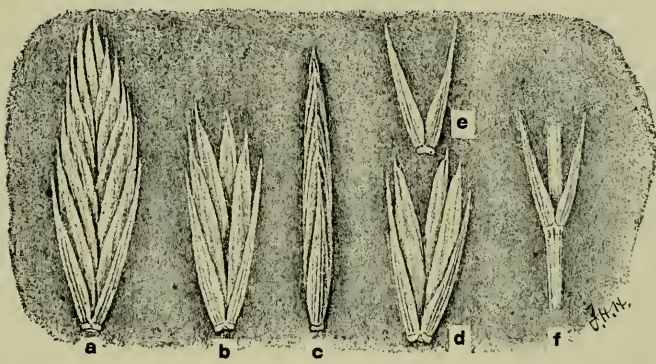


Figure 256D

FIG. 256. D. Western Wheat Grass (*Agropyron smithii*); a, large spikelet; b and d, small spikelet; c, edge view of spikelet; e, empty glumes; f, empty glume attached to axis of spikelet.

(After Hillman. A, Cir. U. S. Dept. Agr.; B. Bull. Mich. Agr. Exp. Sta.; C. Cir. U. S. Dept. Agr.; D, Cir. U. S. Dept. Agr.)

ened, granular-serrate on margins, finely pubescent at apex; rachilla prominent, hairy, minutely roughened. Occasionally occurs in clovers.

Western Wheat Grass (*Agropyron smithii* Rydb.).

Fruit similar in shape and size to *A. repens,* but the broadest portion nearer the tip, giving it more of the characteristic outline of brome grass; tip generally awned, surface finely pubescent; toothing on edge of palea seems finer than in *A. repens.*

Poison Darnel (*Lolium temulentum*).

Flowering glume about three-tenths in. long, awned or awnless, smooth, obscurely nerved; margins folded in over the palet; turgid; shorter than in *Lolium perenne.*

Wild Barley (*Hordeum jubatum* L.).

Spikes narrow, 1-3 in. or more long; empty glumes rigid; the 4 internal ones of each group dilated above the base, those of central sublanceolate, all awn-pointed; outer glumes of lateral spikelets setaceous; flowering glume of central spikelet awned; florets of lateral spikelets awnless.

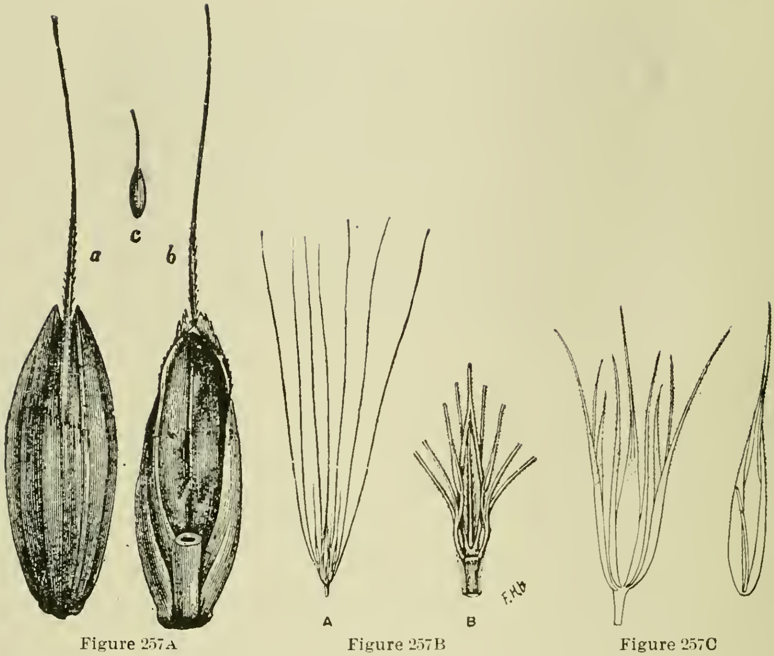


FIG. 257. A. Seed of Darnel (*Lolium temulentum*). a, b, with awns enlarged, c, natural size.
B. Wild Barley (*Hordeum jubatum.*) C. Little Barley (*Hordeum pusillum*). (A, after Winton; B, after Hillman, Bull. Mich. Agr. Exp. Sta; C, drawn by C. M. King.)

Little Barley (*Hordeum pusillum* Nutt.).

Spikelet 1-3-flowered; empty glumes rigid, the 4 internal ones of each group dilated above the base, those of the central spikelet sublanceolate, all awn-pointed; outer glumes of the imperfect lateral spikelets setaceous; flowering glume of the central spikelet awned, awn equaling those of the empty glumes; florets of the lateral spikelets awnless, or nearly so.

URTICACEAE, NETTLE FAMILY.

Hemp (*Cannabis sativa* L.).

Achene ovoid, brown with more or less light markings, 4 mm. in diameter; surface smooth.

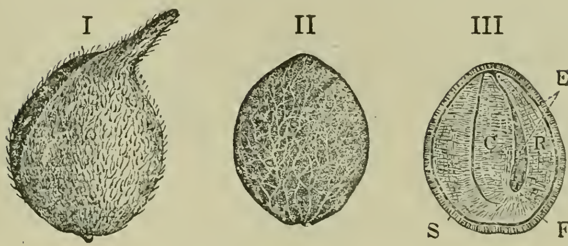


Figure 258A

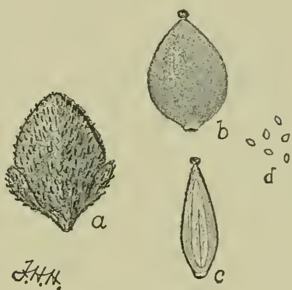


Figure 258B

Fig. 258. A. Hemp (*Cannabis sativa*). I. Seed in envelope. II. Seed without envelope. III. Cross section of seed. F. pericarp; S. testa; E. endosperm. B. Nettle (*Urtica gracilis*). a, seed in envelope; b, seed enlarged; d, natural size.
(A, after Winton; B, after Hillman, Bull. Mich. Agr. Exp. Sta.)

Nettle (*Urtica gracilis* Ait.).

The fruit enclosed in membranous calyx; seed pale straw-color, 1 mm. long, flattened, ovate, slightly pointed toward the ends, smooth; point of attachment at broader end.

POLYGONACEAE, BUCKWHEAT FAMILY.

Sour Dock (*Rumex acetosa* L.).

Inner sepals of calyx in fruit, with wings; achene convex between angles; one-twelfth in. in length, variable, smooth, shining; dark reddish brown. Probably occurs in European grown clover seed.

Sheep Sorrel (*Rumex acetosella* L.).

Calyx usually persistent, not wing-margined in fruit, roughened, with prominent veins; closely fitting achene, elliptical or ovate

Figure 259A

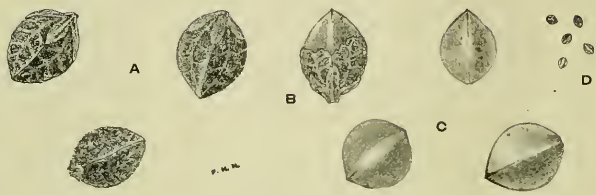


Figure 259B

FIG. 259. A. Sour Dock (*Rumex acetosa*). A, various achenes. B, diagram of the calyx. C, achenes and calyx, natural size.
B. Sheep Sorrel (*Rumex acetosella*). A, seeds bearing the calyx segments. B, one having the segments partially broken away. C, achenes from which the calyx is removed. D, seeds, natural size.
(After Hillman, Bull. Nev. Agr. Exp. Sta.)

with blunt angles, one-twenty-fourth to one-twentieth in. in length; color of fruit grayish to brownish. Common in red, white and alsike clover.

Curled Dock (*Rumex crispus* L.).

Perianth frequently persistent, consisting of thin veined lobes of the calyx, winged in fruit; wings cordate or notched at base;

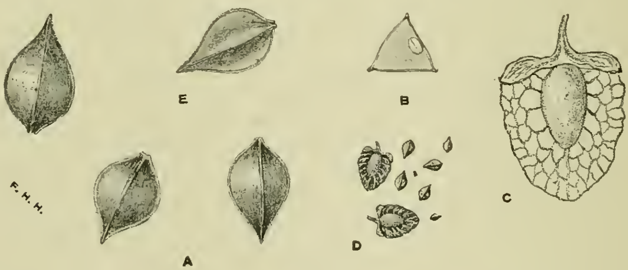


Figure 260

FIG. 260. Curled Dock (*Rumex crispus*). A, views of achenes. B, a cross-sectional view of the same. C, diagram of the calyx. D, achenes and calyces, natural size. E, a shrunken achene.
(After Hillman, Bull. Nev. Agr. Exp. Sta.)

margins entire, each with tubercle on the back; color brown; achene triangular, elliptical, with pointed apex; one-twelfth to one-eighth in. in length; color brown; surface smooth, shining; margins minutely roughened.

Tall Dock (*Rumex altissimus* Wood).

Usually but one wing of fruiting calyx bearing tubercle; pedicel as long as wings; perianth segments veined; margins nearly entire; achene triangular, widened at the base; one-sixteenth to one-twelfth in. in length; scar prominent.

Fig. 261A

Figure 261B

Figure 261C

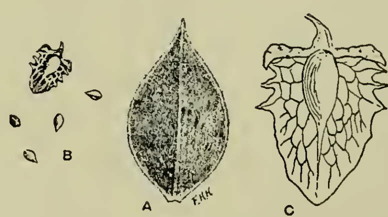


Figure 261D

FIG. 261. A and B, Tall Dock (*Rumex altissimus*). C and D, Broad-leaved Dock (*Rumex obtusifolius*). C, tubercle and calyx. (A, drawn by L. R. Collins; B and C, drawn by Ada Hayden; D, after Hillman, Bull. Nev. Agr. Exp. Sta.)

Broad-leaved Dock (*Rumex obtusifolius* L.).

Wings of the fruit small, only 1-tubercled; margins of wings deeply toothed, backs rugose; fruit three-sixteenths in. long; achenes convex between angles, one-twelfth to one-eighth in. in length; conspicuous scar at base.

Water Smartweed (*Polygonum acre* HBK.).

Achenes oblong, thick, generally 3-angled, somewhat lenticular, one-tenth to one-eighth in. in length, smooth, finely reticulated; color dull; base of perianth adhering.

Dooryard Knotweed (*Polygonum aviculare* L.).

Achenes 3-angled, ovoid, acute, sides deeply concave, one-eighth to one-seventh in. in length; color light to dark and reddish brown; surface finely granulated and striated lengthwise.

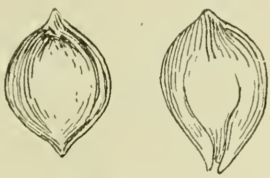


Figure 262A

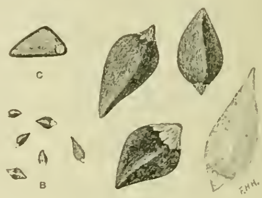


Figure 262B

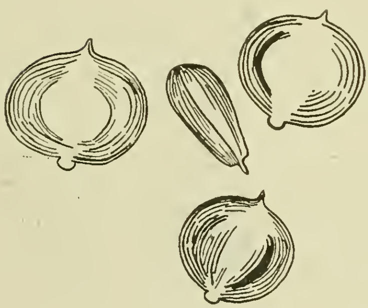


Figure 262C

Figure 262D

FIG. 262. A. Water Smartweed (*Polygonum acre*).
B. Dooryard Knotweed (*Polygonum aviculare*). A, group of seeds (achenes) showing the usual forms; that at the right is one of the smooth, light colored specimens; B, a group showing the natural size; C, a cross section showing the relative positions of embryo and endosperm.
C. and D. Prince's Feather (*Polygonum orientale*).
(A and D, drawn by C. M. King; C, drawn by Ada Hayden; B, after Hillman.)

Prince's Feather (*Polygonum orientale* L.).

Achenes usually orbicular, flattened, with prominent remnant of style, one-ninth in. in length, finely reticulated; color dull brownish to black; base with large scar; remnant of colored calyx at base.

Black Bindweed (*Polygonum convolvulus* L.).

Achenes large, prominently 3-angled, ovoid-pyramidal, one-eighth to one-sixteenth in. in length; surface dull, with minute striae; color blackish; perianth usually removed, when present straw-colored.

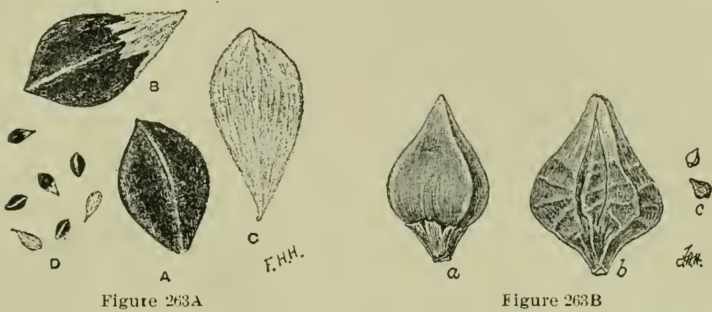


Fig. 263. A. Black Bindweed (*Polygonum convolvulus*). A and B, views of two seeds, the latter bearing a portion of the perianth about the base. C, a view of an entire perianth covering a seed. D, a group showing the natural size.
B. Erect Knotweed (*Polygonum erectum*).
(After Hillman, Bull. Mich. Agr. Exp. Sta.)

Erect Knotweed (*Polygonum erectum* L.).

Achenes 3-angled, ovoid, less deeply concave between the angles than in preceding (*P. aviculare*); one-ninth to one-tenth in. in length; dull, minutely reticulated.

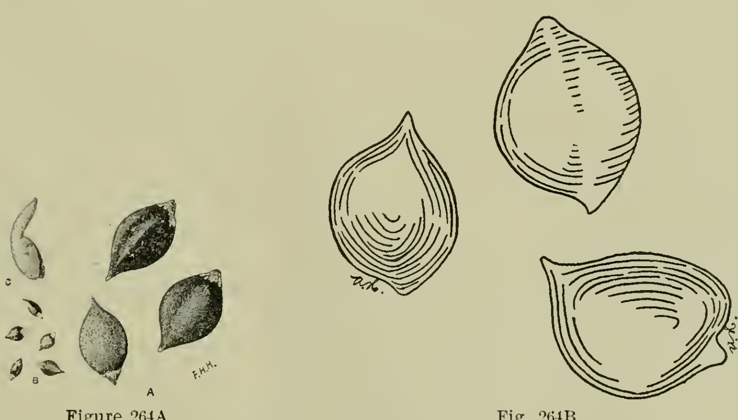


Fig. 264. A. Water Pepper (*Polygonum hydropiper*). Seeds enlarged and natural size; the embryo at C.
B. Mild Water Pepper (*Polygonum hydropiperoides*).
(A, after Hillman; B, drawing by Ada Hayden.)

Water Pepper (*Polygonum hydropiper* L.).

Achene lenticular, triangular; form broadly oblong or ovoid, slightly gibbous; one-tenth in. in length; dull, color light.

Mild Water Pepper (*Polygonum hydropiperoides* Mx.).

Achenes 3-angled, ovoid, angles between flattened, sides rounded, one-eighth to one-tenth in. in length; smooth, shining.

Slender Pink Smartweed (*Polygonum lapathifolium* L.).

Achenes ovoid-oblong, lenticular, edges slightly angled along the center, with a prominent remnant of the style at upper end, one-

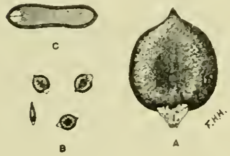


Figure 265A

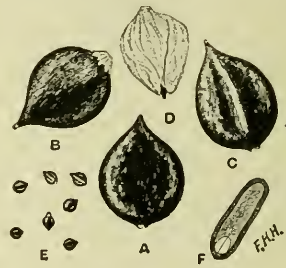


Figure 265B

FIG. 265. A. Slender Pink Smartweed (*Polygonum lapathifolium*). A, a side view of an achene bearing a part of the perianth at the base, enlarged. B, a group showing the natural size, one shown edgewise. C, a cross section of an achene.

B. Lady's Thumb (*Polygonum persicaria*). A, B and C, side views of common forms of achenes; C, a three-angled specimen. D, one covered by the perianth (reduced from the size of A, B and C). E, a group showing the natural size. F, a cross section of an achene.

(After Hillman, Bull. Nev. Agr. Exp. Sta.)

twelfth to one-tenth in. long; color light brown to dark brown, shining; base of achene with remnant of perianth adhering.

Pennsylvania Smartweed (*Polygonum pennsylvanicum* L.).

Achenes orbicular, usually broader than long, with edges as in *P. lapathifolium*, remnant of style short, one-seventh to one-sixth in. long; color blackish, dull, base of achene with perianth adhering.

Lady's Thumb (*Polygonum persicaria* L.).

Achenes broadly ovate, lenticular, often somewhat 3-angled at base, one-eleventh in. in length; surface smooth, shining; color dark; remnant of perianth present at base.

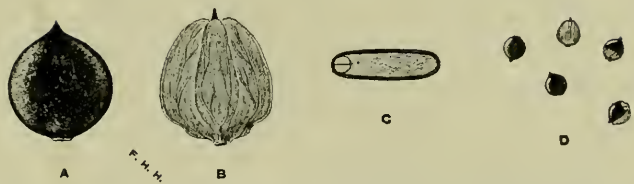


FIG. 266. Pennsylvania Smartweed (*Polygonum pennsylvanicum*). A, a side view of a seed (achene). B, one surrounded by the calyx; the opposite side has two segments between those on the edges. C, a cross section of a seed. D, seeds, natural size.
(After Hillman, Bull. Nev. Agr. Exp. Sta.)

Bushy Knotweed (*Polygonum ramosissimum* Mx.).

Achenes sharply 3-angled, sides less deeply concave than in *P. aviculare,* one-eighth in. in length; color blackish, dull; calyx greenish, light straw-colored in dried specimens.

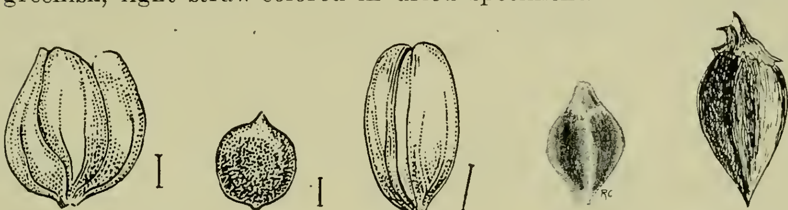


Figure 267A Figure 267B Figure 267C Figure 267C

FIG. 267. A. Pennsylvania Smartweed (*Polygonum pennsylvanicum*). B. Tanweed (*Polygonum muhlenbergii*). C. Bushy Knotweed (*Polygonum ramosissimum*).
(A and B, drawings by Charlotte M. King; C, drawings by L. R. Collins.)

CHENOPODIACEAE, GOOSEFOOT FAMILY.

Cycloloma (*Cycloloma atriplicifolium* (Spreng.) Coult.).

Fruit enclosed by the calyx, lower surface prominently rayed, upper surface depressed, wing-margined, one-tenth to one-eighth in. in diameter; seed nearly spherical, somewhat flattened, one-twelfth in. in diameter, blackish; scar whitish; embryo slender, forming a ring about the endosperm.

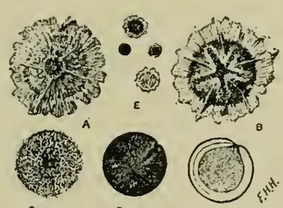


FIG. 268. Cycloloma (*Cycloloma atriplicifolium*). a, b, seed in envelope; c, d, enlarged views; e, seeds, natural size; f, cross section.
(After Hillman, Bull. Mich. Agr. Exp. Sta.)

Lamb's Quarters (*Chenopodium album* L.).

Seeds one-twentieth in. in diameter, often surrounded by thin glandular utricle which varies from grayish to straw-color; seed dark brown, shining, firmly attached to pericarp, edge rounded, lower, convex with a curved groove; seed somewhat irregular in shape; some seeds also surrounded by the pericarp and star-shaped calyx. In seed of small grains, clover and grasses.

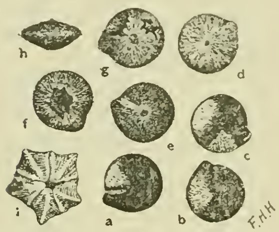


Figure 269A

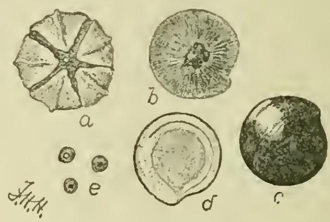


Figure 269B

Figure 269C

FIG. 269. A. Lamb's Quarters (*Chenopodium album*). a to b, different views of seed; d, g, f, seed with utricle; i, calyx attached.
B. Maple-leaved Goosefoot (*Chenopodium hybridum*). a, seed in envelope; b, c, general view of seed; d, cross section; e, natural size.
C. Western Lamb's Quarters (*Chenopodium murale*). A, B and C, views of seed; D, the natural size.
(After Hillman, A and B, Bull. Mich. Agr. Exp. Sta.; C, Bull. Nev. Exp. Sta.)

Maple-leaved Goosefoot (*Chenopodium hybridum* L.).

Seeds dark grayish black, circular, 2.5-3 mm. in diameter, flattened double-convex, with distinct margin, slightly indented by a notch; scar on middle of one face; seed shining, black, when envelope is entirely removed.

Spinach (*Spinacia oleracea* L.).

Fruit broadly ovate, one-sixth in. in length, size variable; utricle unarmed, wrinkled, sometimes tuberculate, straw-colored; achene closely enveloped by utricle; scar elevated.

Figure 270A

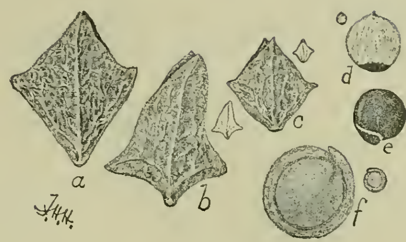


Figure 270B

FIG. 270. A. Spinach (*Spinacia oleracca*).
B. Orach (*Atriplex patula* var. *hastata*). a, b, c, different views of seed in envelope; d, e, f, views of seeds.
(A, drawing by Charlotte M. King; B, after Hillman, Bull. Mich. Agr. Exp. Sta.)

Orach (*Atriplex patula* var. *hastata* (L.) Gray).

Fruiting bracts ovate-triangular, entire toothed, often muricate on the back, united to near the middle; seed jet black, shining, nearly circular, edge bluntly rounded, bearing a notch; a groove leads from protuberance on the margin part way to center of face.

Russian Thistle (*Salsola kali* var. *tenuifolia* G. F. W. Mey.).

Calyx persistent, 5-parted, membranaceous, enclosing the flattened utricle by a broad, flat, membranaceous wing; seed conical,

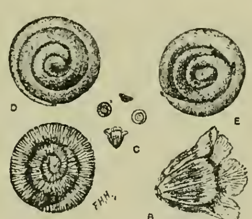


Figure 271A

Figure 271B

FIG. 271. A. Russian Thistle (*Salsola kali* var. *tenuifolia*), a, seed in envelope; b, d, e, views of seed enlarged; c, natural size.
B. Kochia or Mexican Fireweed (*Kochia scoparia*).
(A, after Hillman, Bull. Mich. Agr. Exp. Sta.; B, drawing by Miss King.)

upper end truncate, with a depression one-eighteenth in. in diameter, brownish; seed without endosperm, embryo coiled in a spiral; cotyledons slender.

AMARANTHACEAE, AMARANTH FAMILY.

Spreading Amaranth (*Amaranthus blitoides* Wats.).

Seeds lenticular or round to broadly egg-shaped, one-sixth in. in diameter, both sides convex with distinct margin, glossy, black; seeds borne in ovoid-oblong utricle, 2-3-beaked by the persistent style. Reported in western alfalfa seed.

FIG. 272. Spreading Amaranth (*Amaranthus blitoides*). A, seeds. B, a broken specimen. C, an edge view. D, the natural size. (After Hillman, Bull. Nev. Agr. Exp. Sta.)

Tumbleweed (*Amaranthus graecizans* L.).

Seeds lenticular or roundish, one-twenty-fourth in. in diameter, glossy black, much like the preceding but smaller. In grasses and lawn mixtures.

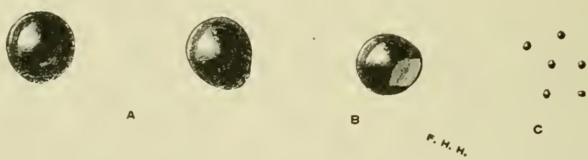


FIG. 273. Tumbleweed (*Amaranthus graecizans*). A, seeds. B, a broken one. C, the natural size. (After Hillman, Bull. Nev. Agr. Exp. Sta.)

Rough Pigweed (*Amaranthus retroflexus* L.).

Seeds from one-eighteenth to one-twentieth in. in length; oval, spherical or nearly spherical, both sides convex with a continuous ring on the margin; scar small; smooth, black, shining; seeds much like *A. blitoides* but somewhat smaller. In seeds of red clover, alsike, and timothy.

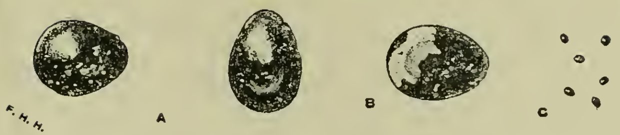


FIG. 274. Rough Pigweed (*Amaranthus retroflexus*). A, seeds; B, one having the seed-coat broken; C, the natural size.
(After Hillman, Bull. Nev. Agr. Exp. Sta.)

Water Hemp (*Acnida tuberculata* Moq.).

Seeds erect, lens-shaped, one-fifteenth in. in diameter, smooth, shining, black, 2-5 remnants of stigmas, sometimes with the at-

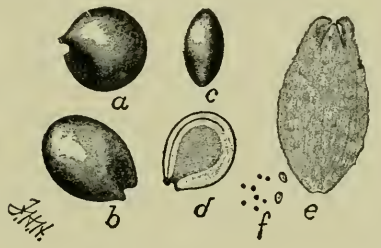


FIG. 275. Water Hemp (*Acnida tuberculata*). a, b, c, different views of seed; d, cross section; e, in seed envelope; f, natural size.
(After Hillman, Bull. Mich. Agr. Exp. Sta.)

tached calyx and mucronate bracts; utricle longer than bracts; circumscissile, not angled. In seed of clover and alsike.

CARYOPHYLLACEAE, PINK FAMILY.

Chickweed (*Stellaria media* (L.) Cyrill.).

Kidney-shaped, broadly egg-shaped, to wedge-shaped, one-twentieth in. in length, finely and closely tubercled; color grayish

FIG. 276. Chickweed (*Stellaria media*). A, seeds, side view. B, one shown in edge view. C, a sectional view showing the embryo and endosperm. D, group showing the natural size.
(After Hillman, Bull. Nev. Agr. Exp. Sta.)

to light brown; scar marked by a longitudinal groove at basal end. Occasionally found in clover.

Corn Cockle (*Agrostemma githago* L.).

Seeds large, angular, broadly wedge-shaped, one-eighth in. in length; tubercles prominent, lines of tubercles beginning at basal end of seed; color brown to black; size of seed variable; according to Dewey the larger ones hard to screen out. Most commonly found in wheat; seed has poisonous properties. "Pest in grain fields." Found in wheat and in chicken feed.

FIG. 277. Corn Cockle (*Agrostemma githago*), a, seed enlarged; b, seed in cross section; c, natural size.
(After Hillman, Bull. Nev. Agr. Exp. Sta.)

Bladder Campion (*Silene latifolia* (Mill.) Brit. & Rendle).

Seed kidney-shaped, more nearly spherical than in *Silene noctiflora*, one-fifteenth in. in length; shape of seed more nearly orbicular than in *S. noctiflora*. Found in some clovers.

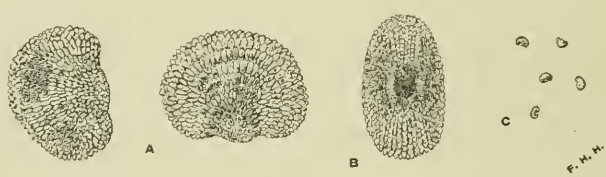


FIG. 278. Bladder Campion (*Silene latifolia*). A, common forms of seeds, side view. B, edge view of a seed, showing the scar-cavity. C, the natural size of the seeds.
(After Hillman, Bull. Nev. Agr. Exp. Sta.)

Forked Catchfly (*Silene dichotoma* Ehrb.).

General shape of seed roundish triangular, somewhat flattened, about 1.5 mm. in breadth; color dull reddish brown; 5-7 rows of tubercles on each side in curved rows following the rounding outline of the shape of the seed; scar on the straight side of seed.

Figure 279A

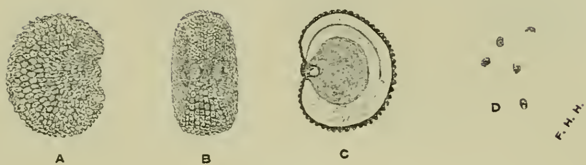


Figure 279B

FIG. 279. A. Forked Catchfly (*Silene dichotoma*). a, seed enlarged; b, natural size.
B. Night-flowering Catchfly (*Silene noctiflora*). A, side view of a seed; B, edge view of the same, showing the scar-cavity. C, a longitudinal section of a seed, showing the embryo curved about the endosperm. D, the natural size of the seeds.
(After Hillman; A, Bull. Mich. Agr. Exp. Sta., B, Bull. Nev. Agr. Exp. Sta.)

Night-flowering Catchfly (*Silene noctiflora* L.).

Seeds kidney-shaped, thick, with rounded edges, one-fifteenth to one-tenth in. in length; surface roughened by peculiar tubercles; on shorter side a black elevated scar; immature seeds red. Found in clover and grass seed.

Figure 280A

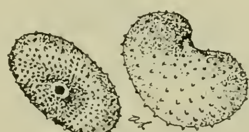


Figure 280B

FIG. 280. A. Evening Catchfly (*Silene vespertina*).
B. Evening Catchfly (*Lychnis alba*).
(Drawings by L. R. Collins and Ada Hayden.)

Evening Catchfly (*Silene vespertina* Sibth.).

Seed smaller than that of *S. noctiflora*, which resembles it, one-fifteenth of an in. in length; ash-colored. Found in alfalfa and clover seed.

Cowherb (*Saponaria vaccaria* L.).

Seed nearly spherical, one-twelfth in. in length, minutely tubercled; color black; immature seeds reddish; scar whitish, in depression. Occurs in wheat and in red clover.

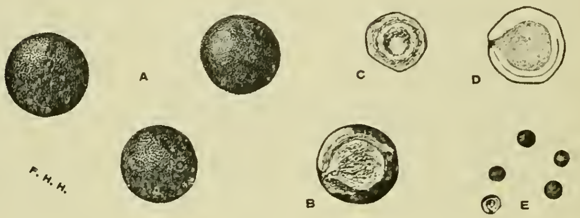


FIG. 281. Cowherb (*Saponaria vaccaria*). A, different views of the seeds; the one at the left and the lower one show the scar; the light spots show the minute surface-projections. B and C, parts of a broken seed, B retaining a part of the embryo. D, a sectional view of a seed. E, seeds, natural size.
(After Hillman, Bull. Nev. Agr. Exp. Sta.)

PORTULACACEAE, PURSLANE FAMILY.

Purslane (*Portulaca oleracea* L.).

Seeds broadly ovate, inclined to kidney-shaped, flattened. one-thirtieth in. in length, roughened by minute tubercles in concentric rows; small scar at smaller end, whitish.

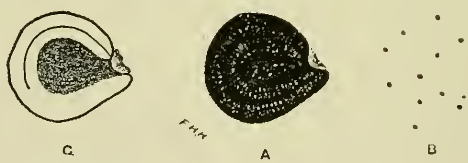


FIG. 282. Purslane (*Portulaca oleracea*). A, a side view of a seed, enlarged, showing the whitish scar; B, a group, natural size; C, section of a seed, taken parallel with the faces.
(After Hillman, Bull. Nev. Agr. Exp. Sta.)

RANUNCULACEAE, CROWFOOT FAMILY.

Meadow Rue (*Thalictrum dasycarpum* Fisch. and Lall.).

Fruit an achene, ovoid, one-fifth in. in length, with remnant of curved style, prominently ribbed, with from 6-8 wings, short-stalked, glabrous or pubescent; seed elongated, ovoid, one-tenth in. long, brownish, smooth, with prominent veins near base of seed. Occasionally found in clover seed.

Figure 283A

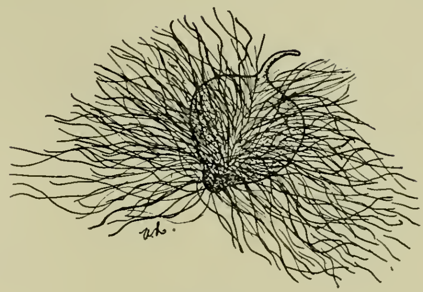


Figure 283B

FIG. 283. A. Meadow Rue (*Thalictrum dasycarpum*).
B. Long-fruited Anemone (*Anemone cylindrica*).
(A, drawing by L. R. Collins, B, by Ada Hayden.)

Long-fruited Anemone (*Anemone cylindrica* Gray).

Achenes one-quarter in. in length and one-fifth in. in width, flat, compressed, 1-seeded, nearly orbicular, greenish, covered by dense pilose mass of whitish hairs.

Prairie Larkspur (*Delphinum Penardi* Huth.).

Seeds somewhat flattened, upper end wider, nearly square, 4-angled or triangular, one-sixteenth to one-twelfth in. long, surface scabrous, becoming rougher on angles; color grayish.

Figure 284A

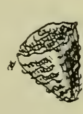


Figure 284B

Figure 284C

FIG. 284. A. Prairie Larkspur (*Delphinium Penardi*).
B. and C. Field Larkspur (*Delphinium consolida*).
(A, drawing by Ada Hayden; B, drawn by L. R. Collins; C, drawn by C. M. King.)

Field Larkspur (*Delphinium consolida* L.).

Seed angular, somewhat convex on back, one-twelfth in. long and equally wide, surface scabrous or scaly, with whitish margins; color blackish, brownish or grayish; seed with sharp bitter taste. Reported as of frequent occurrence in Russian clover seed.

Small-flowered Crowfoot (*Ranunculus abortivus* L.).

Achene flattened-circular, with 2 convex faces, orange-brown in color, smooth and shining, very slightly impressed with wrinkles; remnant of style present as a short curved point on margin.

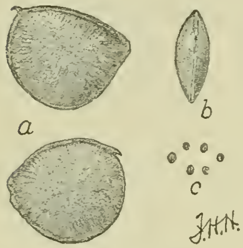


Figure 285A

Figure 285B

FIG. 285. A. Small-flowered Crowfoot (*Ranunculus abortivus*). a, achenes enlarged; b, end view; c, achenes natural size.
B. Tall Buttercup (*Ranunculus acris*). a, b. different views of seed; c, cross section; d, natural size.
(After Hillman, Bull. Mich. Agr. Exp. Sta.)

Tall Buttercup (*Ranunculus acris*).

Carpel 1-ovuled; achene flattened, tipped by remnant of curved style, one-tenth to one-eighth in. long; color greenish to brownish; surface apparently smooth, minutely pitted; scar minute, in a whitish depression at base of achene.

PAPAVERACEAE, POPPY FAMILY.

Poppy (*Papaver somniferum* L.).

Seed about 1 mm. in length, kidney-shaped, one end being slightly larger than the other; hilum and chalaza in a notch, connected by a short raphe; surface covered with fine, beautiful reticulations; embryo straight; considerable endosperm.

Figure 286A

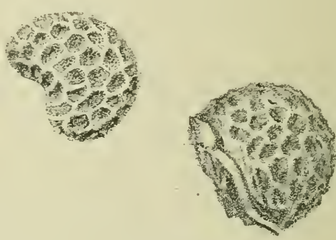


Figure 286B

FIG. 286. A. Poppy (*Papaver somniferum*). To the left embryo of seed.
B. Prickly Poppy (*Argemone intermedia*).
(A, after Winton. B, drawing, C. M. King.)

Prickly Poppy (*Argemone intermedia* Sweet).

Pod ellipsoid, prickly; seeds spherical, crested, about 2 mm. in diameter; dark brown, surface reticulate and deeply pitted.

CRUCIFERAE, MUSTARD FAMILY.

Pennycress (*Thlaspi arvense* L.).

Seed oblong, flattened, one-twelfth to one-tenth in. long; surface marked by curved ridges, simple or occasionally forked, which curve from base to apex in regular rows; color brownish to dark reddish brown; funicle sharp pointed. Found largely in wheat, barley and oats. "A pest of grain (wheat) fields of Manitoba."

Figure 287A

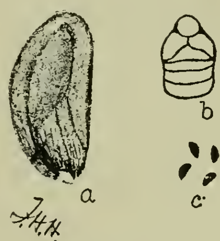


Figure 287B

Fig. 287. A. Pennycress (*Thlaspi arvense*). A, side view of a seed; B, seeds, natural size; C, the embryo.
B. Cress (*Lepidium sativum*).
(After Hillman, Bull. Mich. Agr. Exp. Sta.)

Cress (*Lepidium sativum* L.).

Seed oval, one edge nearly straight, the other convex, one-tenth in. in length, apparently slightly marginate at basal end, basal portion bearing scar, also with white projecting tip, and end of funicle prominent, smooth, brownish.

Small Peppergrass (*Lepidium apetalum* Willd.).

Seeds oblong, flattened, margin colorless, prominent ridge on one side, one-sixteenth to one-twelfth in. long, minutely roughened; cotyledons incumbent; seed coat becomes mucilaginous when wet; funicle prominent. Generally found in small grains and commercial grass seed.

Figure 288A

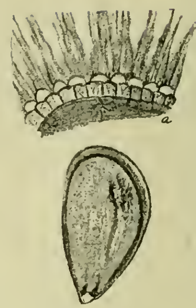


Figure 288B

FIG. 288. A. Small Peppergrass (*Lepidium apetalum*). A, seeds shown in side view; B, a half-section of a pod; C, a seed in cross section, showing the three parts of the embryo, the caulicle being at the right; D, the embryo, the caulicle at the left; E, group of seeds, natural size.

B. *Lepidium apetalum,* with section of seed coat showing action of mucilaginous cells after moistening.

(A, after Hillman, Bull. Nev. Agr. Exp. Sta.; B, drawn by C. M. King.)

Large Peppergrass (*Lepidium virginicum* L.).

Seed elongated with prominent ridge on one side, one-twelfth in. in length; color light reddish brown; cotyledons incumbent; seed

FIG. 289. Large Peppergrass (*Lepidium virginicum*). A, three seeds shown in side view. The upper two show the narrow, curved groove of one face, the lower one shows the broader, shallow depression of the opposite face. The one immediately at the right of A shows the widened border and its light colored edge. B, entire pod. C, a seed showing the mucilage as it appears while wet. D is a cross sectional view of a seed, showing the flattened form of the cotyledons and the edgewise position of the caulicle. E, the embryo in side view. F, seeds, pod, and half-pod, natural size.

(After Hillman, Bull. Nev. Agr. Exp. Sta.)

coat becomes mucilaginous when wet. Generally found in small grains and commercial grass seed. Frequent in timothy.

Shepherd's Purse (*Capsella bursa-pastoris* (L.) Medic.).

Seed small, flattened, oblong, with 2 longitudinal grooves; one-twenty-fourth to one-twentieth in. in length; color light brown; scar whitish, funicle prominent. In alsike clover.

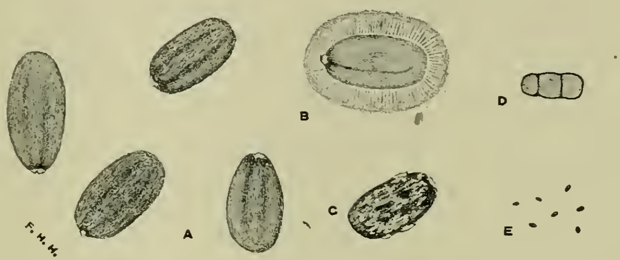


FIG. 290. Shepherd's Purse (*Capsella bursa-pastoris*). A, seeds showing various forms and degrees of color. B, showing the mucilage while wet. C, a seed showing the appearance of the dried mucilage. D, a seed in cross section. E, seeds, natural size.
(After Hillman, Bull. Nev. Agr. Exp. Sta.)

False Flax (*Camelina sativa* (L.) Crantz).

Seeds one-twelfth in. in length, light brown, minutely pitted; caulicle prominent, running lengthwise with conspicuous groove

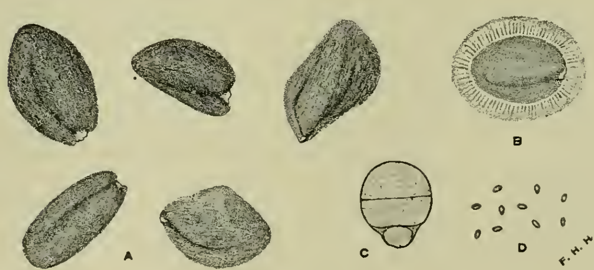


FIG. 291. False Flax (*Camelina sativa*). A, various forms of seeds. B, a seed showing the mucilage. C, a seed in cross section. D, seeds, natural size.
(After Hillman, Bull. Mich. Agr. Exp. Sta.)

between it and the cotyledons which are incumbent. On addition of water the seeds become mucilaginous. In seeds of clovers and grasses.

Radish (*Raphanus sativus* L.).

Seed spherical, ovate to oval, frequently angular, one-eighth to one-fifth in. in length, minutely pitted, brownish with glaucous or shining surface; scar inconspicuous, usually surrounded by small dark area; radicle near scar, prominent.

FIG. 292. Radish (*Raphanus sativus*), two different views. (Drawn by C. M. King.)

White Mustard (*Brassica alba* Boiss.).

Seed nearly spherical, occasionally somewhat oblong, one-twelfth to one-ninth in. long, light colored, reticulations inconspicuous; scar whitish, projecting; seed coats mucilaginous when wet.

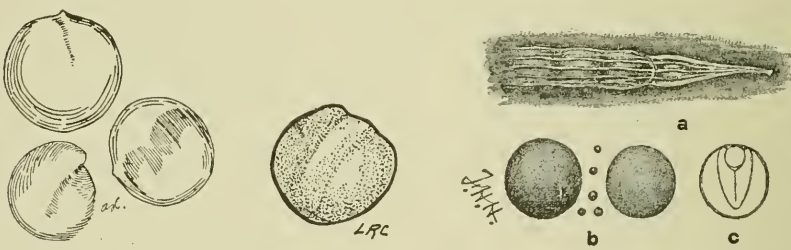


Figure 293A Figure 293A Figure 293B

FIG. 293. A. White Mustard (*Brassica alba*). B. Charlock (*Brassica arvensis*). a, tip of pod; b, seeds enlarged, and natural size; c, cross section. (A, drawings by Ada Hayden and L. R. Collins; B, after Hillman, Bull. Mich. Agr. Exp. Sta.)

English Charlock (*Brassica arvensis* (L.) Ktze.).

Seed nearly spherical, sometimes oblong, one-fourteenth to one-twelfth in. in diameter, marked with fine ridges, reticulated or honeycombed in appearance, light brown or grayish, with paler appearance; scar whitish, an elevated point at one end of the seed; embryo large; cotyledons conduplicate. Only a small amount of mucilage produced in presence of water.

Wild Turnip (*Brassica campestris* L.).

Seeds generally nearly spherical or oblong; the caulicle and radicle usually conspicuous along the middle, one-twentieth to one-twelfth in. in diameter, cultivated forms larger, roughened and

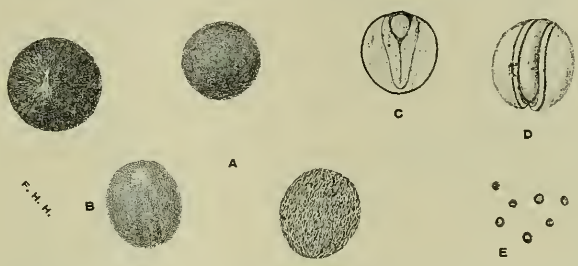


FIG. 294. Wild Turnip (*Brassica campestris*). A and B, various forms of seeds. C, a seed in cross section showing cotyledons and caulicle. D, the embryo. E, seeds, natural size.
(After Hillman, Bull. Mich. Agr. Exp. Sta.)

more finely ridged than in *B. nigra* and *B. arvensis;* color grayish or brownish; scar at one end. With clover and grass seed.

Rape (*Brassica napus* L.).

Seed nearly spherical or sometimes oblong, one-fourteenth to one-twelfth in. in length, prominently reticulated; closely resembles *B. arvensis*. Found in mustard and clover seed.

Figure 295A Figure 295B

FIG. 295. A. Rape (*Brassica napus*). B. Black Mustard (*Brassica nigra*). A, seed enlarged, showing the surface network of dark lines. B, a group of seeds, natural size.
(A, drawings by Ada Hayden; B, after Hillman, Bull. Mich. Agr. Exp. Sta.)

Black Mustard (*Brassica nigra* (L.) Koch.).

Seed nearly spherical, more generally broadly oblong, one-twentieth to one-fifteenth in. in diameter; surface marked with fine ridges; frequently whitish scar at one end; embryo as in *B.*

arvensis; taste pungent. Generally found in seed of clover and alfalfa.

Indian Mustard (*Brassica juncca*).

Seed about the size of wild mustard seed; surface rather coarsely reticulated. Color dark reddish brown.

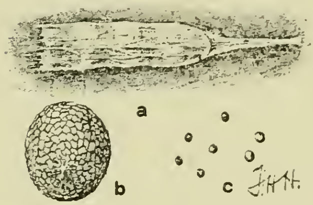


Figure 296A

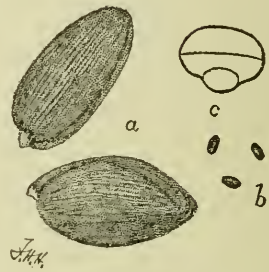


Figure 296B

FIG. 296. A. Indian Mustard (*Brassica juncea*). B. Hare's-ear Mustard (*Conringia orientalis*). a, b, different views of seed; c, cross section; d, natural size.

(After Hillman, Bull. Mich. Agr. Exp. Sta.)

Hare's-ear Mustard (*Conringia orientalis* (L.) Dumort.).

Pod rigid, 4-angled; seeds brown, oblong narrowed to rounding at the ends, 2-2.5 mm. long; surface finely reticulated in checks; scar at end of seed lighter in color; position of caulicle indicated by two distinct, lengthwise grooves.

Tumbling Mustard (*Sisymbrium altissimum* L.).

Seed oblong flattened, one-twenty-fifth in. in length; color reddish yellow; radicle prominent, variable in shape; form of embryo marked by deeper color, by lines; seed coat becomes mucilaginous when wet. A tumbling weed. Distribution wide, reported as a serious weed in commercial seeds of the northwest and Canada.

Hedge Mustard (*Sisymbrium officinale* (L.) Scop.).

Seed oblong, sometimes with upper end truncate, some almost trapezoidal in outline, one-twenty-fourth to one-sixteenth in. long; color yellowish, or brownish, variable; caulicle evident from prominent white scar; funicle sometimes present and pointed; seed coat mucilaginous. Found in alsike and white clovers.

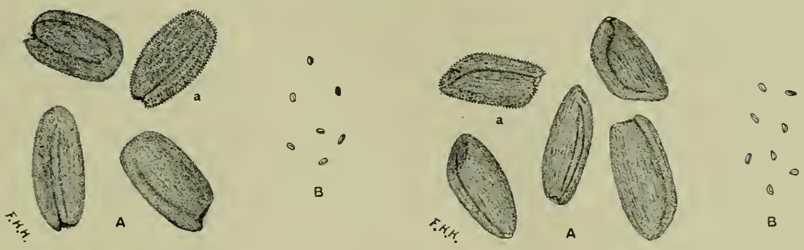


Figure 297A Figure 297B

FIG. 297. A. Tumbling Mustard (*Sisymbrium altissimum*). A, a group of seeds indicating the usual forms; a, one showing the hairy appearance due to the mucilage, either when wet or after drying. B, several seeds, natural size.

B. Hedge Mustard (*Sisymbrium officinale*). A, a group of seeds showing the prevailing forms; a, one showing the fine hairlike mucilage as it appears when wet or after drying. B, group showing the natural size.
(After Hillman, Bull. Mich. Agr. Exp. Sta.)

Marsh Cress (*Radicula palustris* (L.) Moench.).

Pod ovoid; seed pale reddish brown, oval, finely reticulated, length about .6 2-3 mm.; scar near one end, occupying a deep notch in the contour of the margin.

FIG. 298. Marsh Cress (*Radicula palustris*).
(Drawing by Ada Hayden.)

Winter Cress (*Barbarea vulgaris* R. Br.).

Seed oblong, flattened, one-sixteenth in. in length; surface finely reticulated; the scar a light-colored appendage at one end; position

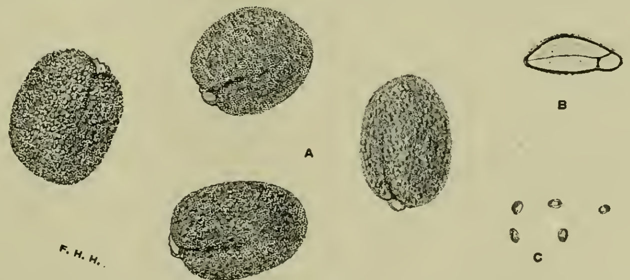


FIG. 299. Winter Cress (*Barbarea vulgaris*). A, various forms of seeds. B, a seed in cross section. C, seeds, natural size.
(After Hillman, Bull. Mich. Agr. Exp. Sta.)

of caulicle marked by groove; color light brown; seed coats do not develop mucilage in water. Occasionally with clover.

CAPPARIDACEAE, CAPER FAMILY.

Rocky Mountain Bee-plant (*Cleome serrulata* Pursh.).

Roughly wedge-shaped to triangular in outline, and wedge-shaped in cross section; mature seeds of a grayish brown color, immature seeds a creamy yellow; size 3 by 2.5 mm.; basal scar ex-

FIG. 300. Rocky Mountain Bee-plant (*Cleome serrulata*). (Drawing by Ada Hayden.)

tends from the edge of the wedge, well up on both flat faces; most of the surface of the seed roughly tubercled.

ROSACEAE, ROSE FAMILY.

Silver Weed (*Potentilla anserina* L.).

Seed pointed, egg-shaped, unsymmetrical, about 1.6 mm. in length; color yellowish to brown; surface furrowed throughout its length.

FIG. 301. Silver Weed (*Potentilla anserina*). (After Burchard.)

Cinquefoil (*Potentilla canadensis* L.).

Seed small, about 0.5 mm. in length, short, obliquely egg-shaped; light brown.

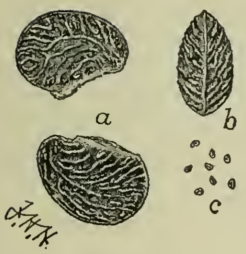


Figure 302A

Figure 302B

Fig. 302. A. Cinquefoil (*Potentilla canadensis*). B, Five-finger (*Potentilla monspeliensis* var. *norvegica*). A, two seeds (achenes), side view. B, a seed in edge view. C, group showing the natural size.
(After Hillman; A, Bull. Mich. Agr. Exp. Sta.; B, Bull. Nev. Agr. Exp. Sta.)

Five Finger (*Potentilla monspeliensis* L. var. *norvegica* (L.) Rydb.).

Achenes small, ovate or kidney-shaped, one-twenty-fourth in. in length, prominently ridged; the ridges simple or branched, starting from base of seed; color light brown or straw-colored. Frequently occurs in alsike clover and timothy, as well as in red clover.

Avens (*Geum canadense* Jacq.).

Achene pale greenish brown, length 3 mm., width 1½ mm., general shape ovate, tapering to base, rounded at apex which bears persistent hooked style 5 mm. in length tipped with a hook; achene slightly flattened, with a narrow ring along each edge.

Figure 303A

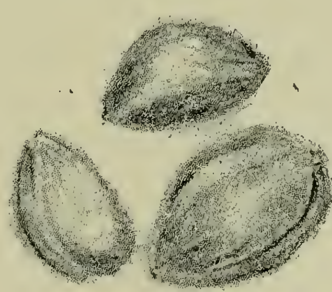


Figure 303B

Fig. 303. A, Avens (*Geum canadense*). B, Rose (*Rosa pratincola*). (Drawings by C. M. King.)

Prairie Rose (*Rosa pratincola* Greene).

Achenes dark to light brown, smooth, shining; length 3-5 mm., width 2-3 mm., general shape ovoid, modified by some flattening of portions at the surface, and corresponding angulation of the seed's form; scar at broader end, with dark line extending to the apex which is tipped with a slight remnant of the style.

LEGUMINOSAE, PULSE FAMILY.

Rattlebox (*Crotalaria sagittalis* L.).

Pod blackish, cylindrical, inflated, many seeded; seed greenish brown, shining, smooth, somewhat flattened, circular-kidney-shaped,

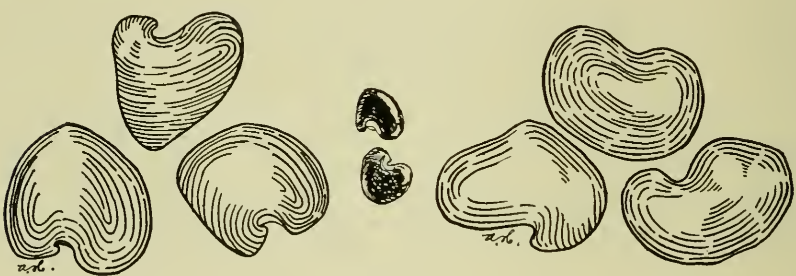


FIG. 304. Rattlebox (*Crotalaria sagittalis*).
(Drawing by Ada Hayden.)

with one side interrupted by a deep rounded notch, bearing the conspicuous scar with dark center and light rim; width of seed 2.5 mm.

White Clover (*Trifolium repens* L.).

Seeds varying from nearly square to triangular, margins rounded, flattened, often concave on one margin, one-twentieth to one-thirtieth in. long; smooth; color dull yellow to light reddish brown, or slightly green; radicle slender club-shaped, about as long as the cotyledons.

Alsike Clover (*Trifolium hybridum* L.).

Seed more nearly round than that of alfalfa or red clover; one-twentieth to one-sixteenth in. in length; color a peculiar yellowish green, often brown and mottled, individual seeds even yellow or brown; the projecting radicle gives the seed the appearance of having a nearly square top.

Figure 305A

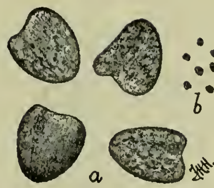


Figure 305B

Figure 305C

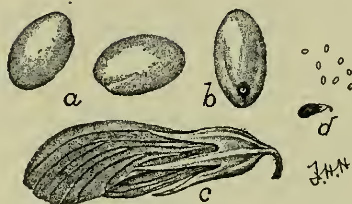


Figure 305D

FIG. 305. A. White Clover (*Trifolium repens*). a, enlarged; b, natural size.
B. Alsike Clover (*Trifolium hybridum*). a, enlarged; b, natural size.
C. Red Clover (*Trifolium pratense*). a, enlarged; b, natural size.
D. Low Hop Clover (*Trifolium procumbens*). a, enlarged; b, opposite face; c, flower; d, seeds, natural size.
(After Hillman, Bull. Nev. Agr. Exp. Sta.)

Red Clover (*Trifolium pratense* L.).

Seeds roughy triangular, with angles rounded; no two sides equal length, sides somewhat convex with rounded edges, one-sixteenth to one-tenth in. long; color light yellow, purple, or of yellow and purple; old seeds more brownish; scar near radicle, which is not so prominent as in other clovers; the seeds of mammoth clover resemble those of red clover but are usually larger.

Low Hop Clover (*Trifolium procumbens* L.).

Seed light brown, shining, oval, length 1-1.3 mm., width 0.6 mm.; scar in a notch a short distance from one end.

Sweet Clover, Bokhara Clover (*Melilotus alba* Desv.).

Seeds contained in an ovoid pod, one-twelfth to one-fifteenth in. long, reticulated, nearly smooth, elliptical, somewhat triangular, variable; color yellowish to greenish, scar brown in color; micropilar processes near scar, not conspicuous. Found in seeds of alfalfa and clover.

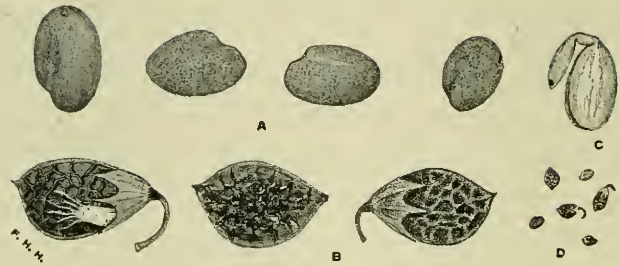


FIG. 306. White Sweet Clover (*Melilotus alba*). A, a group of seeds. B, the pods; the central one without the calyx. C, the embryo. D, a group of seeds and pods, natural size.
(After Hillman, Bull. Nev. Agr. Exp. Sta.)

Yellow Sweet Clover (*Melilotus officinalis* (L.) Lam.).

Pods one-seventh in. in length; rugose, more evenly transversely wrinkled than in *M. alba;* seeds subspherical or elliptical to kidney-

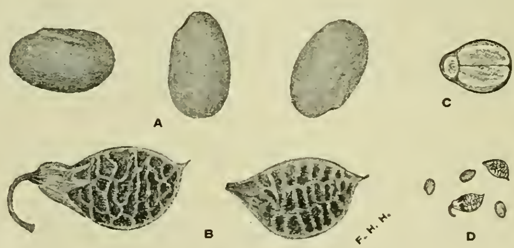


FIG. 307. Yellow Sweet Clover (*Melilotus officinalis*). A, seeds. B, pods; the one at the right without the calyx, and showing the contracted base. C, a view of a seed in cross section, showing cotyledons and caulicle. D, a group of seeds and pods, natural size.
(After Hillman, Bull. Nev. Agr. Exp. Sta.)

shaped, one-twelfth to one-tenth in. in length, smooth; yellowish or brownish to greenish; with small micropilar processes.

Bur Clover (*Medicago hispida* Gaertn.).

Seeds kidney-shaped, occasionally sausage-shaped, both sides convex, one-sixth in. in length, larger than alfalfa, variable in size; color lighter than in alfalfa seed; scar about middle of seed, close to prominent micropilar processes; pods large, spirally twisted into several flat coils, covered by pointed projections; the prickles either straight or curved; each pod several-seeded; seeds have general resemblance to alfalfa seed in form and color.

FIG. 308. Bur Clover (*Medicago hispida*). A, seed; B, pod. (Drawings by Ada Hayden and L. R. Collins.)

Yellow Trefoil (*Medicago lupulina* L.).

Seeds kidney to egg-shaped, much shorter than bur clover seed, one-twelfth to one-tenth in. long; about the size of alfalfa, which it closely resembles; color yellowish, reddish, or greenish; scar near

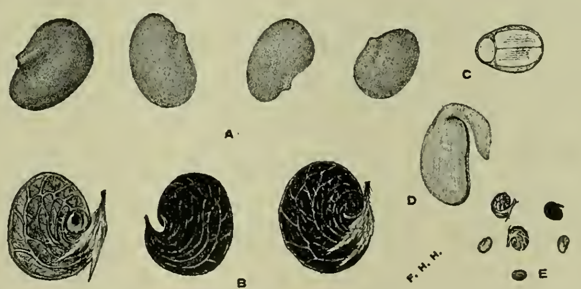


FIG. 309. Yellow Trefoil (*Medicago lupulina*). A, seeds showing the prevailing forms. B, pods; the central one with the calyx removed; the one at the left an immature, lighter colored specimen. C, a view of a seed in cross section, showing cotyledons and caulicle. D, the embryo. E, seeds and pods, natural size.
(After Hillman, Bull. Nev. Agr. Exp. Sta.)

one end; micropilar processes prominent; the pods clustered at the end of the peduncle small, black, wrinkled, and coiled at tip, marked by prominent veins and hairs; each pod contains one seed.

Dalea (*Dalea alopecuroides* Willd.).

Seeds triangular to kidney-shaped, one-tenth in. in length; micropilar scar prominent, with whitish border and 2 micropilar processes; surface shining, slate-colored. Found in clover seed, from which it is separated with difficulty.

Figure 310A

Figure 310B

Figure 310C

FIG. 310. A, Dalea (*Dalea alopecuroides*). B, seed of Pink Dalea (*Dalea laxiflora*). C, seed-pod of the same species.
(A, drawing by L. R. Collins; B and C, by C. M. King.)

Pink Dalea (*Dalea laxiflora* Pursh.).

Seeds one-tenth in. in length, generally triangular, somewhat kidney-shaped, one end projecting beyond sac, which is circular and has two micropilar processes on one side; yellowish or brownish in color; leaves have pellucid dots. This should enable one to recognize the impurity. Occasionally found in clover seed.

Stemless Loco Weed (*Oxytropis lamberti* Pursh.).

Pods coriaceous, silky pubescent, cylindrical; seed flattened, brown, about 2 mm. broad and 2.5 mm. long.

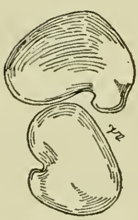


Figure 311A

Figure 311B

Figure 311C

FIG. 311. A, Stemless Loco Weed (*Oxytropis lamberti*). B, Bush Clover (*Lespedeza capitata*), pod and seed.
(Drawings A, by Ada Hayden; B, by Charlotte M. King.)

Bush Clover (*Lespedeza capitata* Michx.).

Pod ovate-oblong, one-sixth in. in length, sessile, 1-ovuled, pubescent, brownish, reticulated, indehiscent, seed scarcely kidney-shaped, one-tenth in. in length, greenish to purplish.

Common Vetch (*Vicia sativa* L.).

Pod linear, several-seeded; seeds nearly spherical or compressed on the sides, variable, blackish to brownish.

FIG. 312. Common Vetch (*Vicia sativa*). (After Hillman, Circular U. S. Dept. Agr.)

Hairy Vetch (*Vicia villosa* Roth.).

Seeds spherical to subspherical; one-tenth to one-sixth in. in diameter; blackish or brownish, surface smooth; scar elongated, repre-

FIG. 313. Hairy Vetch (*Vicia villosa*). (Hillman, U. S. Dept. of Agriculture.)

sented by a narrow line slightly elevated, with depressed center, light in color, brownish to straw-colored.

Trailing Wild Bean (*Strophostyles helvola* (L.) Britton).

Pod terete, 5-7.5 cm. long, nearly glabrous, 4-8-seeded, dark brown; seed cylindrical, rounded, truncate at both ends; length 6 mm., width 4.5 mm.; color dull brown slightly mottled; narrow white scar along inner angle, nearly the entire length of the seed; seed strongly angled longitudinally on side opposite scar.

FIG. 314. Wild Bean (*Strophostyles helvola*). (Drawing by L. R. Collins.)

LINACEAE, FLAX FAMILY.

Common Flax (*Linum usitatissimum* L.).

Seeds ovate, flattened, one-fifth in. long, one-tenth in. wide, basal end curved on one side; color brown, margins with whitish luster,

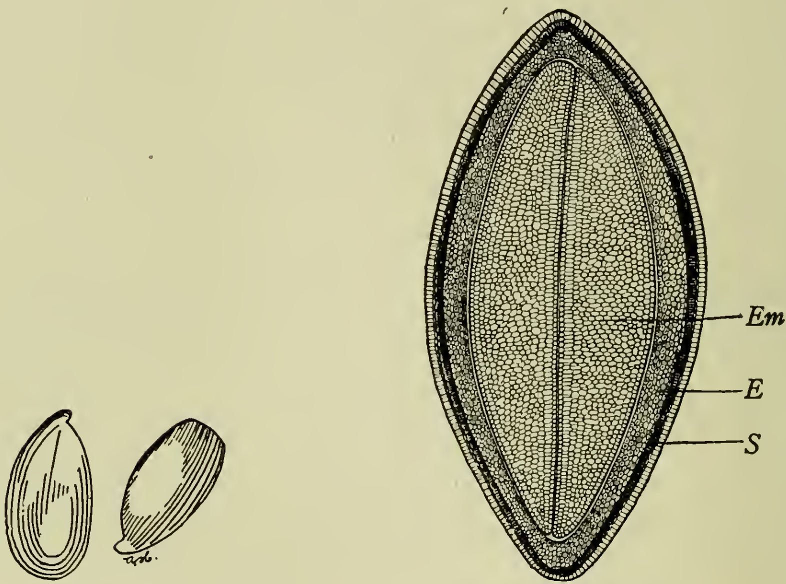


Figure 315A Figure 315B

FIG. 315. Common Flax (*Linum usitatissimum*). A, seed. B, cross section of seed.
(A, drawing by Ada Hayden; B, after Winton.)

smooth, shining; scar on one side, near lower end, small, inconspicuous; embryo, large, straight.

OXALIDACEAE, SORREL FAMILY.

Lady's Sorrel (*Oxalis corniculata* L.).

Pod prismatic, cylindrical, seeds 1 mm. in length; shape and markings similar to preceding.

Oxalis (*Oxalis stricta* L.).

Pod angled, awl-shaped; seeds 1 mm. in length, elliptical, pointed at one end; surface marked by broken transverse lines of white; seed longitudinally ribbed, slightly flattened.

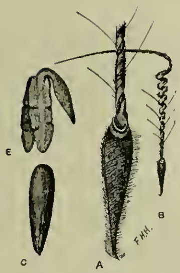


Figure 316A

Figure 316B

Figure 316B

FIG. 316. A, Storksbill or Alfilaria (*Erodium cicutarium*); A, a seed-vessel with a portion of its spirally coiled awn. B, a seed-vessel and its awn, natural size. (In many the awn is smaller.) C, a seed, magnified. D, a line showing the length of the seed. E, the embryo removed from the seed coats, the parts spread.
B. Lady's Sorrel or Yellow Field Sorrel (*Oxalis corniculata*).
(A, after Hillman, Bull. Mich. Agr. Exp. Sta.; B, drawings by C. M. King.)

GERANIACEAE, GERANIUM FAMILY.

Storksbill (*Erodium cicutarium* L'Her.).

Lobes of capsule 1-seeded, with elastic, dehiscent style, coiled at maturity, villous inside; hairs at base pointing obliquely upwardly; awn coiled for half its length; seed broadly club-shaped, one-fifth in. in length without awn; scar removed one-third length of seed from base; groove from scar to tip of seed.

EUPHORBIACEAE, SPURGE FAMILY.

Three-seeded Mercury (*Acalypha virginica* L.).

Seeds ovoid; one-twelfth to one-twentieth in. long; reddish, minutely striate, line running from apex to base; scar at smaller end. Found in clover seed.

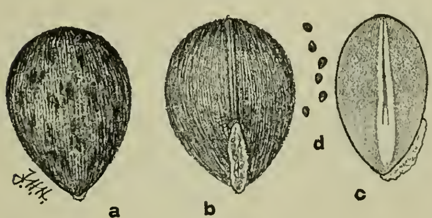


Figure 317A

Figure 317B

FIG. 317. A. Three-seeded Mercury (*Acalypha virginica*). a and b, different views of seed; c, sectional view showing embryo and endosperm; d, seed, natural size.
B. Prostrate Spurge or Milk Spurge (*Euphorbia maculata*). A. Different views of seed. B. Seeds, natural size.
(After Hillman, Bull. Mich. Agr. Exp. Sta.)

Upright Spurge (*Euphorbia preslii* Guss.).

Seeds lead-colored, obovoid-oblong, with 4 unequal sides; surface pitted and transversely wrinkled; a narrow dark raphe along one edge; length 1-1.3 mm.

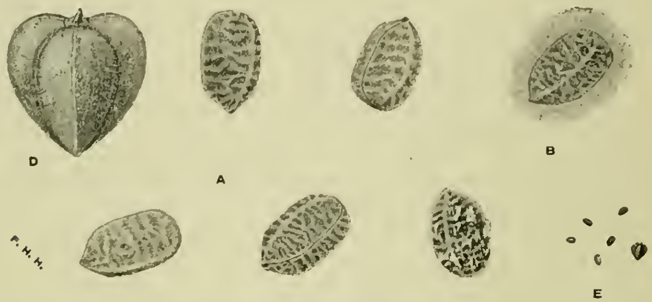


FIG. 318. Seeds of Spotted Spurge (*Euphorbia preslii*). A and B, different views of seed. D. Fruit. E. Seed, natural size. (After Hillman, Bull. Mich. Agr. Exp. Sta.)

Flowering Spurge (*Euphorbia corollata* L.).

Seeds ovoid, one-tenth in. in length, smooth, brownish, a line extending from apex to base on one side, with whitish bordered depression at base; apical point on larger end; seed coat mucilaginous.

Figure 319A

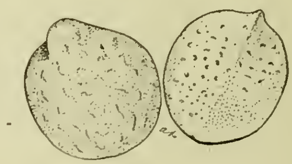


Figure 319B

FIG. 319. A. Flowering Spurge (*Euphorbia corollata*.) B. Snow-on-the-Mountain (*Euphorbia marginata*). (Drawing by Ada Hayden.)

Milk Purslane (*Euphorbia maculata* L.).

Seeds ovoid or oblong, obtusely angled, one-twentieth in. in length, minutely pitted and transversely wrinkled; grayish.

Snow-on-the-mountain (*Euphorbia marginata* Pursh.).

Seed ovoid, slightly flattened at apical end, length 4 mm., width 3 mm.; color light brown; surface roughly tuberculate; one side marked by a dark longitudinal line.

MALVACEAE, MALLOW FAMILY.

Velvet-leaf, Butterprint (*Abutilon theophrasti* Medic.).

Carpels 2-valved, beaked, each usually 2-seeded; seeds somewhat triangular, kidney-shaped, one-eighth in. in length, minutely granular and pubescent; color blackish gray; funicle extending to notch of seed. May occur in small grain.

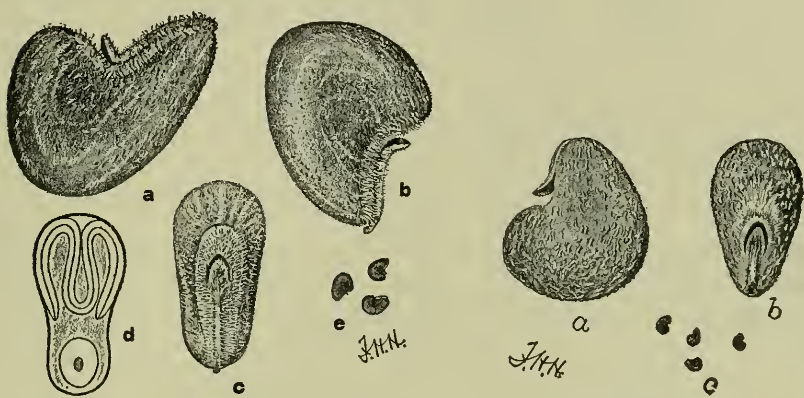


Figure 320A Figure 320B

FIG. 320. A. Indian Mallow or Butterprint (*Abutilon theophrasti*). a, b, c, different views of seed; d, cross section showing embryo and caulicle; e, seeds, natural size.
B. Seeds of Bladder Ketmia. a and b, different views, c, natural size.
(After Hillman, Bull. Mich. Agr. Exp. Sta.)

Prickly Sida (*Sida spinosa* L.).

Seeds oval, one-sixteenth to one-twelfth in. long, one face convex, the other with a prominent ridge across its length; scar at broad end; surface dull, smooth; color brownish. Reported in seed of Missouri red clover.

FIG. 321. Prickly Sida (*Sida spinosa*). A, different views of seeds. B, a seed in section taken midway between the two extremities, showing embryo and caulicle. C, seeds, natural size.
(After Hillman, Bull. Nev. Agr. Exp. Sta.)

Common Mallow (*Malva rotundifolia* L.).

Commonly called cheeses. Carpels arranged about a center, flat, beakless, indehiscent; each carpel a single seed, kidney-shaped, one-sixteenth to one-twelfth in. in diameter, flattened, with a prominent

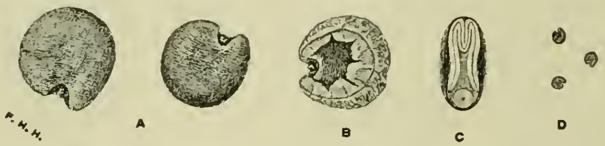


FIG. 322. Common Mallow (*Malva rotundifolia*). A, two seeds in side view. B, a seed retained by a carpel of the seed-vessel. C, a seed in cross section taken midway between the scar and the opposite edge. D, seeds, showing the natural size.
(After Hillman, Bull. Mich. Agr. Exp. Sta.)

notch at base; seeds brownish or gray, minutely granular; scar small, frequently containing spongy tissue; embryo curved; small amount of endosperm. Reported in alfalfa and red clover seed.

Bladder Ketmia (*Hibiscus trionum* L.).

Capsule 5-valved, globose-ovoid, hairy; seeds kidney-shaped, one-fifteenth in. in length, blackened, roughened by short tubercular processes, minutely granular; basal end of seed of much smaller diameter; scar brownish; funicle extending to the notch.

ONAGRACEAE, EVENING PRIMROSE FAMILY.

Evening Primrose (*Oenothera biennis* L.).

Seeds prismatic, 4 or 5-sided, sometimes curved, variable, one-sixteenth in. in length, slightly wing-margined, rugose, brown, scar indistinct at one end, embryo straight.

UMBELLIFERAE, PARSLEY FAMILY.

Water Hemlock (*Cicuta maculata* L.).

Fruit ovate to oval, curved or nearly straight, one-eighth in. in length, smooth, with longitudinal brown and straw-colored lines; apex widened with 2 styles; ribs corky; oil-tubes solitary, in the intervals.

Figure 323A

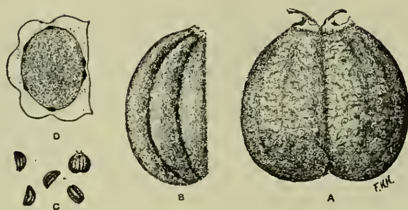


Figure 323B

FIG. 323. A. Evening Primrose (*Oenothera biennis*). A, different views of seed. B, cross section of seed. C, natural size.
B. Water Hemlock (*Cicuta maculata*).
(After Hillman, Bull. Mich. Agr. Exp. Sta.)

Wild Parsnip (*Pastinaca sativa* L.).

''Seeds'', carpels one-quarter in. in length, thin, circular or oblong; color light or dull yellowish brown; lighter conspicuous margin, ribs brownish or reddish; apex notched, with a conspicuous remnant of the style; oil tubes four, alternating with the ribs; inner face concave, with a central longitudinal ridge and one oil-tube on each side.

Wild Carrot (*Daucus carota* L.).

Fruit one-eighth in. long, oblong, flattened dorsally; carpel with 5 slender, bristly, primary ribs bearing numerous spines, and 4 secondary wings; color whitish yellow; oil tubes one under each row of spines, and two between the ridges of the inner face; seeds commonly found with spines broken off. In alfalfa and clover seeds.

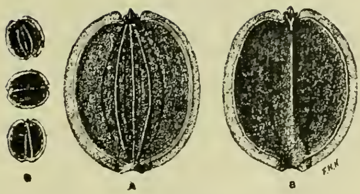


Figure 324A

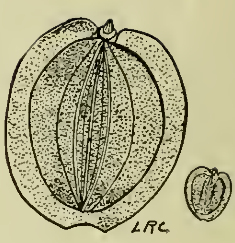


Figure 324A¹

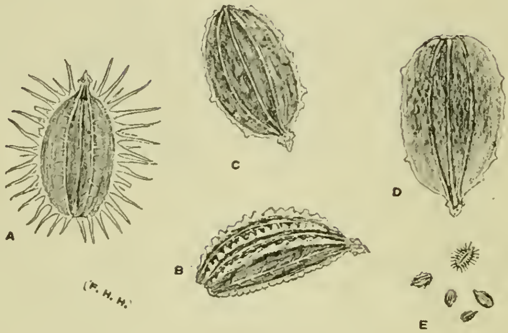


Figure 324B

FIG. 324. A and A1. Wild Parsnip (*Pastinaca sativa*). B. Wild Carrot (*Daucus carota*). A, the outer (at left) and inner (at right) faces of a seed (carpel). The spines occupy the margin and two rows along the outer face. The slender, hairy ridges alternate with the rows of spines. The inner face bears two, separated by a slender ridge or line which is not hairy. B, an oblique view of the outer face of a seed found with clover seed. C and D, views of the inner face of seeds similarly found. E, seeds, natural size.
(A, after Hillman, Bull. Nev. Agr. Exp. Sta.; A1, drawing by L. R. Collins; B, after Hillman.)

ASCLEPIADACEAE, MILKWEED FAMILY.

Swamp Milkweed (*Asclepias incarnata* L.).

Seeds oval, wing-margined, three-tenths in. in length; surface less prominently veined than in *A. syriaca;* raphe marked by distinct ridge; coma attached to smaller end of fine silky hairs. Probably never in commercial seed.

Common Milkweed (*Asclepias syriaca*).

Seeds flattened, oval or elliptical, apical end truncate, three-tenths in. in length, wing-margined; seed and wing distinctly veined; the raphe occurs in form of a distinct ridge on inner face of seed; coma a tuft of silky hairs attached to apical end, easily separated from seed. Not apt to be found in commercial seed.

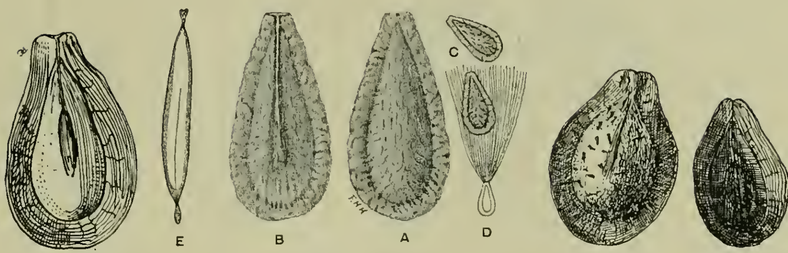


Figure 325A Figure 325B Figure 325C Figure 325D

FIG. 325. A. Swamp Milkweed (*Asclepias incarnata*). B. Common Milkweed (*Asclepias syriaca*). a, b, different views of seed; c, cross section; d, e, natural size. C. Butterfly Weed (*Asclepias tuberosa*). D. Whorled Milkweed (*Asclepias verticillata*).
(A, drawing by L. R. Collins; B, after Hillman; C, D, by C. M. King.)

Butterfly Weed (*Asclepias tuberosa* L.).

Seed ovate or eliptical, three-tenths in. in length; surface roughened by ridges on both back and inner faces; winged margin, lighter brown than middle part of seed; raphe marked by a distinct ridge; coma fine, silky, smooth.

Whorled Milkweed (*Asclepias verticillata* L.).

Seeds ovate, one-sixth in. in length, margin distinct, lighter in color than the rest of the reddish brown seed; surface veined, but not ridged or roughened; raphe a distinct ridge on inner face; coma soft, silky; very smooth.

CONVOLVULACEAE, CONVOLVULUS FAMILY.

Common Morning-glory (*Ipomoea purpurea* (L.) Roth.).

Seed dark brown, with one convex side opposite to 2 flattened faces meeting at an angle, length 5 mm., width 4 mm. at the base of the seed; at lower end of the angle between the two flattened faces is the scar, also dark brown; surface dull, finely roughened.

Small Bindweed (*Convolvulus arvensis* L.).

Seeds large, oval, one side convex, the other side with a broad ridge; one-sixth in. long, a depression at one extremity representing the scar; surface of seed roughened, dark brown in color; embryo large, surrounded by the fleshy endosperm. Found in cereal grains.

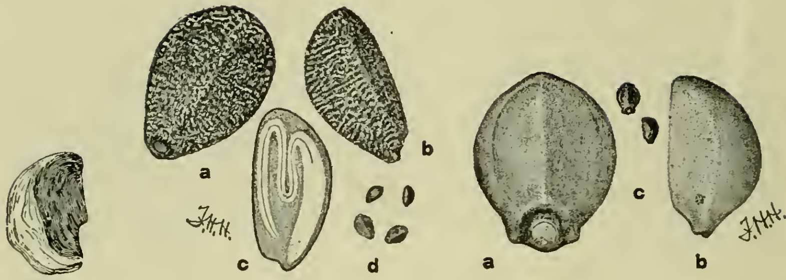


Figure 326A Figure 326B Figure 326C

FIG. 326. A. Common Morning-glory (*Ipomoea purpurea*). B. Small Bindweed (*Convolvulus arvensis*). a, b, different faces of seed, c, cross section, d, natural size. C. Wild Morning-glory (*Convolvulus sepium*). a, b, different faces of seed, c, natural size.
(A, drawing by Charlotte M. King; B and C, after Hillman.)

Wild Morning-glory (*Convolvulus sepium* L.).

The outer surface rounded; inner face with prominent ridge and a depression on each side; seed one-quarter in. long; smooth, brownish or blackish, with minute projections over the surface; hilum prominent, light brown, in semicircular depression.

Field Dodder (*Cuscuta arvensis* Beyrich.).

Capsule globose, indehiscent; seed spherical to kidney-shaped, or ovate, occasionally with prominent angles; one-twenty-fourth to one-sixteenth in. long; roughened but not pitted, dull yellowish, grayish or light brown; scar at one extremity, frequently elevated and prominent; Mr. Hillman finds field dodder seeds usually lighter than those of Chilean dodder; in some samples the Chilean dodder seeds are the lighter in color. Appears in clover seed, in many cases abundantly.

FIG. 327. Field Dodder (*Cuscuta arvensis*).
(A, after Hillman, Bull. Nev. Agr. Exp. Sta.; B, drawing by C. M. King.)

Clover Dodder (*Cuscuta epithymum* Murr.).

Seed spherical or subspherical, one-thirtieth to one-twenty-fourth in. in diameter; surface roughened, with appearance of sponginess, dull, usually ashy, yellowish to light or dark brown, or purplish; embryo coiled, without cotyledons, consisting of slender tapering

FIG. 328. Clover Dodder (*Cuscuta epithymum*). A, a group showing various forms and views of seeds. B and C, seeds having the scurfy appearance. D and E show the angled, scar-bearing face, E, being one of the light-colored, sterile seeds. F, a torn, dried flower having the seed-vessel intact. G, the embryo. H, group of seeds showing the natural size.
(After Hillman, Bull. Nev. Agr. Exp. Sta.)

body, with caulicle and radicle embedded in fleshy endosperm. Commonly distributed in seed of clovers and alfalfa. Brown and Hillman state that this dodder is almost entirely confined to European grown seed, since the plant does not generally produce seed in this country.

Chilean Dodder (*Cuscuta sp.*)

Seeds spherical to subspherical or oval, inclined to be more angular than the preceding species, flattened on one side, one-seventeenth to one-fifteenth in. in diameter, about the size of large field dodder seeds; dull brownish, minutely roughened; scar prominent, at end of flattened surface, lighter in color than rest of seed. Found in both clover and alfalfa seed, from which it is screened with difficulty.

FIG. 329. Chilean Dodder (*Cuscuta chilensis*).
(Drawing after Burchard.)

BORAGINACEAE, BORAGE FAMILY.

Common Hound's Tongue (*Cynoglossum officinale* L.).

Ovary dividing into 4 achenes, each 5-7 mm. in length, ovate to round, flattened; lower side bearing large ovate scar; surface covered with straight, stiff, barbed prickles.

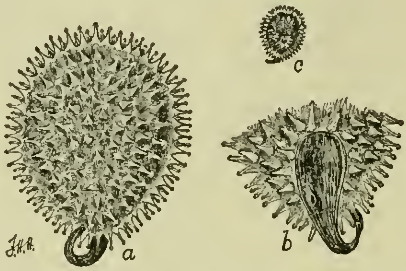


FIG. 330. Common Hound's Tongue (*Cynoglossum officinale*). a, b, views of different faces of seed; c, natural size. (After Hillman, Bull. Mich. Agr. Exp. Sta.)

Wild Comfrey (*Cynoglossum boreale* Fernald.).

Nutlets convex on the upper face, somewhat triangular, one-seventh in. in diameter, bearing short barbed prickles on convex surface; color brown.

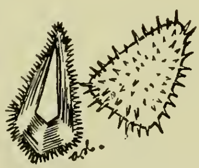


FIG. 331. Wild Comfrey (*Cynoglossum boreale*). (Drawing by Ada Hayden.)

Stickseed (*Lappula echinata* Gilibert).

Ovary separating into 4 achenes, 2.5 mm. long, slightly flattened from ovate, under surface tuberculate, bearing straight ridge from point to middle; on the upper side, the margins bear a double row of slender barbed prickles.

Beggar's Lice (*Lappula virginiana* (L.) Greene).

Achenes 3 mm. long, borne in clusters of 4, broadly ovate, flattened on outer side; the outer surface bearing short stiff barbed prickles, the inner side cone shaped, free from hairs, and bearing a triangular scar.

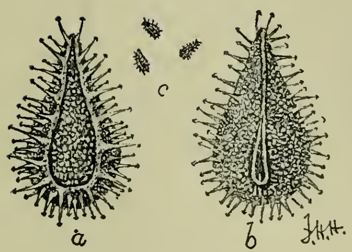


Figure 332A

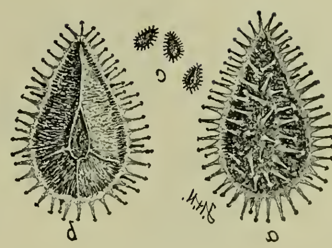


Figure 332B

FIG. 332. A. Stickseed (*Lappula echinata*). a, b, views of different faces of seed; c, natural size.
B Beggar's Lice (*Lappula virginiana*). a, b, views of different faces of seed; c, natural size.
(After Hillman, Bull. Mich. Agr. Exp. Sta.)

Narrow-leaved Puccoon (*Lithospermum angustifolium* Michx.).

Nutlets ovoid, keeled on inner face, one-eighth in. long; surface smooth, shining, pitted; color white to yellowish white; base irregular with projecting margin; bearing base with projecting ridges.

Fig. 333A

Fig. 333B

FIG. 333. A. Narrow-leaved Puccoon (*Lithospermum angustifolium*).
B. American Gromwell (*Lithospermum latifolium*).
(Drawings by L. R. Collins).

American Gromwell (*Lithospermum latifolium* Michx.).

Nutlets ovoid to globose, one-sixth in. in diameter, white, shining; glabrous but prominently pitted; base oblique.

Corn Gromwell (*Lithospermum arvense* L.).

Ovoid nutlets 4 or fewer, convex on back, inner face with distinct ridge; one-sixteenth to one-twelfth in. in length; color from whitish to dark brown, surface glabrous, but wrinkled and pitted; base obliquely flattened, bearing the scar. Reported to occur with grain seed.

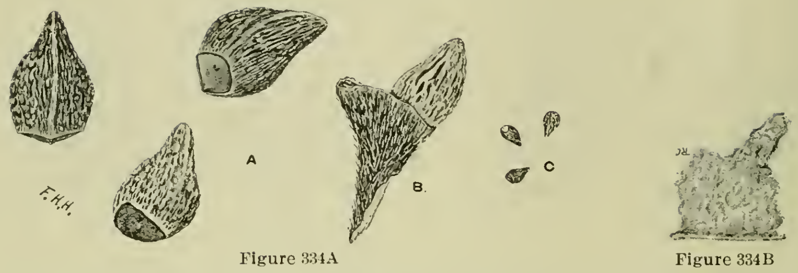


FIG. 334. A, Corn Gromwell (*Lithospermum arvense*). A, different views of nutlets, B, one bearing the flower-receptacle and portion of the stem, C, the natural size of the larger nutlets.
B, Viper's Bugloss (*Echium vulgare*).
(A, after Hillman, Bull. Mich. Agr. Exp. Sta.; B, drawn by L. R. Collins.)

Viper's Bugloss (*Echium vulgare* L.).

Nutlets erect, ovoid, one-eleventh in. in length, back distinctly convex; seed straight or curved; outer face with distinct ridge; surface rugose; color white, base flattened.

VERBENACEAE, VERVAIN FAMILY.

Large-bracted Vervain (*Verbena bracteosa* Mx.).

Nutlets cylindrical, 3-sided, outer face convex, one-tenth in. in length, outer face rugose at upper end, lower end marked by lines, inner face pitted, scar somewhat elevated, whitish. In seeds of clovers and grasses.

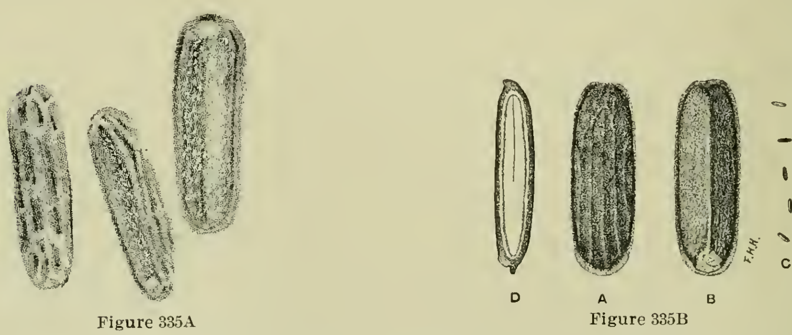


FIG. 335. A. Large-bracted Vervain (*Verbena bracteosa*). B. Blue Vervain (*Verbena hastata*). A, the outer face, and B, the inner face of a nutlet; the latter shows the whitish, spongy scar at the base. C, a group showing the natural size. D, a section of a nutlet, taken lengthwise.
(A, drawing by C. M. King; B, after Hillman, Bull. Nev. Agr. Exp. Sta.)

Blue Vervain (*Verbena hastata* L.).

Nutlets 3-sided, with a distinct line of separation, back convex, rugose, inner face 2-sided; one-fifteenth to one-thirteenth in. long; color light brown; scar slightly elevated, whitish, at base of nutlet. Often found in seed of clover.

Hoary Vervain (*Verbena stricta* Vent.).

Nutlets cylindrical, 3-sided, one-eighth in. in length, outer face convex, back with 4 prominent veins, upper portion slightly pitted; color dark brown; whitish scar at base. Seed found in clover.

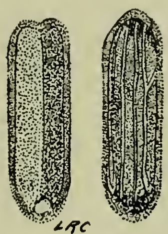


Figure 336A

Figure 336B

FIG. 336. A. Hoary Vervain (*Verbena stricta*). B. White Vervain (*Verbena urticaefolia*).
(A, drawing by L. R. Collins; B, after Hillman, Bull. Mich. Agr. Exp. Sta.)

White Vervain (*Verbena urticaefolia* L.).

Nutlets cylindrical, convex on back, 2-faced on inner side, with prominent central line; one-tenth to one-eighth in. in length; back somewhat rugose, with 2 or 3 prominent lines extending from base to apex and some cross lines; inner face somewhat granular; scar a whitish elevated point. Found in seeds of clovers.

LABIATAE, MINT FAMILY.

Catnip (*Nepeta cataria* L.).

Oval, dark brown seeds, about 1.5 mm. in length, slightly flattened, surface smooth; one face bears a broad central, longitudinal ridge, the base of which is marked by two white characteristic spots, which are a part of the scar.

American Germander (*Teucrium canadense* L.).

Nutlets obovoid, one-tenth in. in length, outer surface convex; color brown; surface prominently rugose, reticulated except the scar at the lower end. Common in commercial seed.

Figure 337A

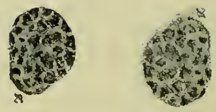


Figure 337B

FIG. 337. A. Catnip (*Nepeta cataria*). A, views of various seeds (nutlets), three showing the scar-marking. B, one having the nutlet wall partially broken away, exposing the seed proper. C, a nutlet in longitudinal section, showing the embryo. D, group showing the natural size.
B. American Germander (*Teucrium canadense*).
(A, after Hillman, Bull. Nev. Agr. Exp. Sta.; B, drawn by L. R. Collins.)

Horehound (*Marrubium vulgare* L.).

Seed ovate, one side convex, flattened side divided into 2 faces by strong central ridge; one-twelfth of an inch in length; brownish

Figure 338A

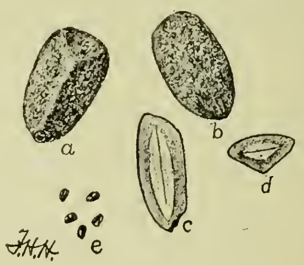


Figure 338B

FIG. 338. A. Giant Hyssop (*Agastache scrophulariaefolia*).
B. Common Horehound (*Marrubium vulgare*); a, angled face; b, convex face; c, longitudinal section; d, transverse section; e, natural size of seed.
(A, drawing by L. R. Collins; B, after Hillman, Mich. Agr. Exp. Sta.)

or blackish, with straw-colored markings; scar inconspicuous, in a slight depression somewhat paler in color than seed.

Self-heal (*Prunella vulgaris* L.).

Nutlets ovoid, faces convex, marked by longitudinal grooves; one-twelfth of an inch in length; smooth, shining; color brown; small bud marked by white scar appendage. Found in red clover.

Motherwort (*Leonurus cardiaca* L.).

Nutlets 3-sided, occasionally flattened, 1.10 in. long, smooth except upper end, which is papillose; minutely roughened; straw-colored to brownish. Found in cultivated grass seed.

Figure 339A

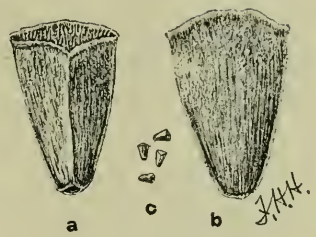


Figure 339B

FIG. 339. A. Self-heal (*Prunella vulgaris*). A, a group of seeds, enlarged, the lower left-hand one with the scar-appendage broken away; the upper left-hand one showing the outer face. B, a group showing the natural size; C, a longitudinal section of a seed, showing the embryo.
B Motherwort (*Leonurus cardiaca*). a and b, different views of seed, c, seed, natural size.
(After Hillman, A, Bull. Nev. Agr. Exp. Sta.; B, Bull. Mich. Agr. Exp. Sta.)

SOLANACEAE, NIGHTSHADE FAMILY.

Horse Nettle (*Solanum carolinense* L.).

Berry orange-yellow, 1.6 to 2 cm. in diameter; seeds pale dull yellow, much flattened, obovate, 2 to 3 mm. in length; finely granular, or indented over whole surface.

Black Nightshade (*Solanum nigrum* L.).

Berries black, globular, smooth; seed asymmetrically ovate, flattened, pale yellowish brown, finely granular; diameter about 1.5 mm.

Buffalo Bur (*Solanum rostratum* Dunal.).

Black berry enclosed in spiny yellow calyx; seeds nearly circular, bearing a dent on one side of the margin; flattened, pitted on the surface; both sides irregularly indented with depressions; color, dull dark brown; seed about 2.5 mm. broad.

Jimson Weed (*Datura stramonium* L.).

Seed one-eighth in. in length, brownish or blackish, kidney-shaped, elliptical or nearly spherical, with numerous large depressions and smaller pits; hilum with a small depression.

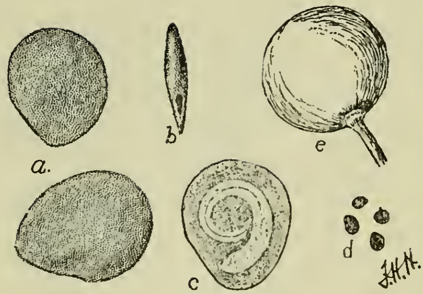


Figure 340A

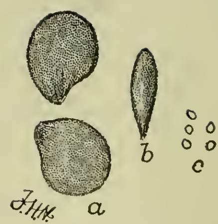


Figure 340B

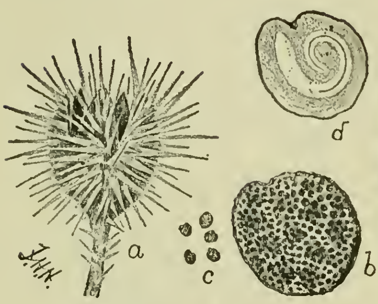


Figure 340C

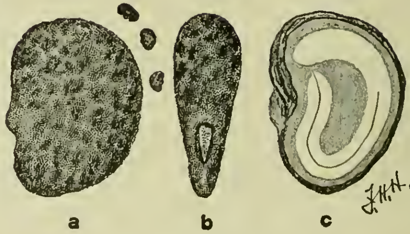


Figure 340D

FIG. 340. A. Horse Nettle (*Solanum carolinense*). a, b, c and d, different views of seed; e, fruit.

B. Black Nightshade (*Solanum nigrum*). a, two seeds, side view, enlarged; b, group showing the natural size; c, a section of a seed, parallel with the faces, showing the spirally curved embryo imbedded in the endosperm.

C. Buffalo Bur (*Solanum rostratum*). a, prickly calyx; b, seeds with pits; c, seed, natural size; d, cross section of seed with embryo.

D. Jimson Weed (*Datura stramonium*). a and b, seeds from different views; between a and b, seeds, natural size; c, cross section of seed showing embryo.

(After Hillman, A, C, D, Mich. Agr. Exp. Sta. Bull; B, Bull. Nev. Agr. Exp. Sta.)

SCROPHULARIACEAE, FIGWORT FAMILY.

Moth Mullein (*Verbascum blattaria* L.).

Seeds light to dark brown, 0.5 to 1 mm. in length, prismatic, 6-sided, base truncate, broader than the rounded apex; each side face pitted in longitudinal rows.

Mullein (*Verbascum thapsus* L.).

Seeds columnar, 4-6-sided, top usually truncate, base nearly so; one-thirtieth in. in length; faces deeply transversely pitted; surface dull; color brown; scar in middle of flattened base. Reported as frequently found in seeds of timothy and similar grasses.

Figure 341A

Figure 341B

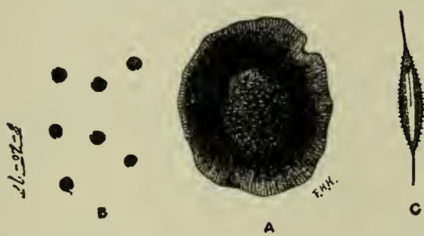


Figure 341C

FIG. 341. A. Moth Mullein (*Verbascum blattaria*). A, a group of seeds, enlarged, showing different forms, and kinds of surface markings. a, b and c were produced from seeds of *V. blattaria,* and d from *V. thapsus.* B represents a group natural size. C, a section taken lengthwise through the center of a seed, showing the embryo and surrounding endosperm.

B. Common Mullein (*Verbascum thapsus*).

C. Toad Flax (*Linaria vulgaris*). A, a side view of a seed much enlarged, the scar within the notch on the upper right-hand margin. B, a group showing the natural size. C, a section through the center of a seed showing the embryo.

(A, after Hillman, Bull. Mich. Agr. Exp. Sta.; B, drawing by L. R. Collins; C, after Hillman, Bull. Mich. Agr. Exp. Sta.)

Toad-flax (*Linaria vulgaris* Hill.).

Seeds flattened, wing-margined, orbicular in outline, wing wavy, notched at one end; one-twelfth in. in diameter; surface rugose; wings one-thirtieth to one-twenty-fifth in. wide; embryo slender, curved. Commonly occurs in grass seed and occasionally in clover.

Speedwell (*Veronica peregrina* L.).

Seeds oblong to egg-shaped, flattened, one-thirty-second to one-thirtieth in. long, slightly curved, the outer face with a central ridge; embryo straight, surrounded by the endosperm; raphe on the inner face; scar projecting.

FIG. 342. Speedwell (*Vernonia peregrina*). a, b, d, different views of seeds; c, seeds, natural size.
(After Hillman, Mich. Agr. Exp. Sta.)

PLANTAGINACEAE, PLANTAIN FAMILY.

Bracted Plantain (*Plantago aristata* Mx.).

Seeds oval or oblong, back of seed convex with transverse ring across the middle or nearly so, one-twelfth to one-eighth in. long; inner face with white marginal ring, in center of inner face 2 pit-like markings each surrounded by whitish area, giving appearance of 2 rings, or 2 links of a chain.

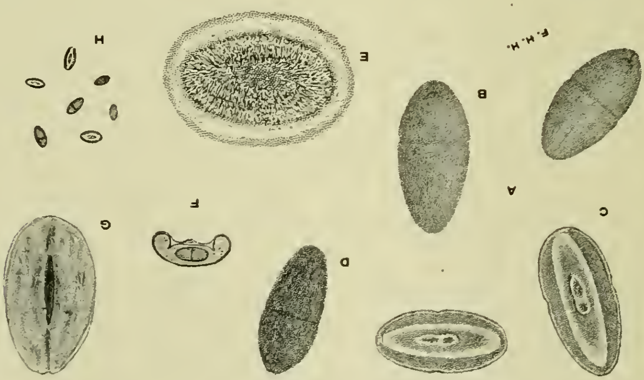


Figure 343A

Figure 343B

Figure 343C

FIG. 343. Bracted Plantain (*Plantago aristata*). A, group of seeds. B and C, the convex and grooved faces, respectively.
(A, after Hillman, Bull. Nev. Agr. Exp. Sta.; B and C, drawings by Charlotte M. King.)

Ribgrass, Buckhorn (*Plantago lanceolata* L.).

Seeds oblong, convex on back, one-twelfth to one-seventh in. in length, edges folded inwardly to deep central longitudinal groove

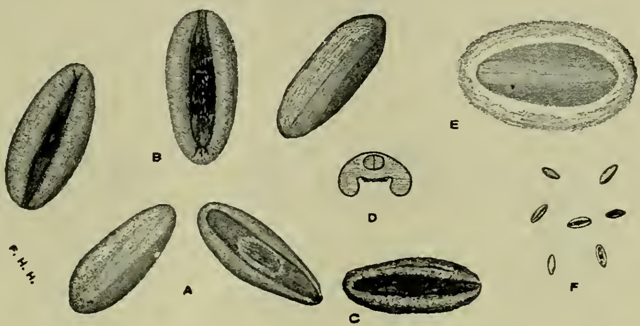


FIG. 344. Buckhorn (*Plantago lanceolata*). A and B, group of seeds showing both the convex and grooved faces. C, a sterile seed. D, a seed in cross section. E, seed showing the mucilage. F, the natural size. (After Hillman, Bull. Nev. Agr. Exp. Sta.)

on inner face; brown, smooth, shining; scar at center of groove frequently of dark color.

Dooryard Plantain (*Plantago major* L.).

Seeds oblong to trapezoidal in shape, usually 4-sided, some of them 3-sided, one-twenty-second to one-sixteenth in. long; brownish to black; surface bearing 5 ridges radiating from scar; scar on middle of inner face, often with white markings.

Rugel's Plantain (*Plantago rugelii* Dcne.).

Seeds oblong, rhomboidal, generally trapezoidal with flattened edges, one-eighteenth to one-twelfth in. in length; color brownish to black; surface minutely roughened, ridgelike markings absent; scar circular, whitish.

Figure 345A

Figure 345B

FIG. 345. A. Common Plantain (*Plantago major*). a, a group of seeds, enlarged, showing the relative form and size, also the surface ridges as dark lines; b, a group showing the natural size; c, a cross section of a seed.
B. *Plantago rugelii.* A, seeds, the upper two showing the scar. B, seed showing the mucilage. C, a seed-vessel. D, seeds, natural size.
(After Hillman, Bull. Nev. Agr. Exp. Sta.)

RUBIACEAE, MADDER FAMILY.

Cleavers (*Galium aparine* L.).

Fruit indehiscent, spherical, one-tenth to one-eighth in. in diameter, roughened with prickles, tuberculate when prickles are rubbed off; color blackish; embryo curved; endosperm horny; fruit covered with hooked trichomes.

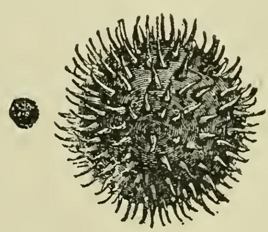


FIG. 346. Cleavers, or Bedstraw (*Galium aparine*). (After Winton.)

COMPOSITAE, COMPOSITE FAMILY.

Baldwin's Ironweed (*Vernonia baldwini* Torr.).

Achenes practically indistinguishable from those of the following species.

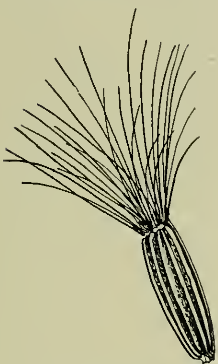


Figure 347A

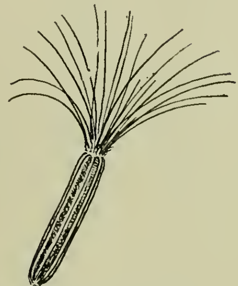


Figure 347B

FIG. 347. Ironweed seeds. A. *Vernonia fasciculata.* B. *Vernonia baldwini.* Achenes with pappus. (Drawings Charlotte M. King.)

Ironweed (*Vernonia fasciculata* Mx.).

Achenes 3-3.5 mm. long, and 1 mm. broad; general form slender, cylindrical, often slightly curved; strongly 9-10-ribbed, ribs of same color as achene, pale brown; tuft of purplish brown pappus bristles attached at larger end; length of pappus hairs 6 mm.

White Snakeroot (*Eupatorium urticaefolium* Reichard).

Achene long, 5-angled, prominently grooved between the angles one-twelfth to one-tenth inch; generally blackish except at the base where it is yellowish; the scar at base with a small circular opening, and whitish border; smoothish (see figure), pappus of fine white capillary bristles; the upper part of beak expanded into candelabra form, bearing the somewhat fragile pappus.

Joe-Pye Weed (*Eupatorium purpureum* L.).

Achenes smooth, prominently ribbed; 5-angled, truncate; about one-eighth of an inch long; base white; pappus with numerous tawny-colored, capillary bristles. Miss Mary Nichols, who studied the achenial hairs of *E. villosum,* finds that they are short with lateral canals. The achenial hairs of *E. purpureum,* according to Mr. Fracker, are simple, in *E. villosum* duplex.

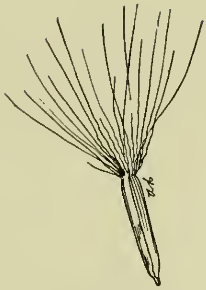


Figure 348A

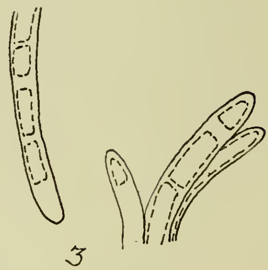


Figure 348B

Figure 348C

Fig. 348. Seeds of Snakeroot (*Eupatorium urticaefolium*) and Joe-Pyeweed (*Eupatorium purpureum*). A. *Eupatorium purpureum.* B. Achenial hairs of same. C. *Eupatorium urticaefolium.*
(A and C, drawings by Ada Hayden; B, drawing by S. B. Fracker.)

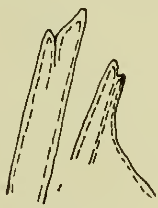


Figure 349 1

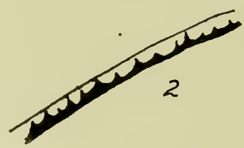


Figure 349 2

Fig. 349. 1. Hairs from achenium of *Eupatorium villosum.* 2. Surface of achenium of *Eupatorium urticaefolium.*
(Drawings by S. B. Fracker.)

False Boneset (*Kuhnia eupatorioides* L.).

Achenes oblong, columnar, 10-15-ribbed; blackish or reddish, base with prominent disklike area marked by circular, somewhat bulging ring; from one-eighth to one-tenth inch in length; pappus of fine tawny colored capillary, somewhat brittle, bristles. The achenial hairs of *Kuhnia eupatorioides,* according to Miss Mary A. Nichols, are mostly simple and short; a few duplex hairs also occur.

Blazing-star (*Liatris punctata* Hook.).

Achenes 10-ribbed; slender, tapering to the base; one-quarter to one-third inch long; grayish, pubescent, almost pilose; apex brownish; scar at base indistinct; pappus or numerous plumose bristles. The achenial hairs of *Liatris gracilis,* according to Miss Nichols, are duplex with an indistinct wall arising from the base. The hairs of *L. punctata,* according to Mr. Fracker, are duplex and simple.

Figure 350A

Figure 350B

FIG. 350. Seeds (achenes) of: A. Blazing Star (*Liatris punctata*). B. False Boneset (*Kuhnia eupatorioides*).
(Drawings by Ada Hayden.)

Figure 351A

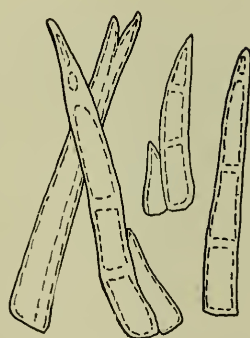


Figure 351B

FIG. 351. Achenial hairs of: A. *Kuhnia eupatorioides*. B. *Liatris punctata*.
(Drawings by Fracker.)

Broad-leaved Gum-plant (*Grindelia squarrosa* Dunal).

Achenes short, thickened, faintly 4-angled, with veins between the angles; curved; one-twelfth to one-eighth of an inch in length; straw-colored; apex truncate; base with light scar. The related *Bigelovia nudata,* according to Mr. Fracker, has duplex hairs.

Canadian Goldenrod (*Solidago canadensis* L.).

Achenes minute, nearly terete, obovate, many-ribbed; brownish or greenish, somewhat pubescent; pappus of numerous fine capillary equal bristles.

Figure 352A

Fig. 352B

Figure 352C

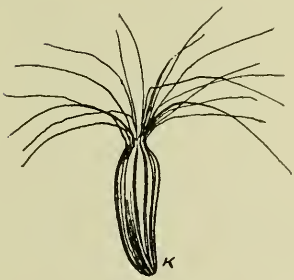


Figure 352C

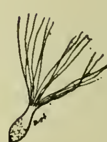


Fig. 352D

FIG. 352. Seeds (achenes) of: A. Gum Weed (*Grindelia squarrosa*), enlarged and natural size. The one at the top shows the wrinkled appearance of the corky-thickened angles. B, Canadian Goldenrod (*Solidago canadensis*). C, Stiff Goldenrod (*Solidago rigida*). D, Late Goldenrod (*Solidago serotina*). (A, after Hillman, Bull. Nev. Agr. Exp. Sta.; C, drawing by Charlotte M. King; B and D, drawings by Ada Hayden).

Stiff Goldenrod (*Solidago rigida* L.).

Achenes ribbed, somewhat 4-angled, with minute ribs between the angles; scar at base small, whitish, one-sixth to one-twelfth in. long, pale straw-colored; pappus of minute capillary bristles of nearly equal size, spreading.

Late Goldenrod (*Solidago serotina* Ait.).

Achenes minute, somewhat teretish, many-ribbed, minutely pubescent, straw-colored, one-twentieth in. in length; small obovoid scar at base, whitish; pappus spreading, of fine white capillary bristles.

Willow-leaved Aster (*Aster salicifolius* Ait.).

Achene slender, pale brown, about 1.5 mm. long and .25 mm. broad; 5 longitudinal ribs at angles of seed; pappus straw-colored, hairs or bristles 6 mm. in length. The achenial trichomes are long, the duplex character very pronounced, according to Mr. Fracker.

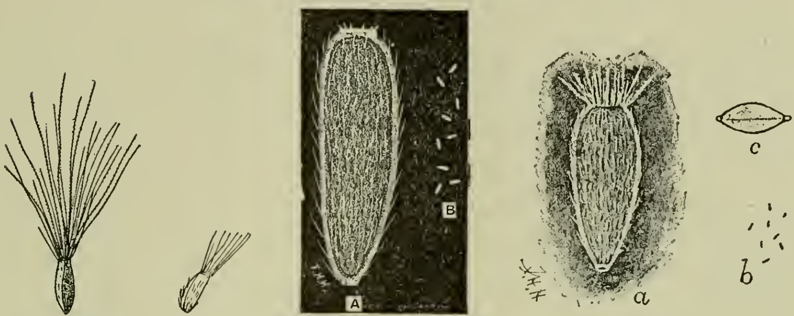


Fig. 353A Fig. 353B Fig. 353C Fig. 353D

FIG. 353. Seeds of Aster, Whiteweed and Horseweed. A, *Aster salicifolius*. B, Daisy Fleabane or Whiteweed (*Erigeron annuus*). C, Horseweed (*Erigeron canadensis*). D, Whiteweed (*Erigeron ramosus*).
(A and B, drawings by Charlotte M. King; C and D, after Hillman; C, Bull. Nev. Agr. Exp. Sta.; D, Bull. Mich. Exp. Sta.)

He found much variation in the trichomes of the genus. The hairs of *A. drummondii* are shorter. The trichomes of *A. tradescanti* and *A. macrophyllus* are longer and more slender than in *A. drummondii*. The duplex hairs of *Aster laevis, A. oblongifolius, A. novae-angliae* and *A. multiflorus* are slender.

Fig. 354A Fig. 354B Fig. 354C Fig. 354D Fig. 354E

FIG. 354. Achenial hairs of Asters. A. *Aster novae-angliae*. B. *Aster salicifolius*. C. *Aster tradescanti*. D. *Aster oblongifolius*. E. *Aster multiflorus*.
(Drawings by Mary A. Nichols and S. B. Fracker.)

Daisy Fleabane (*Erigeron annuus* (L.) Pers.).

Achenes pale straw color, smooth, shining, flattened, obovate; length 0.7-0.9 mm.; the apex bears a row of small straw-colored bristles.

Horseweed (*Erigeron canadensis* L.).

Achenes one-twenty-fourth to one-twentieth in. long, white or whitish, oblong lance-shaped, much flattened, one side often more convex than the other; scar of seed with small, whitish, raised

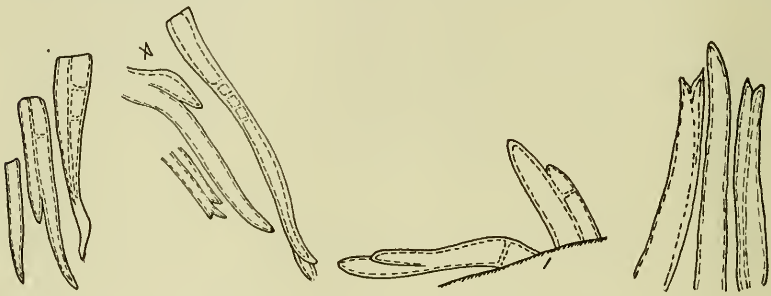


Fig. 355A Fig 355B Fig. 355C Fig. 355D

FIG. 355. Achenial hairs of Asters and Bigelovia. A. *Aster laevis.* B. *Aster macrophyllus.*. C. *Aster drummondii.* D. *Bigelovia nudata.* (Drawings by Mary A. Nichols and S. B. Fracker.)

border, pubescent; pappus small, of numerous, fragile, capillary bristles, usually breaking away. With grass seeds and lawn mixtures.

Cup Plant (*Silphium perfoliatum* L.).

Achenes large, two-fifths in. in length, dorsally flattened, 2-winged, notched at apex, grayish or bronze-colored, margins thin.

Marsh Elder (*Iva xanthifolia* Nutt.).

Achenes obovoid, brown to black, with somewhat flattened longitudinal faces 1.5 to 2 mm. in length, longitudinally striate with fine markings.

Small Ragweed (*Ambrosia artemisiaefolia* L.).

Involucre containing a single achene one-twelfth to one-sixth in. long, obovoid or globular, tipped by a tapering beak one-quarter length of involucre; ridges several (4-10), prominent, with projecting tubercles, short, acute; color grayish or brownish, pubescent;

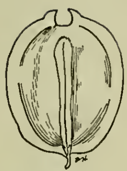


Fig. 356A

Fig. 356B

Fig. 356. Seeds of Small Ragweed and Cup Plant. A. Single achene of Cup Plant (*Silphium perfoliatum*).
B. Achenes, various views of Small Ragweed (*Ambrosia artemisiaefolia*); A, five specimens having the outer covering, and showing the crown of teeth, or spines; B, one having the covering partially broken away, exposing the achene; C, achene, the covering persisting only at the base; D, a sectional view of a fruit; E, a group showing the natural size.
(A, drawing by Ada Hayden; B, after Hillman, Bull. Nev. Agr. Exp. Sta.)

involucre reticulated, somewhat brittle, achene with thick, rather hard wall; cotyledons 5, large, thick, fleshy, oily; caulicle short. In clovers and alfalfa.

Lance-leaved Ragweed (*Ambrosia bidentata* Michx.).

Involucre top-shaped (turbinate), closed, yellowish or brownish; length, exclusive of the spine, one-tenth to one-eighth in.; 1 very prominent lobe and 6 or more prominent tubercles; surface of involucre rough and hispid, pubescent.

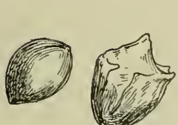


Fig. 357A

Fig. 357B

Fig. 357C

Fig. 357. Seeds of some Ragweeds. A. *Ambrosia bidentata*. B. *Ambrosia psilostachya*. C. *Ambrosia trifida*.
(Drawings, A, Charlotte M. King; B, Ada Hayden; C, after Hillman. Bull. Mich. Exp. Sta.)

Western Ragweed (*Ambrosia psilostachya* DC.).

Bur teretish, one-eighth to one-fifth in. long, obovoid, with beak less prominent than in preceding species; tubercles when present, short; ridges 4-5; color grayish; pubescent; involucre pitted, readily removed leaving brown achenium, with short beak; cotyledons large, fleshy, oily. In clover seed.

Large Ragweed (*Ambrosia trifida* L.).

Achene one-fifth to three-tenths in. in length, one-sixth in. across at widest portion near upper end, containing seed one-fifth to three-tenths in. long, or in extreme cases nearly one-half in.; width at upper end 1.6 in., involucre obovate, narrow below, gradually widening toward top, tipped by tapering beak; fruit prominently

Fig. 358A

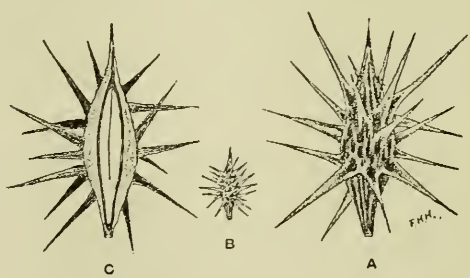


Fig. 358B

Fig. 358. A. White-leaved Franseria (*Franseria discolor*). B. *Franseria Hookeriana*. A, bur enlarged; B, natural size; C, bur cut lengthwise. (A, drawings by Ada Hayden and Charlotte M. King; B, after Hillman, Bull. Nev. Agr. Exp. Sta.)

ridged, forming rather long projecting tubercles, 4-10 in number, near upper end; involucre pitted or marked by cross ridges; color grayish or brownish; pubescent or nearly smooth; encloses a single achene, commonly called seed; outer portions of achene blackish or brownish; embryo with large thick cotyledons; seed oily, caulicle thick, short. In uncleaned clover seed.

White-leaved Franseria (*Franseria discolor* Nutt.).

Involucre with burs from a little less than one-quarter in. to slightly more in length, with 2 achenes, each in a separate cell, oblong, with 2 pointed spines usually incurved at apex and tapering base; several prominent ridges; 3 or more tubercles, furrowed; light straw color, surface pubescent; achene slightly reticulated.

Hooker's Franseria (*Franseria hookeriana* Nutt.).

Involucre lanceolate or oval, two-fifths in. in length, with a prominent conical spine and numerous, straight or recurved rigid spines, variable in number, as long as the width of the bur; surface wrinkled; involucre with one elongated achene; color yellowish, slightly pubescent.

Cocklebur (*Xanthium canadense* Mill.).

Involucre containing 2 seeds; three-quarters to one in. or more long, each in a separate cell, the lower placed further down in the bur than the upper; bur hard, woody, thick-walled, bearing numerous hispid recurved spines, the 2 spines at the end thicker, heavier, and incurved; surface of achene blackish in color, thin-walled; and embryo slender with 2 long cotyledons and a thick caulicle; each seed cavity connects with a channel, frequently may also show styles connecting with this channel; odor of seed strong.

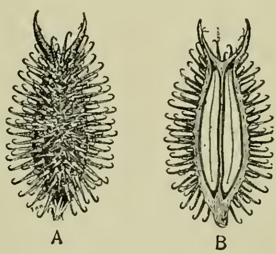


Fig. 359A

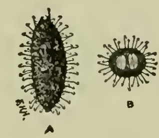


Fig. 359B

Fig. 359. Burs of Cockleburs. A. Common Cocklebur (*Xanthium canadense*), with view of entire bur, and of cross section showing the pair of seeds in place. B. Spiny Clotbur or Cocklebur (*Xanthium spinosum*). (After Hillman, Bull. Mich. Agr. Exp. Sta.)

Cocklebur (*Xanthium spinosum* Kearney).

Involucre one-third to one-half in. long, cylindraceous, obtuse, armed with short prickles, inconspicuous, 2-beaked, or pointless, occasionally a single straight spine; bur oblong or somewhat flattened; surface sparingly covered with slender hooked prickles one-twelfth in. long; color dull; smooth or covered with yellowish hairs; achenes 2 in each bur.

Cocklebur (*Xanthium strumarium* L.).

Involucre one in. long; brownish in color; prominently bristly spines curved; achenes 2 in each bur; closely resembles *X. canadense.*

Rough-Ox-eye (*Heliopsis scabra* Dunal).

Achenes thick, obtusely 3-4-angled, with truncate summit; one-eighth to one-seventh in. long; margins pubescent; blackish; apex somewhat depressed; scar at base light or straw-colored; pappus none.

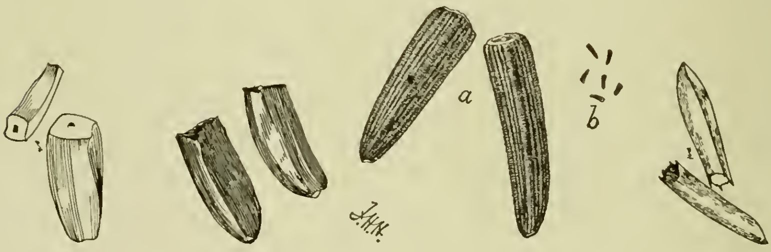


Fig. 360A Fig. 360A1 Fig. 360B Fig. 360C

Fig. 360. Seeds of Heliopsis and Rudbeckia. A, A1, Ox-eye (*Heliopsis scabra*). B. Black-eyed Susan or Nigger-head (*Rudbeckia hirta*); a, two views of achenes, b, achenes, natural size. C. Coneflower (*Rudbeckia laciniata*). (A, C, drawings by L. Collins; A1, Charlotte M. King; B, after Hillman, Bull. Mich. Agr. Exp. Sta.)

Nigger-head (*Rudbeckia hirta* L.).

Achene purplish black, 1.5-1.8 mm. long, tapering slightly from base to apex; a distinct ridge at each of the 4 angles of the achene; each side with fine longitudinal strips; no pappus.

Cone-flower (*Rudbeckia laciniata* L.).

Achenes 4-angled, brownish, truncate, one-fifth in. long; minutely roughened; upper end with projecting truncate point; apex with an inconspicuous scar.

Gray-headed Cone-flower (*Lepachys pinnata* Torr. & Gray).

Achene short, flattened or angular, one-tenth of an inch long, 2 slightly marginal wings, and 2 intermediate ones, or only 1, convex; apex whitish, depressed with slight projecting scar; base with inconspicuous scar of nearly the same color as the rest of the achene.

Sunflower (*Helianthus annuus* L.).

Achenes obovate, oblong, somewhat flattened, one-fifth to one-quarter of an inch long; with appressed pubescence (see figure) especially at upper end, grayish and mottled with brown; marked by longitudinal lines; more prominent ridge in center; lower end of achene notched, containing the scar; the apical scar with a slightly elevated circular margin; cotyledons large and fleshy. The achenes, according to Mr. Fracker, are long, slender, and duplex; *H. tuberosus* has simple and several-celled trichomes but not duplex. *H. occidentalis* has short, thick, duplex hairs.

Fig. 361A Fig. 361B Fig. 361C Fig. 361D

FIG. 361. Seeds of Cone-flower and Sunflower. A. Coneflower (*Lepachys pinnata*). B and C. Common Sunflower (*Helianthus annuus*). D. Meadow Sunflower (*Helianthus grosse-serratus*).
(A, drawing by Ada Hayden; B and D, drawings by C. M. King; C, after Hillman, Bull. Mich. Exp. Sta.)

Saw-toothed Sunflower (*Helianthus grosse-serratus* Martens).

Achenes oblong, narrowed at base and broad at apex, flattened, with 2 edges, and 1 prominent ridge, sometimes 2 on each side; one-sixth to one-fifth in. long; pappus of 2 lanceolate awns; smooth or slightly hairy; brownish or lighter color, mottled with brown; the scar at the end is in the form of a small notch; the remnant of a corolla tube at the apex; cotyledons fleshy.

Prairie Sunflower (*Helianthus petiolaris* Nutt.).

Achenes obovate-oblong, but slightly flattened, villous pubescent, (see figure), a prominent longitudinal ridge and several lines on each side; grayish, mottled with brown; scar in notch at the lower end; scar on upper end circular; cotyledons 2, large and fleshy. According to Mr. Fracker, the achenial hairs are long and slender and duplex.

Fig. 362A

Fig. 362B

Fig. 362. Seeds of Sunflowers. A. Prairie Sunflower (*Helianthus petiolaris*). B. Wood Sunflower (*Helianthus strumosus*). (Drawings by L. R. Collins.)

Wild Sunflower (*Helianthus strumosus* L.).

Achenes obovate, flattened, several fine lines and a longitudinal ridge on each side, one-sixth to one-fifth in. long, nearly glabrous; yellowish or light brown, finely mottled, except near apex and base which are lighter in color; lower end marked by small distinct scar, occurring in a notch; upper end bearing large circular scar; cotyledons 2, large, fleshy.

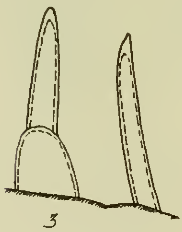


Fig. 363A

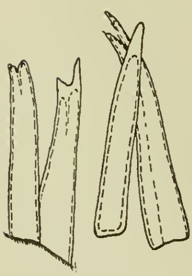


Fig. 363B

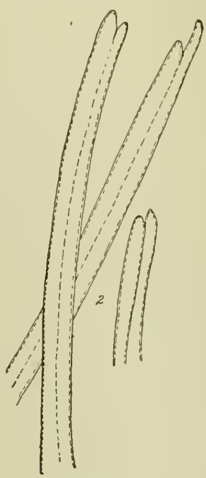


Fig. 363C

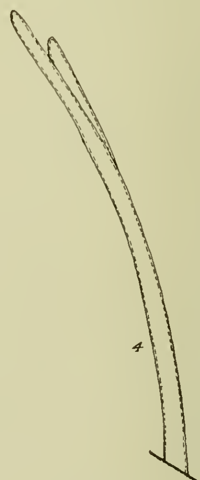


Fig. 363D

Fig. 363. Achenial hairs of Sunflower seeds. A. Artichoke (*Helianthus tuberosus*). B. Prairie Sunflower (*Helianthus occidentalis*). C. Common Sunflower (*Helianthus annuus*). D. Prairie Sunflower (*Helianthus petiolaris*). (Drawings by S. B. Fracker.)

Spanish Needles (*Bidens bipinnata* L.).

Achenes exclusive of awns one-half to three-fifths in. long, linear, 4-angled, slightly pubescent; pappus consisting of usually 4 divergent downwardly barbed awns, lighter in color than the achene; base of seed with a lightish ringed border and a small depression.

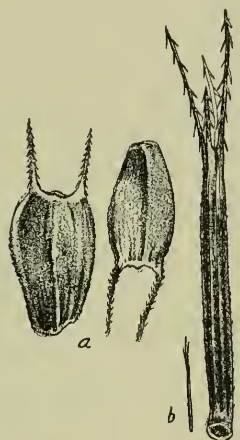


Fig. 364A

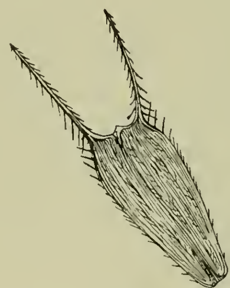


Fig. 364B

FIG. 364. A. Seeds of Spanish Needles, Pitchforks, or Bootjacks. a, Spanish Needle (*Bidens frondosa*), b, *Bidens bipinnata*.
B. *Bidens discoidea*.
(Drawings by Charlotte M. King.)

Small Stick-tight (*Bidens discoidea* (T. & G.) Britton).

Achenes small, flat, narrowly acuminate, upwardly strigose; pappus of upwardly hispid, rarely downwardly barbed awns.

Beggar-ticks (*Bidens frondosa* L.).

Achenes flattened, oval or obovate, three-tenths to two-fifths inch exclusive of the awns; slightly ciliate on the margins (see figure); awns generally diverging, downwardly barbed; corolla tube, whitish, with small opening in the center; basal portion of achene with a prominent depression with a light border. The achenial hairs, according to Miss Mary A. Nichols and Mr. Fracker, are duplex. In *B. cernua* they are simple. The related species (*B. aristosa*) formerly called Coreopsis has duplex hairs, although some hairs are simple.

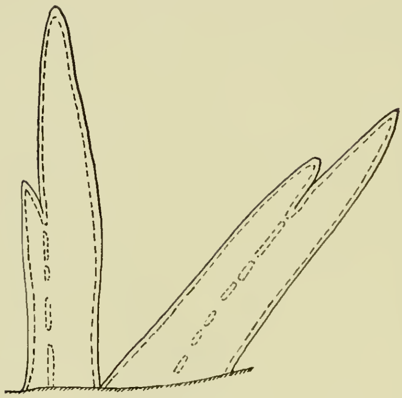


Fig. 365A

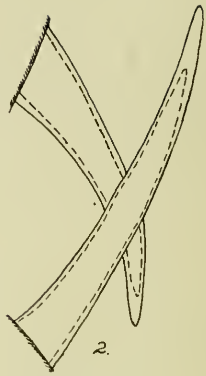


Fig. 365B

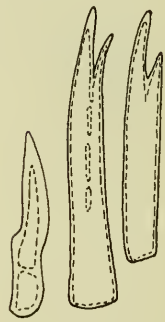


Fig. 365C

FIG. 365. Achenial hairs of Beggar-ticks. A. *Bidens frondosa.* B. *Bidens cernua.* C. *Bidens aristosa.*
(Drawings by Mary A. Nichols.)

Sneezeweed (*Helenium autumnale* L.).

Achenes straw-colored, with several longitudinal ribs, length 1 mm., breadth 0.3 mm. at apex, toward which the achene widens; surface bears scattered appressed hairs; pappus several chaffy points on margin of truncate apex.

Fetid Marigold (*Dyssodia papposa* (Vent.) Hitchc.).

Achene slender, 4-angled; length 3 mm., width at truncate apex .75 mm.; black, with numerous, scattered, appressed black hairs; pappus a row of chaffy scales, dividing into numerous, rough, bristly hairs; 3 mm. long. According to Mr. Fracker, the achenial hairs are simple and duplex, the tip in duplex hairs deeply cleft.

Fig. 366A

Fig. 366B

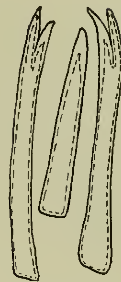


Fig. 366C

FIG. 366. Seeds and achenial hairs of Sneezeweed and Fetid Marigold. A. Sneezeweed (*Helenium autumnale*). B. Fetid Marigold (*Dyssodia papposa*). C. Achenial hairs of Fetid Marigold.
(A and B, drawings by Charlotte M. King; C, from drawing by Mary A. Nichols.)

Yarrow (*Achillea millefolium* L.).

Achenes one-twelfth to one-tenth in. long, oblong to obovate, somewhat compressed; light on the margin, the remainder somewhat brownish; sometimes slightly curved, base with prominent scar with slightly raised border; apex larger with a notch in the center and a projecting knob; surface of the achene marked with fine lines; pappus absent.

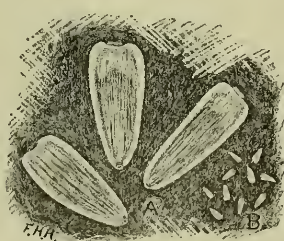


Fig. 367A

Fig. 367B

FIG. 367. Seeds of Yarrow and Mayweed. A, Yarrow (*Achillea millefolium*); a, seeds (achenes) in side view, the two at the left showing the minute, circular scar; b, group showing the natural size.
B. Mayweed (*Anthemis cotula*); a, a group of seeds showing the prevailing forms; b, a group showing the natural size.
(After Hillman, Bull. Nev. Agr. Exp. Sta.)

Mayweed (*Anthemis cotula* L.).

Achenes one-twentieth to one-sixteenth in. long, oblong with prominent tubercled ribs, or occasionally smoothish curved, the base tipped with smooth nipple-like projections; pappus absent; straw-colored to light brown; bearing a projection scar; base with round, light-colored scar. Common in clover and grass seeds.

Ox-eye Daisy (*Chrysanthemum leucanthemum* L.).

Achenes flattened, club-shaped, straight or slightly curved, one-twentieth to one-tenth in. long, oblong; angles white, with brown interstices; 5-10-ribbed; small scar at basal end; pappus wanting.

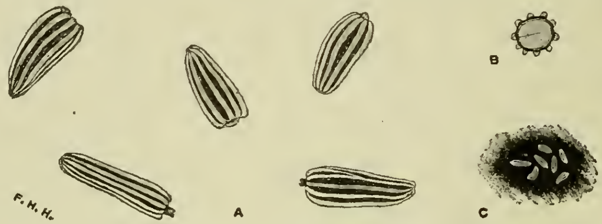


FIG. 368. Seeds of Ox-eye Daisy (*Chrysanthemum leucanthemum*). A, prevailing forms of seeds (achenes); B, one in cross section; C, a group showing the natural size.
(After Hillman, Bull. Nev. Agr. Exp. Sta.)

Wormwood (*Artemisia biennis* Willd.).

Achenes brown, smooth, from 3-4 flattened faces, angled between longitudinally; length .8 mm., width .3 mm., broader at apex than at base.

Fig. 369A

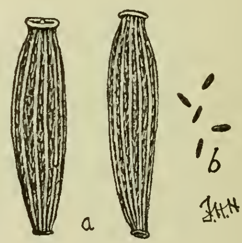


Fig. 369B

FIG. 369. Seeds of Wormwood and Fireweed. A. Wormwood (*Artemisia biennis*); a, achenes, b, natural size.
B. Fireweed (*Erechtites hieracifolia*); a, achenes, b, natural size.
(After Hillman, Bull. Nev. Agr. Exp. Sta.)

Fireweed (*Erechtites hieracifolia* (L.) Raf.).

Achene linear-oblong, straight, or curved, prominently striate, pubescent, beakless, one-sixth in. in length; upper end with a white ring, within the ring a slight depression; scar at the lower end with whitish ring, and a small depressed opening; pappus of numerous white soft, capillary bristles.

Indian Plantain (*Cacalia tuberosa* Nutt.).

Achenes oblong, straight, or slightly curved, one-fifth in. in length; brown; prominently ribbed, the ribs minutely roughened; the apex of the seed with a slightly projecting rim or border to which the pappus is attached; the base with a circular ring; pappus with numerous fine, white, capillary bristles.

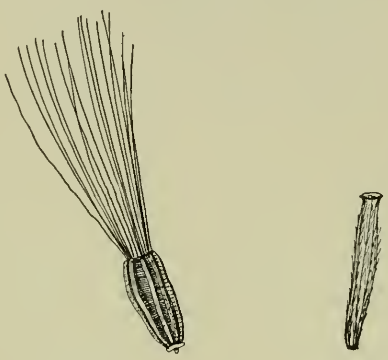


Fig. 370A Fig. 370B

FIG. 370. Seeds of Indian Plantain and Groundsel. A. Indian Plantain (*Cacalia tuberosa*). B. Groundsel (*Senecio vulgaris*). (Drawings by Charlotte M. King.)

Groundsel (*Senecio vulgaris* L.).

Achenes teretish or those of marginal flowers compressed, narrow, cylindrical; 5 or 10-ribbed, pubescent; one-half in. long; upper part expanded, extending beyond narrow portion of upper part of achene; lower portion with a depression; color reddish; pappus of fine, white, capillary bristles.

Burdock (*Arctium lappa* L.).

Achenes 3-5-ridged, upper portion truncate, one-fifth to one-fourth in. long, compressed or oblong, nearly straight to slightly curved, 3-angled; surface mottled in appearance, due to the small serrulate scales with projecting tips of ridges beyond the border; scar surrounded by a circular lighter colored area; scar at base lighter in color; pappus of numerous short scales. In commercial seeds, occasionally.

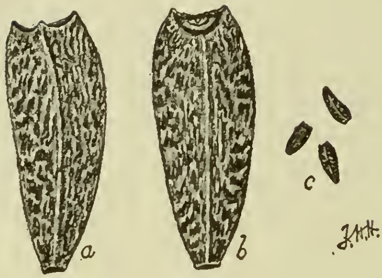


FIG. 371. Seeds of Burdock (*Arctium lappa*). a, a side view of one of the inner achenes of a bur; b, showing the inner surface of a curved, outer achene, and exhibiting the character of the apex, both enlarged; c, a group showing natural size.
(After Hillman, Bull. Nev. Agr. Exp. Sta.)

Tall Thistle (*Cirsium altissimum* Willd.).

Achenes lanceolate-obovate, tapering toward lower end, and somewhat narrowed toward the apex, wider in the middle, one-eighth in. in length; width one-twelfth in.; dull brown or grayish excepting light colored ring at upper end; numerous fine ridges; apex concave, with the remnant of corolla tube projecting from the center; color uniform; not marked by light and dark areas as the bull thistle.

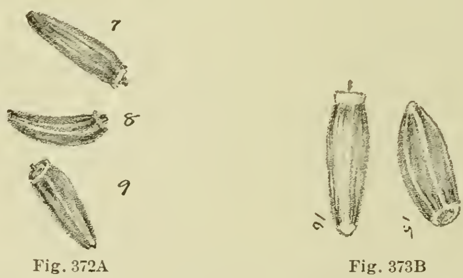


FIG. 372. Seeds of Thistles. A. Different views of Canada Thistle (*Cirsium arvense*). B. Bull Thistle (*Cirsium lanceolatum*).
(Drawings by Charlotte M. King.)

Canada Thistle (*Cirsium arvense* (L.) Scop.).

Achene lanceolate, narrowed at lower end, tapering from somewhat thickened top, one-twelfth to one-eighth in. long; the cup-shaped top with a projecting conical portion, straight or slightly curved; marked with longitudinal dark lines or furrows; apex with a light colored border, giving appearance of a ring. Found in seed of small grains, clovers and grasses.

Field Thistle (*Cirsium discolor* (Muhl.) Spreng.).

Achenes obovate, inner edge nearly straight, outer curved, convex; one-seventh to one-sixth in. long, tapering from narrowed base to apex, upper part longitudinally striated, slightly pigmented;

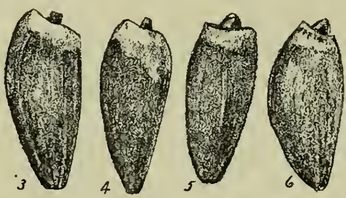


FIG. 373. Seeds of Thistle. 3. *Cirsium altissimum.* 4. *Cirsium discolor.* 5. *Cirsium undulatum.* 6. *Cirsium ioense.* (Drawing by Charlotte M. King.)

grayish, upper part yellowish for one-third length of the achene. Found in seed of alfalfa and red clover.

Iowa Thistle (*Cirsium ioense* (Pammel) Fernald).

Achenes obovate, lanceolate, one side of seed straight, outer side slightly convex, one-fifth to one-fourth in. long, one-twelfth to one-sixteenth in. in width, gradually tapering from lower end toward upper end, prominently widened just below the apex, marked by longitudinal striations and dark areas, upper part yellowish, prominent rim glossy; apex concave, with the prominent projecting remnant of flower center.

Bull Thistle (*Cirsium lanceolatum* (L.) Hill).

Achene lanceolate, curved, tapering, in many cases somewhat angular, one-eighth to one-sixth in. long; brownish, not darkly striated, marked with definite grooves, upper part lighter, ringed, also showing at center of concave apex; apex with projecting point. Found in red clover and in alfalfa seed.

Wavy-leaved Thistle (*Cirsium undulatum* (Nutt.) Spreng.).

Achene in general outline lanceolate, tapering from base, inner edge slightly convex, several prominent ridges, light brown, not pigmented; upper part yellowish; apex with prominent rim and prominent remnant of corolla tube; achene slightly thicker than that of *C. discolor*. Found in seeds of red clover and alfalfa.

Chicory (*Cichorium intybus* L.).

Achenes oblong, ribbed, 5-angled, spotted, grayish or straw-colored, with darker spots, one-twelfth to one-eighth in. in length apex with the base of the pappus scales extending beyond the scar;

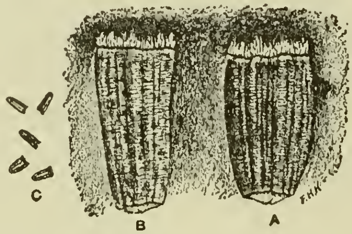


FIG. 374. Chicory (*Cichorium intybus*). A, B, two views of seeds; C, seeds, natural size.
(After Hillman, Bull. Mich. Agr. Exp. Sta.)

minutely, transversely roughened; base of seed lighter in color, with small depressed scar; achenes from the inner part of the flower more slender and straight than from outer part. Found with various commercial seeds.

Corn-flower (*Centaurea cyanus* L.).

Achene oblong or obovoid, compressed, one-sixth to one-fifth in. long; smooth, shining; with inconspicuous veins or nerves; lower part of achene oblique; ivory-white; the elliptical or somewhat circular scar at base with whitish rimmed border, depressed, made up of soft tissue; pappus of several series of scaly bristles; brownish in color. The achenial trichomes, according to Mr. Fracker, are long and simple.

Barnaby's Thistle (*Centaurea solstitialis* L.).

Involucre ovoid, 1.5 cm. in diameter, with stout straw-colored spines, widely spreading; achene cream or pale brown after matted; length 2 mm., scar of attachment in a notch above rounded base; apex truncate, bearing tubercle in the center.

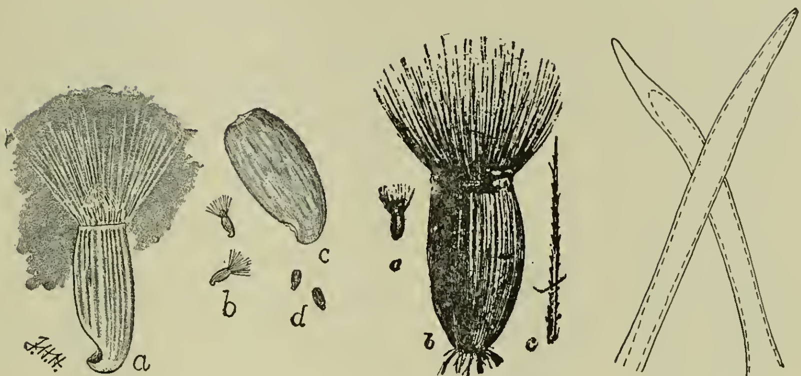


Fig. 375A Fig. 375B Fig. 375C

FIG. 375. Seeds of Corn-flower and Knapweed. A. Barnaby's Thistle or Knapweed (*Centaurea solstitialis*); a, achene with pappus, c, pappus removed, b and d, achenes, natural size.
B. Corn-flower (*Centaurea cyanus*). C. Achenial hairs of Corn-flower.
(A, after Hillman, Bull. Nev. Agr. Exp. Sta.; B, after Nobbe; C, drawing by S. B. Fracker.)

Bristly Ox-tongue (*Picris echioides* L.).

Achene elliptical, narrowed at base, with projection at tip; one-tenth in. in length; light brownish red; wrinkled transversely, especially toward apical end. Found in seed of alfalfa and clover.

Oyster Plant, Salsify (*Tragopogon porrifolius* L.).

Achenes linear, terete, beaked or long, covered with scalelike tubercles on the ribs, or merely roughened, light straw-colored or darker pappus of numerous plumose bristles; small scar at apex, whitish with a depression scar at base with an oval depression. Reported as a "weed of alfalfa meadows."

Meadow Salsify (*Tragopogon pratensis* L.).

Achenes linear, terete, one-half in. or little more long, exclusive of beak; scar at base, whitish, with an oval depression; beak one-third in. long; scar at end of beak whitish, with a depression, striate, smooth or slightly roughened, light straw-colored or darker; pappus of numerous soft, brownish, plumose bristles.

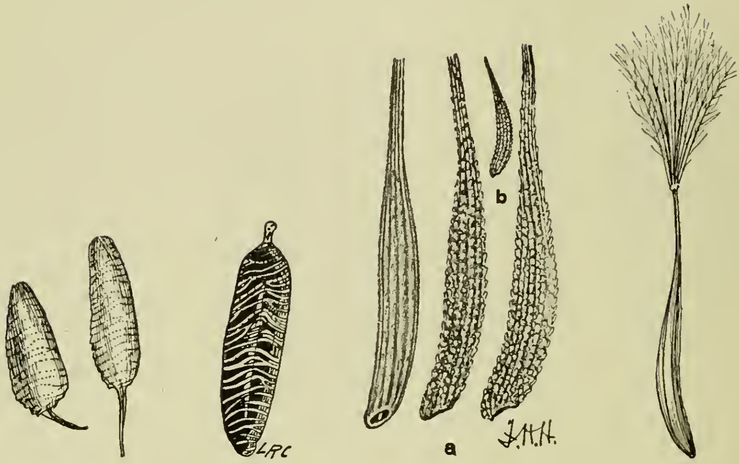


Fig. 376A Fig. 376A1 Fig. 376B Fig. 376C

FIG. 376. Seeds of *Picris and Tragopogon*. A and A1. Bristly Ox-tongue (*Picris echioides*). B. Oyster Plant (*Tragopogon porrifolius*) ; a, achenes enlarged, b, achenes natural size.
C. Meadow Salsify (*Tragopogon pratensis*).
(A, drawings by L. R. Collins; B, after Hillman, Bull. Mich. Agr. Exp. Sta.; C, drawing by C. M. King.)

Dark-seeded Dandelion (*Taraxacum erythrospermum* Andrz.).

Achenes one-sixth to one-fifth in. long; lance-shaped, or spindle-shaped, 5 longitudinal ridges, upper end with rough tubercles, persistent long beak about two-fifths in. long, brownish, somewhat pointed, prominently ribbed; pappus of numerous capillary, fragile, white bristles; color reddish; toothed at apex; beak and pappus both shorter; achenes more prominently tubercled than in *T. officinale.*

Fig. 377A Fig. 377B

FIG. 377. Dandelion seeds. A. Red Seeded Dandelion (*Taraxacum erythrospermum*) ; a, seed enlarged, b and c, seed, natural size, c, with pappus.
B. Common Dandelion (*Taraxacum officinale*). A, an enlarged view of one of the two similar faces of an achene, in which no attempt is made to show the minute surface-scales which are not evident under the ordinary lens. B, a group of seeds, natural size. b, one bearing the beak and pappus. C, a group showing common variation in the form of the achenes.
(After Hillman: A, Bull. Mich. Agr. Exp. Sta.; B, Bull. Nev. Agr. Exp. Sta.)

Dandelion (*Taraxacum officinale* Weber).

Achenes two-fifths in. long including persistent beak, fusiform in shape, prominent ribs, and projecting teeth at ribs, especially at upper end; beak four-fifths to one in. in length; achenes light gray in color, otherwise like preceding; pappus capillary, whitish, fragile. With grass seeds.

Field Sow Thistle (*Sonchus arvensis* L.).

Achenes dark reddish brown, dull, ends slightly truncate, length 2.5-3 mm., width 0.8 mm., somewhat flattened, with 4 strong ribs or angles, between which lie smaller ridges; numerous transverse ridges on the ribs.

Fig. 378A

Fig. 378B

Fig. 378C

FIG. 378. Seeds of Sow Thistles. A. Field or Perennial Sow Thistle (*Sonchus arvensis*); B, natural size, showing pappus on one achene.
B. *Sonchus oleraceus*, different views of achenes.
C. *Sonchus asper*, A and B, different views of achenes, C, achenes, natural size. (After Hillman, Bull. Mich. Agr. Exp. Sta.)

Spiny Sow Thistle (*Sonchus asper* Vill.).

Achenes broadly oblong or lance-shaped, similar faces, many-ribbed, one-tenth in. long, slightly pubescent, prominent ridges minutely roughened; base with a minute scar, brownish; the apex with projecting point and fine, capillary, white, bristles. Found with grass seeds.

Sow Thistle (*Sonchus oleraceus* L.).

Achenes light brown, flattened, ribbed, the prominent ribs roughened; one-eighth in. long; pappus of white capillary bristles, much like the preceding. "Apt to occur among grass seeds."

Wild Lettuce (*Lactuca canadensis* L.).

Achene three-twentieths in. in length, straight or curved, sides somewhat unequal, transversely wrinkled, blackish brown, beak one-twentieth in. long, shorter than in *L. floridana;* one faint rib on each side of prominent midrib; decidedly convex on each side of midrib to the flattened margin; scar with whitish ring and small depression; pappus white, capillary. Much like *L. floridana,* beak smaller and shorter. With commercial seed.

Fig. 379A Fig. 379B

FIG. 379. Seeds of Lettuce. A. *Lactuca canadensis;* a, enlarged achene, b, natural size. B. *Lactuca floridana.*
(A, after Hillman, Bull. Mich. Agr. Exp. Sta.; B, drawing by Charlotte M. King.)

False Lettuce (*Lactuca floridana* (L.) Gaertn.).

Achene brown, transversely wrinkled, three-twentieths to seven-fortieths in. in length, straight or slightly curved; beak light brown, about one-fifth in. long, generally persistent, convex; ribs rather faint, 1 on each side of prominent midrib, strongly convex on each side of midrib, margin flattened; pappus white, capillary.

Prickly Lettuce (*Lactuca scariola* var. *integrata* Gren. & Godr.).

Achenes brownish, margin somewhat lighter, surface roughened, one-ninth to one-sixth in. long; beak one-tenth to one-eighth in. long, lance-shaped, straight or slightly curved, upper end tapering

Fig. 380A

Fig. 380B

FIG. 380. Lettuce Seeds. A. *Lactuca scariola*; A, side view of an achene, enlarged. B, a group of the same, natural size. C, an achene bearing its beak and fragile pappus.
B. Prickly Lettuce (*Lactuca scariola* var. *integrata.*)
(A, after Hillman, Bull. Nev. Agr. Exp. Sta.; B, drawing by L. R. Collins.)

toward the beak, somewhat flattened, on one side margined, faces convex, with 5-7 longitudinal nerves; scar circular, with a small depression.

Rattlesnake Root (*Prenanthes alba* L.).

Achene oblong or columnar, truncate, somewhat flattened, 4-5 angled, brownish; upper part with a projecting ring to which the bristles of pappus are attached; scar at the base whitish, not prominent; one-eighth in. in length; pappus tawny.

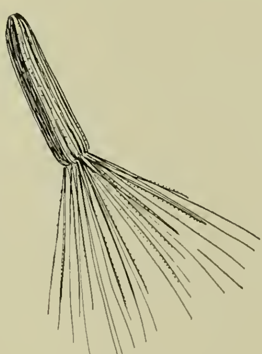


Fig. 381A

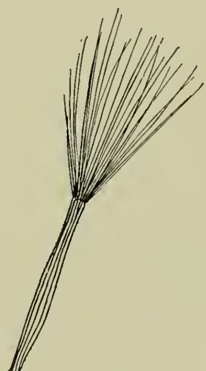


Fig. 381B

FIG. 381. Seeds of Rattlesnake Weed and False Calais. A. Rattlesnake Weed (*Prenanthes alba*). B. False Calais (*Agoseris cuspidata*).
(Drawings by Charlotte M. King.)

False Calais (*Agoseris cuspidata* (Pursh.) Steud.).

Achenes fusiform, slightly contracted at the apex, with 10 prominent ribs; one-half in. long, or little longer; pappus of soft, white, capillary bristles; scar at base, whitish, with a small opening.

Orange Hawkweed (*Hieracium aurantiacum* L.).

Achene oblong, columnar, one-tenth in. long; blackish or dark brown, marked with prominent longitudinal ridges, minutely roughened; base of achene with small circular raised border, lighter than remainder of achene; pappus of numerous somewhat brownish bristles, frequently breaking away near the top of the achene, then showing short bristles.

Fig. 382A

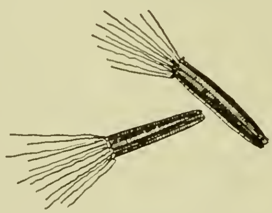


Fig. 382A1

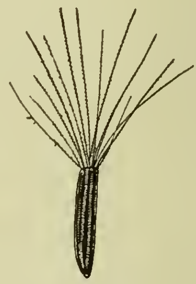


Fig. 382B

FIG. 382. Seeds of Hawkweeds. A and A1, Orange Hawkweed (*Hieracium aurantiacum*). B, Hawkweed (*Hieracium canadense*). (A, after Hillman, Bull. Mich. Agr. Exp. Sta.; A1, drawing by L. R. Collins; B, drawing by Charlotte M. King.)

Hawkweed (*Hieracium canadense* Mx.).

Achenes one-tenth to one-eighth in. long, oblong, columnar, 10-15-ribbed; blackish or reddish; base with prominent disklike area marked by circular ring; apex with somewhat fine tawny-colored capillary bristles; below point of attachment is an area bulging outward; capillary bristles have tendency to break.

CHAPTER III.

MICROSCOPIC STRUCTURE OF SOME WEED SEEDS

By

L. H. PAMMEL

and

CHARLOTTE M. KING

CHAPTER III.

GRAMINEAE,* GRASS FAMILY.

Smooth Crab Grass (*Digitaria humifusa* Pers.).

A cross section of seed shows but slight development of the pericarp and testa. The epidermal cells of the former are smaller than the underlying rows of cells of the wall of the ovary. The testa is reduced to a single layer of cells, longer than broad. The aleurone layer is filled with protein grains. The starch cells of the endosperm are larger and densely packed with polygonal grains.

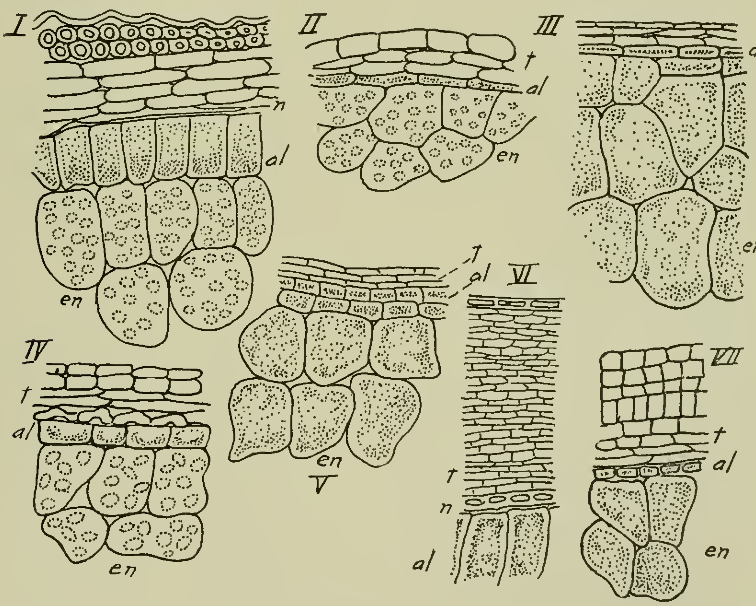


FIG. 383. Structure of the grain fruits of some Grasses (*Gramineae*). I. Wild Barley (*Hordeum jubatum*). II. Timothy (*Phleum pratense*). III. Smooth Crab Grass (*Digitaria humifusa*). IV. Sandbur (*Cenchrus tribuloides*). V. Millet (*Setaria italica*). VI. Corn (*Zea mays*). VII. Barnyard Grass (*Echinochloa crusgalli*).

t=testa. al=aleurone. en=endosperm. n=nucellus.

(Drawings by L. H. Pammel.)

*The material for this family has been taken from the accounts by Pammel and Winton.

Broomcorn Millet (*Panicum miliaceum* L.).

The walls of the ovary are similar to those of *Digitaria humifusa* except that they are wider. The testa is much compressed and consists of several layers of small cells. The cells of the aleurone layer are small, somewhat longer than broad. The cells of the starch layer are similar to those of *D. humifusa.*

Barnyard Grass (*Echinochloa crusgalli* (L.) Beauv.).

The adherent glumes in this species consist of several rows of parenchyma cells, the inner portion, of one row of thick-walled sclerotic cells with pore canals. The cells of the pericarp and testa are much as in the other species, thin-walled and compressed. The protective features are preserved in the coriaceous glumes. The starch and aleurone layers are similar to those of *Digitaria humifusa.*

Hungarian Grass or Millet (*Setaria italica* (L.) Beauv.).

The colorless smooth pericarp is but slightly thickened and consists of three or four rows of elongated cells. These in colored seeds contain the pigment. The testa is but slightly developed. The cells of the aleurone layer are not much longer than broad, and are densely filled with protein grains.

Green Foxtail (*Setaria viridis* (L.) Beauv.).

Dr. A. L. Winton describes the microscopic structure as follows: *Empty Glumes and Glume of Sterile Flower.* The lower empty glume is three-nerved and less than 1 mm. long; the upper empty glume and the glume of the staminate flower are five-nerved and 2 mm. long. In microscopic structure the three are practically identical. 1. *Outer Epidermis.* Characteristic of this layer are the elongated cells with sinuous side walls and longitudinal rows of pits so arranged that one pit occurs in each concave bend of the wall. On the middle portion of the mature glume each of these pits is so large that it fills completely the bend of the wall, and in addition has a thickened border, half of which coincides with the cell wall, thus giving the tissue a lacelike appearance. This structure is optically delusive, the pit borders often appearing to be the cell walls, but is resolved by careful focusing and comparison with the tissue in earlier stages of growth. In addition to these

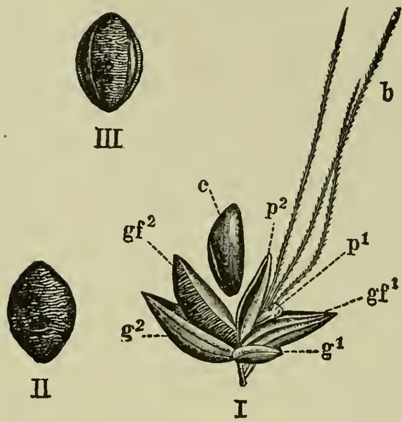


FIG. 384. Green Foxtail (*Setaria viridis*). I, spikelet with ripe fruit. g^1, lower empty glume; g^2, upper empty glume; gf^1, glume, and p^1, palet of the staminate flower; gf^2, glume, and p^2, palet of fertile flower; c, caryopsis; b, bristles. II and III. caryopsis enclosed by flowering glume and palet. X 8. (After Winton, Conn. Agr. Exp. Sta.)

elongated cells, pairs of short cells, one isodiametric, probably a hair-scar, the other more or less crescent-shaped, occur here and there, and less frequently stomata and thin-walled one to three-jointed hairs. 2. *Mesophyl.* Only about the nerves and the basal

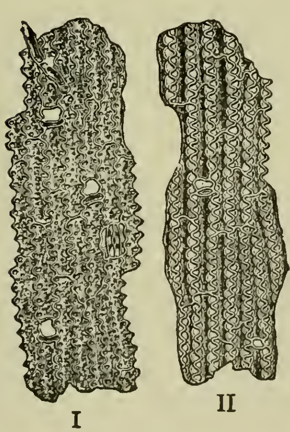


Fig. 385A

Fig. 385B

FIG. 385. Green Foxtail. A. Outer epidermis of the staminate flower; I, at the edge; II, in the middle. X 300.
B. Outer epidermis of the glume of the fertile flower, showing the wrinkled central portion and the smooth edge.
(After Winton, Conn. Agr. Exp. Sta.)

portions of the glumes is this coat evident. It has no diagnostic importance. 3. The *Inner Epidermis* is composed of elongated cells with straight walls.

Palet of Staminate Flower. Within the glume of the staminate flower is the palet, a hyaline scale only 1 mm. or less long with a notch at the end. In general structure, it is much the same as the other thin envelopes, but the cell walls are thinner. 1. *Outer Epidermis.* The narrow, elongated cells are wavy in outline, but pits are lacking or are indistinct. Isodiametric cells are thin-walled; jointed hairs also occur. 2. *Inner Epidermis.* Except at the base, where traces of mesophyl are sometimes evident, the inner epidermis immediately underlies the outer epidermis.

Glumes and Palet of Perfect Flower. Both the glume and the palet of the fertile flower closely envelop the grain at maturity, the former being strongly convex, the latter flat except on the edges, which clasp about the caryopsis. At the time of flowering these envelopes are thin and of a green color, but at maturity they are coriaceous, silicified and of a brown or mottled color. Under the lens, numerous transverse wrinkles are evident on the glume and on the middle or flat portion of the palet, the lateral portions of the latter which clasp the caryopsis being smooth and shining. 1. *Outer Epidermis.* Throughout the glume and on the middle portion of the palet, the cells are isodiametric or moderately elongated and are arranged not only in longitudinal rows but also in irregular transverse rows, the wrinkles being formed by the outbending of the cells at the end walls and the inward bending half way between. At the time of flowering, it may be seen that at the outer surface the end walls are sinuous and the side walls are compoundly sinuous, but farther inward the end walls are nearly straight and the side walls are simply, not compoundly sinuous. At the end of each cell nearest the apex of the envelope, a cuticular wart bearing a group of pits is usually evident, particularly on the palet. About these warts the adjoining end walls are more or less curved and the side walls are not so deeply sinuous. At maturity the cell cavity beneath the wart is conspicuous (on the palet nearly circular), but at the other end of the cell is narrow or not evident at all owing to the encroachment of the strongly thickened walls. The cell contents during the early stages of development are colorless, but later on usually become dark brown. The epidermal cells on the lateral or smooth portions of the palet which

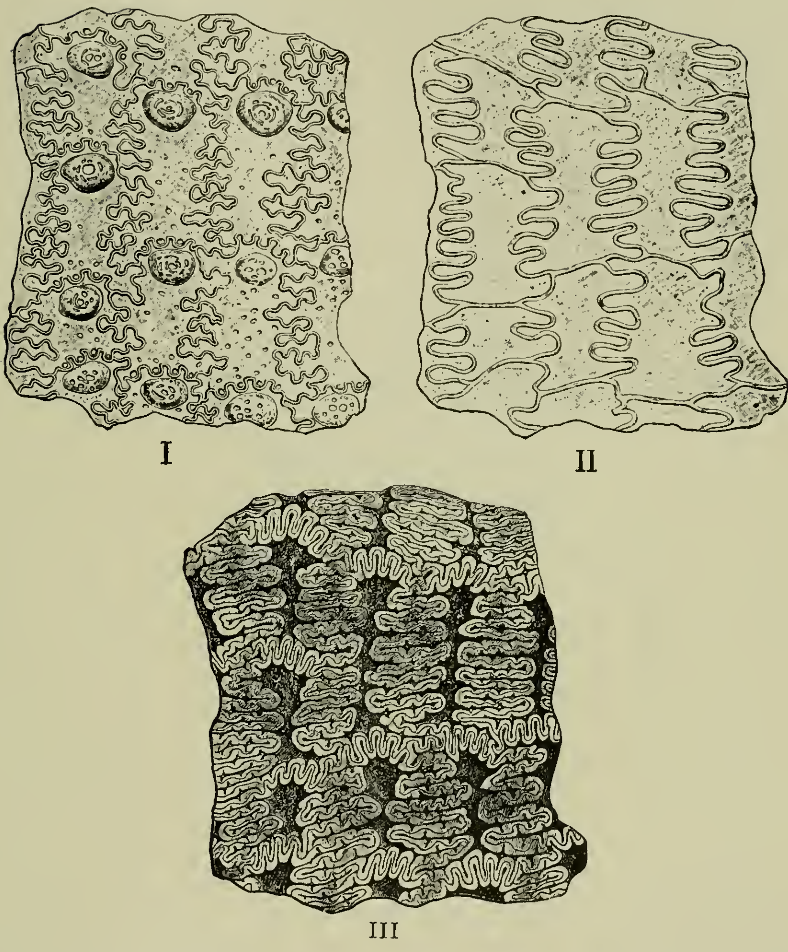


FIG. 386. Green Foxtail. Outer epidermis from the middle of the glume of the fertile flower. I, outer surface, and II, inner surface soon after blooming. III, outer surface when in fruit. X 300.
(After Winton, Conn. Agr. Exp. Sta.)

clasp about the caryopsis are longer, narrower, and less complex than those already described. At maturity the wrinkles are usually from 0.03 to 0.06 mm. apart. 2. The *Hypodermal Fibers* may be readily isolated by treatment on the slide with caustic alkali. They vary in length up to 0.6 mm. and are often toothed at margin. 3. *Mesophyl.* Rectangular parenchyma cells without intercellular spaces make up this layer. Numerous chlorophyl granules are present at the time of flowering. 4. The *Inner Epidermis* is composed of rectangular cells resembling those of the mesophyl. Both of these layers become more or less obliterated at maturity and are of no diagnostic importance.

Pericarp. The ventral side is flat and has a darker colored spot, the remains of the hilum, near the base. Extending half way from the base to the apex on the dorsal side is a groove, which marks the position of the embryo. Vogl describes minutely the histology of the caryopsis of common millet (*Panicum miliaceum* L.) and

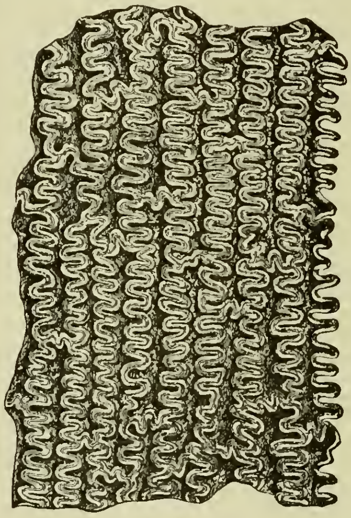


FIG. 387. Green Foxtail. Outer epidermis from the edge of the glume of the fertile flower. X 300.
(After Winton, Conn. Agr. Exp. Sta.)

states that German millet (*Setaria panis* Jessen) has practically the same structure. I find that his description applies also to the caryopsis of both green and yellow foxtail. 1. *Epidermis.* As in the outer epidermal layers of the floral envelopes the cells are elongated and wavy in outline. On the dark colored spot already referred to, the epidermal cells are more or less rectangular.

2. The *Cross-Cells* are similar to the tube-cells in form but are usually shorter, broader, and more irregular in shape. 3. *Tube-Cells.* These are 0.002 to 0.004 mm. wide and often reach the length of 0.3 mm. *a. Nucellar* or *Hyaline Layer.* After treatment with alkali, this layer is clearly seen in surface view. The cells are of large size and have beaded walls. *b. Endosperm.* 1. *Aleurone Layer.* The cells vary in diameter from 0.01 to 0.02 mm.

2. *Starch-Cells.* Polygonal starch granules with conspicuous hilums fill the parenchyma cells of the endosperm. In the outer layers they are from 0.004 to 0.008 mm. in diameter but farther inward they reach the maximum diameter of 0.018 mm. After dissolving the starch with potash, there remains a network of threads containing conspicuous granules. In this respect, however, this fruit cannot be distinguished from the fruits of *S. glauca* Beauv., *S. panis* Jessen, *Panicum miliaceum* L. (see Vogl) and all the other species of *Panicum* which I have examined. *Detection in Powder Form.* The membranous glumes with pores in the bends of

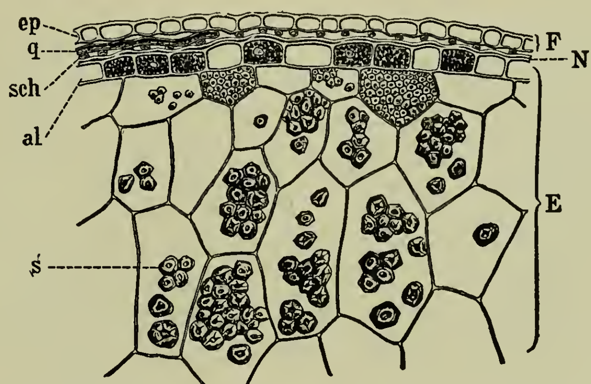


FIG. 388. Green Foxtail. Transverse section of caryopsis. F, pericarp consisting of the epidermis ep and the tube-cells sch; N, nucellar layer; E, endosperm consisting of the aleurone-cells al and the starch cells s. X 300. (After Winton, Conn. Agr. Exp. Sta.)

the walls and the coriaceous, transversely wrinkled, more or less spotted, envelopes of the fertile flower with compoundly sinuous, thickened cell walls are highly characteristic of both green and yellow foxtail. These tissues are usually present in all stages of development. The fruit elements are like those of common millet and German millet. Treatment with caustic alkali brings out the structure of the fruit coats and nucellar layer, and serves to distinguish this fruit from the common cereals. The starch is hardly distinguishable from the starch of bindweed.

Dr. A. L. Winton describes the microscopic character of yellow foxtail (*Setaria glauca* Beauv.) as follows:

The fruit of this species is larger than that of green foxtail, the envelopes are also proportionately larger (with the exception of the upper empty glume which is but half the length of the spikelet) and the wrinkles on the glume of the fertile flower are more pronounced. In microscopic structure the fruits of the two species are identical. The floral envelopes are also much alike, the only distinction being in the distance apart of the wrinkles on the mature flowering glumes. In green foxtail this distance is usually from 0.03 to 0.06 mm., but in yellow foxtail it is often from 0.08 to 0.12 mm. Since this distinction does not apply to the mature glumes and since the wrinkles on the palets of the two species are practically the same, it is often difficult to identify the species in ground mixtures. Fortunately, identification of the genus is all that is usually required.

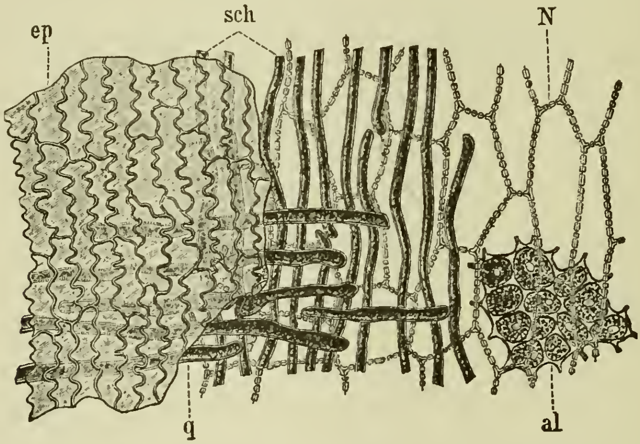


FIG. 389. Green Foxtail. Caryopsis in surface view. Significance of letters same as in Fig. 388.
(After Winton, Conn. Agr. Exp. Sta.)

Broom Corn (*Andropogon sorghum* var. *technicus* Koern).

Dr. A. L. Winton describes the microscopic structure of the pericarp and testa of broom corn as follows:

Empty Glumes.—Both glumes are from 4 to 6 mm. long, equaling and closely enveloping the fruit. They vary in color from yellow-brown to red-brown. The soft hairs, which nearly cover the outer surface, are loosely attached and most of them are removed during the threshing and cleaning of the seed, leaving the glumes smooth and shining. 1. The *Outer Epidermis* consists of strongly sclerenchymatized cells several times as long as they are broad, with wavy contour, interspersed here and there with isodiametric hair-scars, each accompanied by a crescent-shaped cell

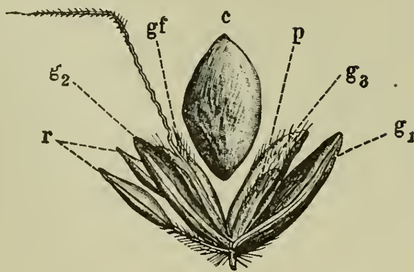


FIG. 390. Broom-corn. Fruit with chaff. r, two staminate spikelets; g^1, lower empty glume; g^2, upper empty glume; g^3, glume of rudimentary flower; gf, flowering glume with awn; p, palet; c, caryopsis. X 4.
(After Winton, Conn. Agr. Exp. Sta.)

with granular contents. The hairs, which are almost invariably detached in preparing the mount, if not in cleaning the seed, are often 1.0 mm. long and 0.012 mm. broad in the middle but taper toward both ends. Invariably the lumen is much broader than the walls. 2. The *Hypoderm Fibers,* of which there are several layers, have thick walls and narrow cavities. They vary in length

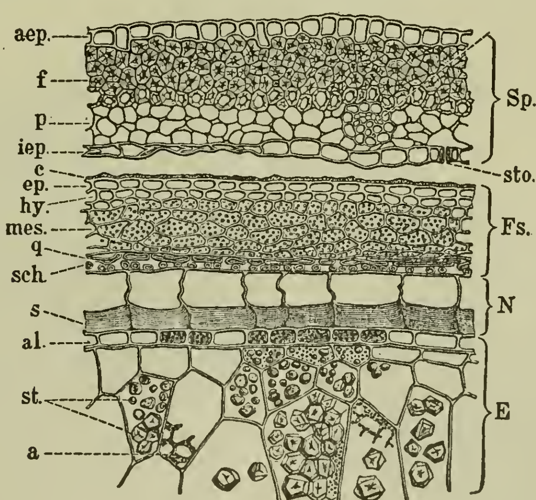


FIG. 391. Broom-corn. Transverse section of caryopsis and an empty glume. Sp, empty glume, consisting of the outer epidermis aep, the fiber layer f, the spongy parenchyma p, and the inner epidermis iep; g, bundle; sto, stoma; Fs, pericarp, consisting of the epidermis ep with the cuticle c, the hypoderm hy, the starchy mesocarp mes, the cross-cells q, and the tube-cells sch; N, nucellar or hyaline layer with swollen inner walls s; E, endosperm, consisting of the aleurone layer al and the starch-cells with starch granules st and proteid network a. X 160.
(After Winton, Conn. Agr. Exp. Sta.)

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up to 0.5 mm. or more. 3. *Spongy Parenchyma.* As seen in surface view, the cells of this layer are more or less rectangular with circular intercellular spaces and resemble those of rice and barley glumes. 4. *Inner Epidermis.* In cross section this layer is not readily studied since the radial walls are usually collapsed; but in surface preparations, the large elongated cells, often 0.15 mm. long and 0.05 mm. wide, interspersed with stomata and hairs, are clearly displayed.

Thin Glume.—Within the lower or first glume and nearly equaling it in length, is the third or thin glume, the remnant of an abortive flower. This glume is exceedingly thin and membranous and bears numerous hairs, particularly in the margin. 1. *Outer Epidermis.* In general form the cells are similar to those of the outer epidermis of the thick glumes, but are narrower and much thinner-walled. The marginal hairs are long (often 0.5 mm.) single-celled and pointed; but on the surface shorter hairs, with two or three joints and blunt ends, also occur. Both of these

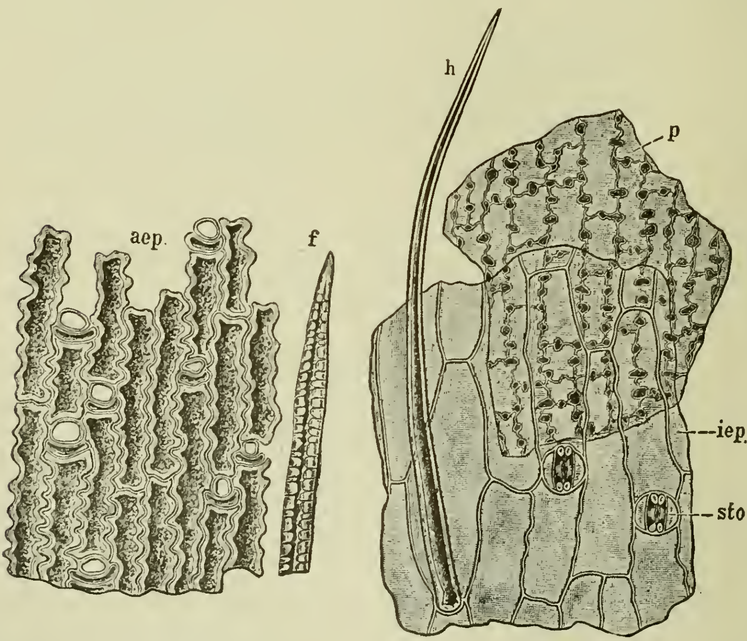

FIG. 392. Broom-corn. A. aep, outer epidermis and f, fiber of an empty glume in surface view. X 300.
B. p, spongy parenchyma and iep, inner epidermis of an empty glume in surface view; sto, stoma; h, hair. X 300.
(After Winton, Conn. Agr. Exp. Sta.)

forms have exceedingly thin walls. 2. The *Inner Epidermis* is distinguished from the outer by the straight walls and almost entire absence of hairs.

Flowering Glume.—The fourth or flowering glume, situated between the upper or second glume and the grain, is also membranous and bears an upwardly barbed awn 5 to 7 mm. long. This awn, with the larger part of the flowering glume, being readily detached by threshing, it is seldom found in the grain on the market.

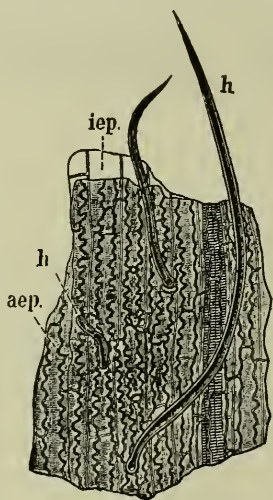

FIG. 393. Broom-corn. Glume of rudimentary flower in surface view. aep, outer epidermis with h, one-celled hair and h, two-celled hair; iep, inner epidermis. X 300.
(After Winton, Conn. Agr. Exp. Sta.)

Palet.—This is membranous and hairy like the third or thin glume, but is much smaller.

Pericarp.—The grain or caryopsis is about 5 mm. long and from 2 to 3 mm. wide, tapering to a blunt point at both ends. It varies in color from yellow-brown to red-brown.

Harz, Hassack and particularly Mittlacher have described so fully the histological elements of the caryopsis, that only a brief description, essential for a clear understanding, need here be given. 1. *Epidermis.* The cells are longitudinally extended and have thick wavy side walls, with more or less distinct pores. Hassack has noted that the cuticle is of uneven thickness, due to minute granules or crystals, which may be seen in either section or sur-

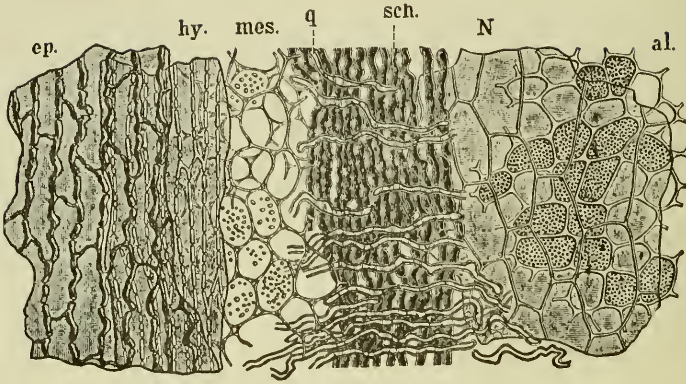

FIG. 394. Broom-corn. Layers of the pericarp in surface view. Significance of letters same as in Fig. 391. X 160. (After Winton, Conn. Agr. Exp. Sta.)

face view. 2. The *Hypoderm* consists of from one to three layers of cells, with walls somewhat thinner than those of the epidermis. 3. *Starchy Mesocarp.* Several layers of thin-walled parenchyma cells, filled usually with small round or rounded polygonal starch granules seldom over 0.006 mm. in diameter, make up this coat. In all the varieties here described the starch appears during the early stages of growth and persists until the fruit nearly or quite reaches full maturity. As the caryopsis, even when nearly mature, is intensely green owing to chlorophyll grains in the outermost layers of the mesocarp, it may be inferred that this starch is a direct product of photosynthesis in the pericarp. So far as I have observed, the presence or absence of a starchy mesocarp in the grain at the time of harvest is not a definite varietal peculiarity, but is dependent on the ripeness of the fruit or other conditions. Some kernels of the same variety may possess it, while others show only empty, obliterated cells. Whether or not the starch is present in a given seed may often be determined by careful scraping and observation with the naked eye. 4. *Cross-Cells.* These cells are usually long and narrow, being distinguished from the tube-cells only by their transverse arrangement. Near the extremities of the seed they are, however, shorter and of more irregular shape. 5. *Tube-Cells* (sch). The cells of this layer lie at right angles to the cross-cells. They are about 0.005 mm. wide and often reach a length of 0.20 mm. *a. Nucellar or Hyaline Layer.* This layer is frequently 0.05 mm. thick. The outer radial walls are thin, but the inner wall is greatly swollen. In surface view the large cells are conspicuous, not only because of their size, but because of their yellow or brown color. *b. Endosperm.* 1. *Aleurone Layer* (al). The individual cells of this layer are characterized by their great variation in size (0.01 to 0.04 mm. in diameter) and form. 2. *Starch-Cells* (st). In the outer layers the starch granules, if present, are much smaller than in the interior of the seed, where they sometimes reach a diameter of 0.03 mm. They are usually sharply polygonal, with a distinct hilum and radiating fissures. The starch is surrounded by small protein granules, forming a network which is especially evident after removing the starch by reagents. In some specimens, one or more of the outer cell layers are filled with these protein granules to the complete exclusion of the starch.

Sandbur (*Cenchrus tribuloides* L.).

The pericarp is divided into two portions. The cells of the outer portion are thick-walled and short; of the inner portion, elongated, thick-walled and fusiform. The testa consists of one to two rows of thin-walled cells, much compressed. The aleurone cells are much larger than in *Panicum* and *Setaria,* thick-walled, densely filled with protein grains. Walls of the starch cells thickened; starch grains larger and loosely arranged.

Timothy (*Phleum pratense* L.).

The testa and pericarp are dark colored. The epidermal cells are thin-walled, elongated, sometimes slightly irregular. The testa consists of several rows of thick-walled dark brown cells much longer than broad. The aleurone layer consists of a single row of cells relatively thin-walled, somewhat variable in size, solidly packed with aleurone grains. The nucellus is very evident as a remnant in some places. The cells of this layer are thick-walled, clear and colorless. The starch cells are much larger than the aleurone, and contain angular starch grains.

Cheat or Chess (*Bromus secalinus* L.).

Dr. A. L. Winton describes the microscopic structure as follows: *Flowering Glume.*—The structure throughout is much the same as in darnel, but the cells of the outer epidermis are much more conspicuously thick-walled, and the wavy-walled cells throughout much longer than broad. The circular cells also have wavy walls. The cells on the margins, interspersed with lance-shaped hairs, are the same as in darnel.

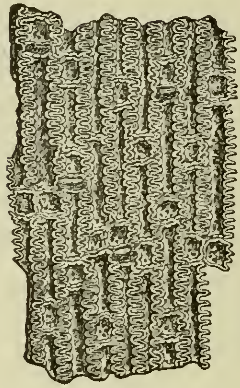

FIG. 395. Chess (*Bromus secalinus*). Outer epidermis of flowering glume in surface view. X 160.
(After Winton, Conn. Agr. Exp. Sta.)

Palet.—The flowering glume and palet of chess are very similar in structure, but the outer epidermis of the latter is barbed on the keel, the stiff hairs often reaching 45μ in length.

Pericarp (F).—The pericarp consists of two layers with rudiments of another layer in parts. 1. *The Epidermal Cells* (ep) are large, elongated-polygonal, and have thin, non-porous walls. 2. *Mesocarp.* As a rule, the cross-cells immediately underlie the

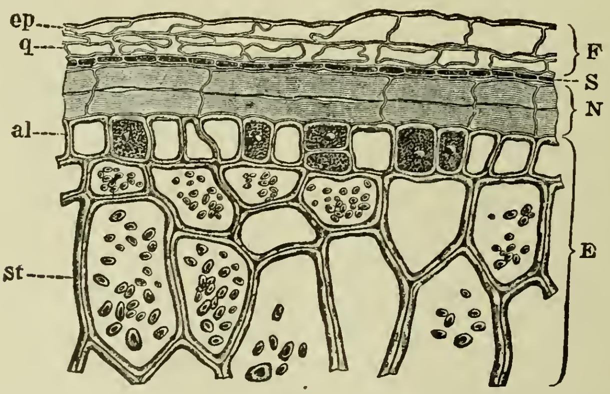

FIG. 396. Chess. Transverse section of fruit. F, pericarp consisting of epidermis ep, and cross-cells q; S, testa; N, perisperm; E, endosperm consisting of aleurone layer al, and starch-parenchyma st. X 160.
(After Winton, Conn. Agr. Exp. Sta.)

epidermis, but occasionally traces of the mesocarp are evident. 3. *Cross-Cells* (q). Whether this layer corresponds with the cross-cells of the tube-cells of other grasses, I have been unable to decide.

The tissue is made up of irregular spongy-parenchyma cells, usually transversely elongated with large, round or elongated intercellular spaces.

The *Testa* (S).—Consists of one layer of elongated brown cells 10-20μ wide.

Perisperm (N).—This layer is enormously developed. As may be seen in cross section, the cells are 40μ thick, but the walls are so swollen as to almost entirely obliterate the cavity. After soaking for some time in 1 per cent soda solution they are evident in surface view.

Endosperm.—1. The *Aleurone Layer* (al) is not of especial interest. 2. The *Starch-Parenchyma* (st) is remarkable for the thickness of the cell walls (often 10μ thick) and the elliptical starch grains 3-20μ in diameter. With proper illumination each grain may be seen to have an elliptical hilum.

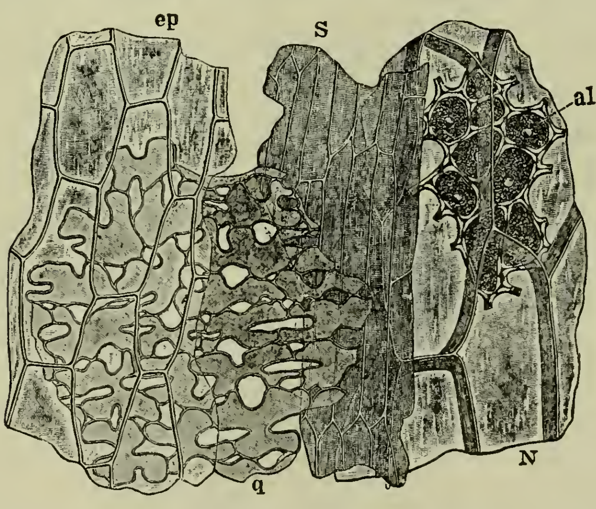

FIG. 397. Chess. Elements of fruit in surface view. Significance of letters same as in Fig. 396.
(After Winton, Conn. Agr. Exp. Sta.)

Wild Barley or Squirrel-tail Grass (*Hordeum jubatum* L.).

The grain is adherent to the palet. The epidermis consists of thick-walled, tangentially elongated cells, most of which are longer than broad. In part the cells are developed into short conical trichomes. The underlying cells are thick-walled with prominent pore canals. The remainder of the adhering palet consists of thin-walled cells much larger than broad. The pericarp as well as the testa is but slightly developed. In some cases the underlying parenchyma cells are not clearly defined. The blackish pigment is found in the internal part of the palet; some also occurs in pericarps and the aleurone layer. The pericarp consists of one or two rows of rather thin-walled, tangentially elongated cells. The testa is reduced to a single layer of cells longer than broad. The nucellus is nearly absent except in the groove. It consists of a single row of thin-walled, colorless, compressed cells. In the groove several rows of cells occur. The aleurone in the specimens studied is made up of a single row of cells. The cells of the starch layer are larger than those of the aleurone.

Darnel (*Lolium temulentum* L.).

Dr. A. L. Winton describes its microscopic structure as follows: The *Flowering Glume* is 6-8 mm. long, equaling or exceeding the caryopsis. It is obscurely five-nerved, lobed at the end, and bears an upwardly barbed awn often 15 mm. long. Like the glumes of barley, oats, and other cereals, it consists of four coats, some of which, however, are lacking on the margins and at the end. 1. The *Outer Epidermis* differs greatly in structure in different parts of the glume. At the margins (as is clearly shown in Fig. 1 by Moeller*), it consists of straight-walled, elongated cells interspersed here and there with short lance-shaped hairs. On the greater part of the surface, however, the cells, as in barley and some other cereals, are of three kinds: first, cells of wavy outline,

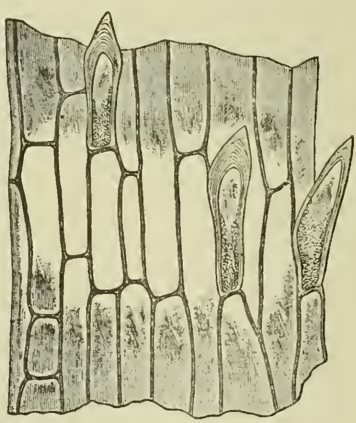

FIG. 398. Darnel (*Lolium temulentum*). Margin of flowering glume showing lance-shaped hairs. X 300. (After Winton, Conn. Agr. Exp. Sta.)

into which the straight-walled cells at the margin pass; second, circular cells corresponding to the conical hair-cell of barley; third, exceedingly short, more or less crescent-shaped cells. Near the margins and on the veins, where they alternate with stomata, the cells of wavy outline are elongated; but in other parts they are very short, often being broader than long. Although thick-walled, the walls are transparent, whereas the middle lamella is conspicuous, giving the impression of thin-walled cells. Pores are few and inconspicuous. Near the margin the circular cells are small and are usually accompanied by crescent-shaped cells which often exceed them in size. On the greater part of the glume, however, the circular cells are much larger, often being 70$^{\mu}$ in diameter. Numerous pores are conspicuous, both in the radial and tangential walls. Often one, sometimes two, crescent-shaped cells accompany a circular cell. Characteristic of this coat are the short, wavy

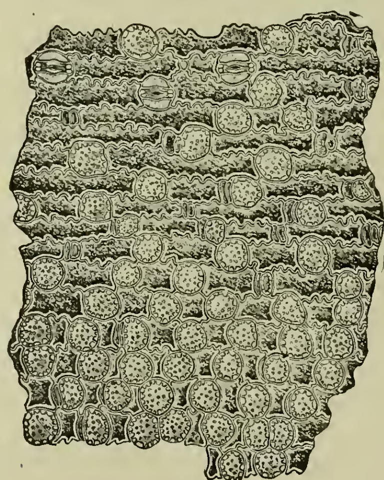

FIG. 399. Darnel. Middle portion of flowering glume. X 160. (After Winton, Conn. Agr. Exp. Sta.)

cells and the numerous circular cells, the latter frequently exceeding in area the former. 2. *Hypoderm.* The fibers in this layer are much the same as in cereals. Fibers of similar structure also make up the ground-tissue of the awn. 3. *Spongy-Parenchyma.* The elements are more or less rectangular in shape, like those of the corresponding layer of barley, and are readily distinguished from the star-shaped elements of oats. 4. *Inner Epidermis.* This layer is made up of thin-walled cells and stomata, and is of no diagnostic importance.

Palet.—The two-keeled palet is about the same size as the flowering glume, but is of a thinner texture, owing to the absence of a well developed hypoderm layer. The *Outer Epidermis* is much the same as that of the flowering glume, except that it is barbed on the keels with rigid thornlike hairs 150μ or less in length, as is shown in Fig. 3 by Moeller.

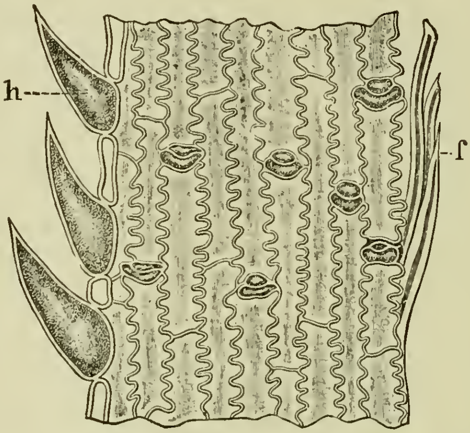

FIG. 400. Darnel. Keel of palet showing outer epidermis with hair h, and hypoderm fibers f. X 160.
(After Winton, Conn. Agr. Exp. Sta.)

The *Pericarp* (F).—Consists of four coats, of which only two, the epidermis and cross-cells, are fully developed. 1. *Epidermis* (ep). Cross sections of the mature seed show that this layer consists of collapsed, moderately thick-walled cells, which are best studied after heating with potash. Seen in surface view, the cells at the apex of the seed are nearly isodiametric, but at other parts are elongated. The walls are indistinctly beaded. 2. The *Mesocarp* (m) is not developed on all parts of the seed, but is conspicuous on the angles. The cells vary greatly in shape and size, some being irregularly isodiametric, others transversely elongated, resembling the cells of the next layer. 3. *Cross-Cells* (q). Especially striking are the cells of this layer, which resemble the cross-cells of barley. As has been noted by Moeller, the radial walls appear indistinctly beaded, but this is evident only under favorable conditions. 4. *Tube-Cells,* spongy-parenchyma, and various intermediate forms, make up the interrupted inner layer of the pericarp.

Testa (S).—The cells are for the most part elongated and are often diagonally arranged with reference to the axis of the fruit. In

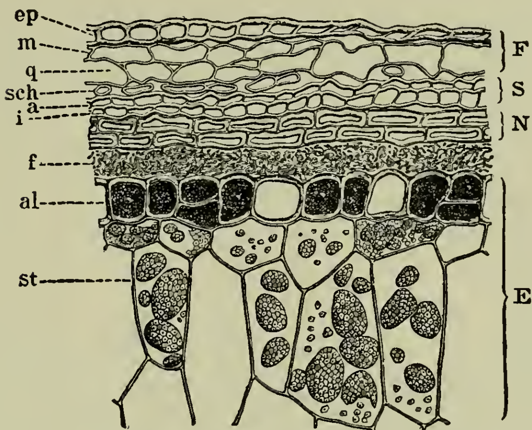

FIG. 401. Darnel. Transverse section of fruit. F, pericarp consisting of epidermis ep, mesocarp m, cross-cells q, and tube-cells sch; S, testa consisting of outer layer a. and inner layer i; N, perisperm; f, fungus layer; E, endosperm consisting of aleurone layer al, and starch-parenchyma st. X 160.

(After Winton, Conn. Agr. Exp. Sta.)

transverse sections this coat often separates from the pericarp on the one hand and the perisperm on the other. Examined in water, only one cell layer (the inner) is evident; but successive treatments with 5 per cent potash, dilute acetic acid and chlorzinc iodine, bring out two layers. 1. The *Outer Layer* (a) is made up of thin-walled cells with cuticularized outer walls. Treated as above described, the cuticle is colored yellow-brown, the radial and inner walls, blue. 2. The *Inner Layer* (1) is not only thicker than the outer, but the cells are thicker-walled and, in addition, swell greatly with potash. These swollen walls are stained deep blue by chlorzinc iodine, thus differentiating them from the yellow-brown cuticle on the inner wall.

Perisperm (N).—Characteristic of this seed is the nucellar-coat, consisting usually of two cell layers. In cross section these cells are rectangular with swollen walls; in surface view, as may be seen after soaking for a long time in dilute potash, they are irregularly polygonal or more or less elongated.

Fungus Layer (F).—In most specimens a layer of fungus-threads 20μ thick is present between the perisperm and the aleurone layer. So commonly is this fungus present in darnel grown in Europe, that it is of no little value in identifying the grain; but it remains to be determined whether in California, where the plant is a pest in wheat fields, the fungus is also a common accompaniment. After treatment with potash this layer is stained bright yellow by zinc chloride of iodine.

Endosperm.—1. The *Aleurone Cells* (al) vary from less than 20 to 40μ in diameter. 2. *Starch-Parenchyma* (st). The thin-walled cells contain small polygonal grains 3 to 7μ in diameter. The individual starch grains are not distinguishable from the grains of rice and oats, and like the latter, often occur in aggregates of various sizes.

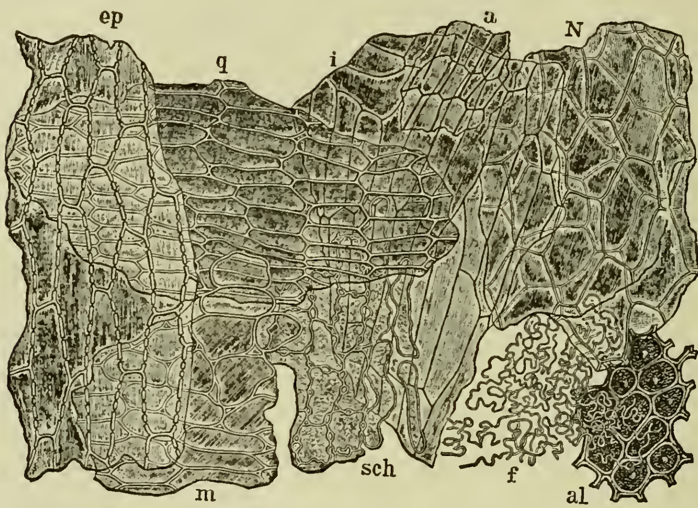

FIG. 402. Darnel. Elements of fruit in surface view. Significance of letters same as in Fig. 401. X 160.
(After Winton, Conn. Agr. Exp. Sta.)

URTICACEAE, NETTLE FAMILY.

Hemp (*Cannabis sativa* L.).

The smooth crustaceous achene consists of an outer epidermal layer of thick-walled cells with wavy outline, the thickness of the radial walls varying somewhat. This is followed by a layer of loosely arranged parenchyma cells, and a layer of cells with brown contents. A layer of small cells spoken of as the dwarf cells by Winton, may also be made out in some sections. The palisade layer consists of thick-walled cells with pore canals, the walls having a wavy outline. The cell cavity is very much reduced. The testa is very thin and consists of thin-walled elongated parenchyma cells, the second layer of spongy parenchyma. The compressed nucellus follows. The endosperm consists mostly of a single layer of cells, the embryo of small epidermal cells and the elongated palisade parenchyma on the upper face of the cotyledon; cells of embryo and endosperm contain fat and protein.

Nettle (*Urtica gracilis* Ait.).

The pericarp of the small achenes consists of an outer epidermal layer of rather large cells with exterior walls thickened, and underneath several layers of loosely arranged parenchyma cells. The testa and nucellus are compressed; cells of the embryo squarish, containing fat and protein grains.

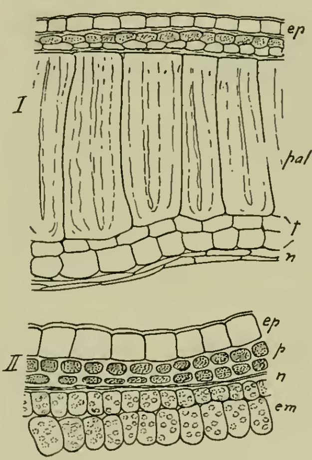

FIG. 403. Microscopic structure of the seeds of the Nettle family. (*Urticaceae*). I. Hemp (*Cannabis sativa*). II. Common nettle (*Urtica gracilis*). ep=epidermis, thick-walled short cells, underneath followed by a pigment layer, thinner-walled parenchyma cells and a layer of thick-walled cells. pal= palisade cells. p=parenchyma cells with the pigment. t=testa. n= nucellus. em=embryo.
(Drawings by L. H. Pammel and Charlotte M. King.)

POLYGONACEAE,* BUCKWHEAT FAMILY.

Miss E. Sirrine finds, "In the seed coats of the family, the palisade portion constitutes the outer part of the achenium; this is followed in most cases by the testa consisting of several layers of cells varying, however, in some cases; they are quite regular in form and in some instances are of a dark color. In the mature palisade cell, the cavity is present; this varies greatly in the different genera; in some cases occupying nearly the entire cell, in others small and irregular."

*A study of the microscopic structure of the achenes is largely based on Miss Emma Sirrine's work and upon that of Dr. Winton.

Sorrel or Sour Clover (*Rumex acetosa* L.).

This species has very small palisade cells, rectangular in shape and with a small cell cavity which occupies only a small portion of the lower end of the palisade cell. No canals or irregularities of cell cavity. The cell is light in color while canal is darker. The sub-palisade portion is composed of small round cells of a variable number. The endosperm is composed of irregularly arranged cells. Measurements: whole seed coats, 38.3μ; palisade cells, 23μ; sub-palisade, 13.2μ.

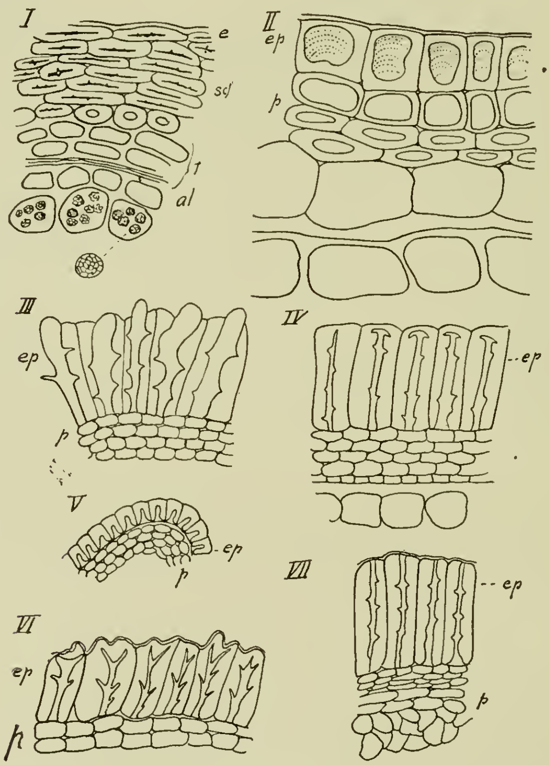

FIG. 404. Microscopic structure of the seed of some Polygonaceous weeds. I. Buckwheat (*Fagopyrum esculentum*). II. Curled Dock (*Rumex crispus*). III. (Wild Buckwheat or Bindweed (*Polygonum convolvulus*). IV. Smartweed (*Polygonum persicaria*). V. Sorrel (*Rumex acetosa*). VI. Knotweed (*Polygonum erectum*). VII. Smartweed (*Polygonum hydropiper*).
e=epidermis. sd=sclerotic layer. t=testa. al=aleurone layer. p=parenchyma cells.
(Drawings by L. H. Pammel.)

Curled Dock (*Rumex crispus* L.).

The brownish achenes of this species consist of an epidermal layer of elongated cells with thick stratified walls, outer wall colorless and a thick cuticle. The underlying parenchyma cells of three rows are smaller, with thick, brownish walls; cells contain tannin. The testa consists of two layers of cells, one large, thin-walled with brownish walls, the other compressed. The endosperm cells are large, thin-walled, and contain simple starch grains.

Lady's Thumb or Smartweed (*Polygonum persicaria* L.).

In this species the palisade cells are long, narrow and truncate. The cell cavity extends the whole length of cell at the upper end, with prominent branching pore canals. The sub-palisade portion consists of four layers of small roundish cells, a small chainlike layer also between the sub-palisade and endosperm. The endosperm consists of large irregular cells. Measurements: 138.6μ; palisade cells, 108.9μ; sub-palisade, 29.7μ.

Knotweed (*Polygonum erectum* L.).

In this species the "palisade cells" are much broader than in the other species here described. The cells have irregular papillate projections as in *P. dumetorum* var. *scandens*. The cell cavity is narrow with long canals extending from it; cavity branches divide near the end of the cell. In *P. erectum* the whole cell is of a light brown color while the cavity is colorless. The sub-palisade portion consists of two layers of isodiametric cells. The endosperm has long, narrow, regular cells. Measurements: whole seed coat, 82.5μ; palisade cell, 60μ; sub-palisade, 22.5μ; papillate projections, 3.3μ.

Smartweed (*Polygonum hydropiper* L.).

In this species the palisade cells are long and narrow, very irregular and truncate at end. The cell cavity is very narrow and extends nearly the whole length of the cell. The cavity has sinuate canals which extend out from sides of the cavity. The cell is colored light brown while the cavity is deeper in color. The palisade cells resemble very much those of *P. virginianum*. The sub-palisade cells, however, are much smaller with more numerous indistinct layers, there being at least six layers well defined. The endosperm cells also are small and quite irregular. Measurements: whole seed coat, 132μ; palisade cells, 92.4μ; sub-palisade, 39.6μ.

Wild Buckwheat or Bindweed (*Polygonum convolvulus* L.).

Dr. A. L. Winton describes its microscopic structure as follows: *Pericarp* (f).—The black hulls or shells of the grain should be studied in cross section and in surface preparations, the latter being freed from the black coloring matter by warming on the slide with caustic alkali, or better by boiling for half an hour with 1.25% sodium hydrate solution as in the determination of crude fiber. 1. *Epicarp* (epi). Cross sections show that the cells are about 0.10 mm. in radial diameter on the sides of the achenes and are still longer at the angles. The inner wall is thin, but the outer

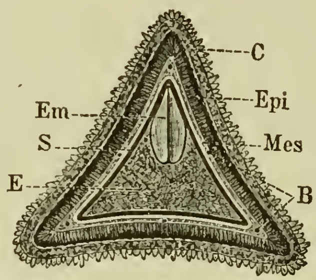

FIG. 405. Black Bindweed. (*Polygonum convolvulus*). Transverse section of the fruit. C, calyx; Epi, epicarp; Mes. mesocarp; B, fibro-vascular bundle; S, testa; E, endosperm; Em, embryo. X 16.
(After Winton, Conn. Agr. Exp. Sta.)

wall and the outer portions of the curiously wrinkled radial walls are strongly thickened. Proceeding from the inner wall outward, the radial walls increase in thickness until the much-branched cell cavity is almost obliterated. On the surface are numerous warts from 0.015 to 0.03 mm. in diameter, into each of which a narrow branch of the cell cavity passes. Surface preparations of the pericarp with the outer surface uppermost clearly show that the warts are arranged in irregular longitudinal rows, also that the epicarp cells at the surface are sinuous in outline, but gradually approach a circular form farther inward. As may be seen in preparations of the pericarp with the inner surface uppermost, the contour of the inner cell walls of the epicarp is, like the outer wall, sinuous in outline. 2. *Hypoderm* (hy). Beneath the epicarp is a layer of slightly elongated parenchyma cells somewhat larger than the cells of the mesocarp. 3. *Mesocarp* (p.) At the angles of the fruit this layer is somewhat thicker than on the sides. The cells of the ground tissue are thin-walled and isodiametric, those of the inner layers being more or less obliterated

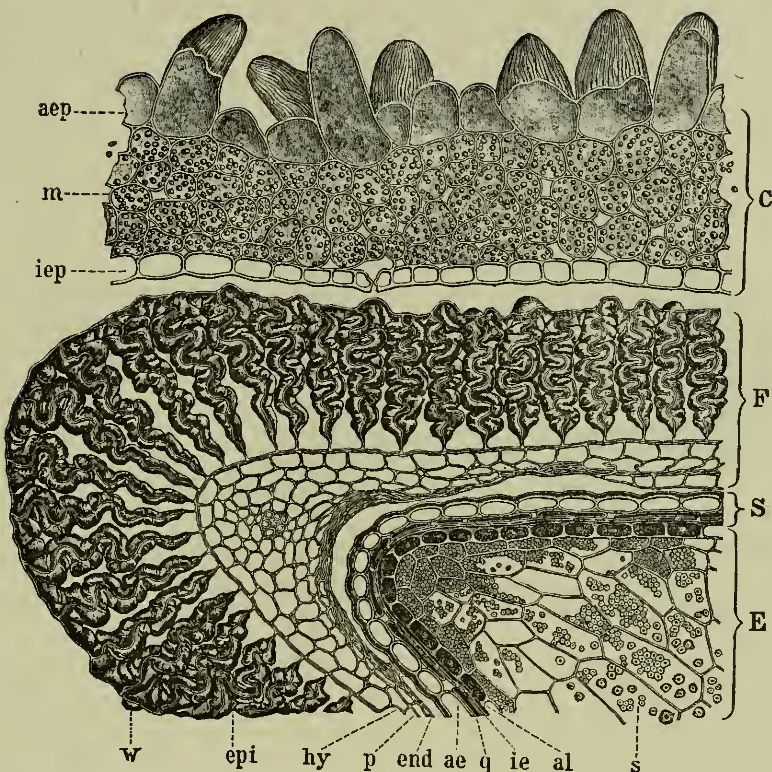

FIG. 406. Black Bindweed. Transverse section of the fruit. C, calyx consisting of the outer epidermis aep, the mesophyll m and the inner epidermis iep; F, pericarp consisting of the epicarp ei with cuticular warts w, the mesocarp p and the endocarp end; S, testa consisting of the outer epidermis ae, the cross-cells q and the inner epidermis ie; E, endosperm consisting of the aleurone-cells al and the starch-cells s. X 160. (After Winton, Conn. Agr. Exp. Sta.)

in the ripe fruit. Six primary, sparingly branched vascular bundles pass longitudinally through the ground tissue of the mesocarp, one in each angle and one in each of the faces. 4. *Endocarp* (end). Like the inner mesocarp, the cells are usually obliterated in the mature seed and are seldom evident either in cross section or in surface view.

Testa (S).—Three coats, analogous to those of buckwheat, but differing in form, make up the testa. 1. *Epidermis* (ae). As in buckwheat, the epidermal cells are wavy in outline; but in bindweed they are strongly elongated, whereas in buckwheat they are nearly isodiametric. 2. *Cross-Cells* (q). Most of the cells of this layer are elongated, resembling the tube-cells of cereals; but short cells of more irregular shape also occur, particularly near the base and apex. These are more or less separated from each other, but in no part do they form a spongy parenchyma with circular intercellular spaces like that of buckwheat. 3. *Inner Epidermis* (ie). This coat consists of thin-walled, elongated elements.

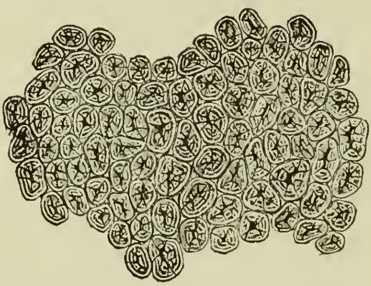

Fig. 407A

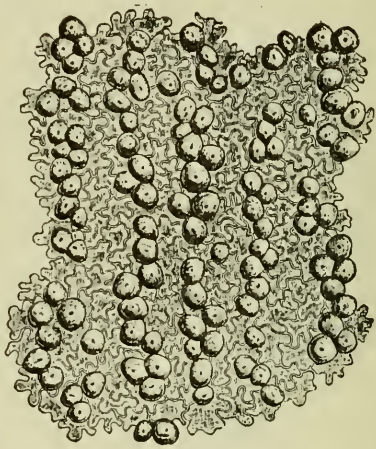

Fig. 407B

FIG. 407. Black Bindweed. A. Epicarp in surface view. X 160.
B. Tangential section of the epicarp.
(After Winton, Conn. Agr. Exp. Sta.)

Endosperm (E).—None of the elements are distinguishable from those of buckwheat, either in form or size. 1. *Aleurone Cells* (al) are of variable size and irregular shape. 2. *Starch-Cells* (s). In the outer layers the cells are tangentially elongated; farther inward, they are radially elongated and of large size. The polygonal or rounded granules vary in diameter from 0.003 to 0.012 mm. Vogl has noted that after treating the starch aggregates of buckwheat with caustic potash, there remains a network corresponding to the outline of the starch granules, the threads of which are of homogeneous structure without granules. This phenomenon I have also observed in the fruits of *P. convolvulus* and other species of *Polygonum* as well as in a number of species of *Rumex*, and it is probably characteristic of the entire family. The *Embryo*, consisting of an elongated radicle and two oblong cotyledons, may be conveniently isolated by soaking the seed in 1.25 per cent. caustic soda solution for some hours until the starch is removed.

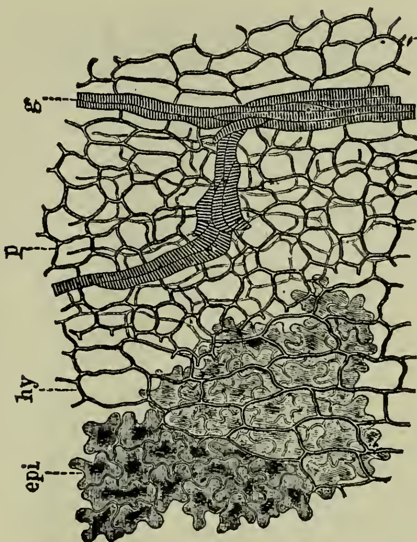

FIG. 408. Black Bindweed. Seed in surface view. Significance of letters same as in Fig. 406.
(After Winton, Conn. Agr. Exp. Sta.)

Detection in Powder Form.—Characteristic of this fruit are the papillae on the outer epidermis of the calyx and the epicarp with sinuous cell walls and rows of warts. The outer epidermal cells of the testa are sinuous in outline, like those of buckwheat, but, unlike the latter, are commonly elongated. Although the cross-cells are morphologically the same as the spongy parenchyma of buckwheat, they resemble more nearly in structure the tube-cells of the cereals. The starch granules are not characteristic and the network obtained after treatment with caustic alkali serves merely as an indication that the seed belongs to a Polygonaceous plant.

Buckwheat (*Fagopyrum esculentum* Moench.).

The achenium consists of elongated epidermal cells with thickened walls, underneath similarly elongated thick-walled sclerotic parenchyma cells with pore canals. This layer contains the pigment. The testa follows the pericarp and is differentiated into an epidermal layer of yellowish brown walls, followed by smaller thin-walled, parenchyma cells. The testa is much compressed; the albumen consists of an outer aleurone layer of small cells followed by larger cells. The albumen cells contain compound starch grains.

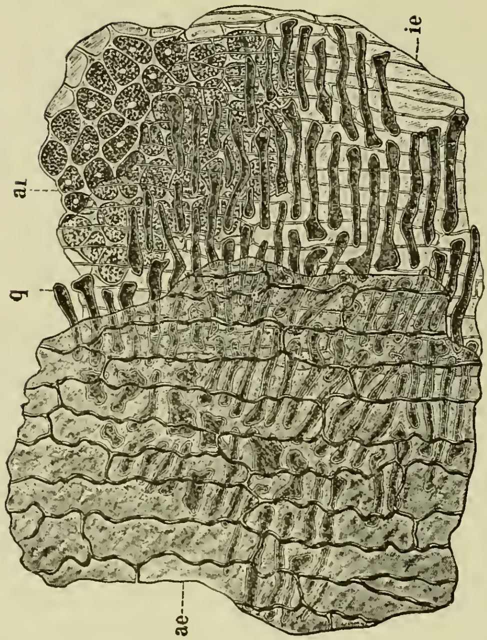

FIG. 409. Black Bindweed. Surface view of the pericarp from below. X 160.
Significance of letters same as in Fig. 406.
(After Winton, Conn. Agr. Exp. Sta.)

CHENOPODIACEAE, GOOSEFOOT FAMILY.

Goosefoot or Lamb's Quarters (*Chenopodium album* L.).

Harz has given an account of the structure of *Beta* and *Spinacia*. The structure of the seed of lamb's quarters is somewhat different. The thin utricle consists of an epidermal layer of somewhat wavy cells and an indistinct layer underneath. The testa contains the brownish pigment. The cells are thick-walled; the nucellus is compressed. The cells of the endosperm are large and contain an abundance of small starch grains.

Russian Thistle (*Salsola kali* (L.) var. *tenuifolia* G. W. F. Meyer).

The seed is without endosperm; the embryo fills the seed, and is coiled in a conical spiral. The seed coat consists of two parts, a layer of three rows of elongated cells followed by a layer of three rows of irregular parenchyma cells. One side of the seed coat is wider than the other and these cells contain an abundance of calcium oxalate crystals. The cells of the outer layer of the embryo are somewhat elongated; the remainder are nearly as broad as long; these contain no starch but albuminoids and fat.

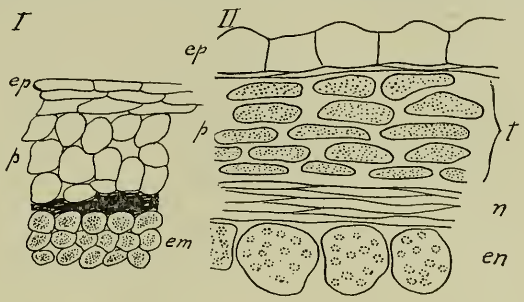

FIG. 410. Microscopic structure of seeds of the Chenopod family. (*Chenopodiaceae*). I. Russian Thistle (*Salsola kali* var. *tenuifolia*). II. Lamb's Quarters (*Chenopodium album*).
ep=epidermis. p=parenchyma cells. t=testa. n=nucellus. en=endosperm.
(Drawings by L. H. Pammel and Charlotte M. King.)

NYCTAGINACEAE, FOUR-O'CLOCK FAMILY.

Wild Four-o'clock or Umbrella Plant (*Oxybaphus nyctagineus* (Mx.) Sweet).

The nutlike fruit of the wild four-o'clock or umbrella plant is somewhat hairy; the outer portion of the pericarp is made up of thick black-brownish cells from 6 to 9 rows. The epidermal cells are smaller, some of the cells elongated into one-celled thick-walled trichomes. Adjacent to the testa are bundles of thick-walled, sclerotic cells, the outer layer of cells of the testa consisting of mucilaginous cells with colorless walls. This is followed by a second layer of thin-walled parenchyma cells. The nucellus consists of an indefinite granular mass, followed by the endosperm, and the thin-walled cells of the embryo.

CARYOPHYLLACEAE, PINK FAMILY.

Soapwort or Bouncing Bet (*Saponaria officinalis* L.).

The kidney-shaped, black, roughish seeds consist of tangentially elongated, thick, black, rough cells, the outer layer being brownish colored, while the cell cavity is red or blackish brown. The inner walls of the testa are thinner, the cells are elongated and the inner seed coat is much compressed. The nucellus is indistinguishable from the inner seed coat. This is followed by the endosperm,

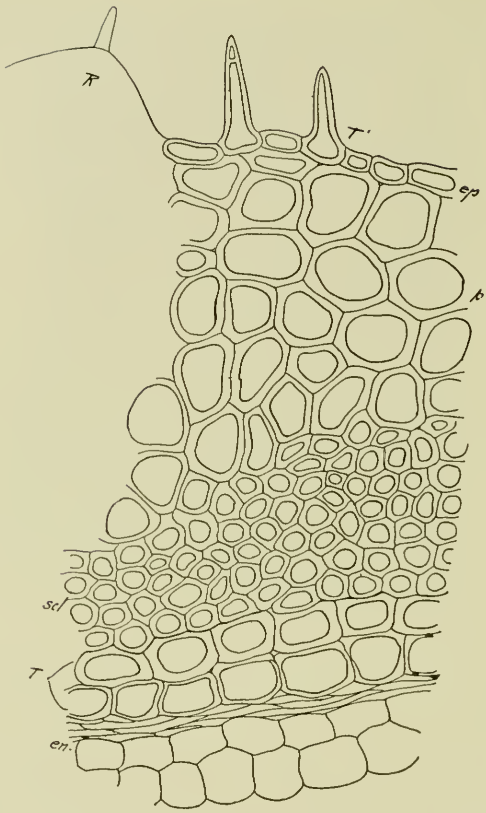

FIG. 411. Wild Four-o'clock (*Oxybaphus nyctagineus*). The sclerotic parenchyma, parenchyma and epidermis belong to the pericarp. ep=epidermis. p=parenchyma. scl=sclerotic parenchyma. t=testa. t^1=trichome. en=endosperm. r=ribs.
(Drawing by L. H. Pammel and Charlotte M. King.)

consisting of an outer tangential layer with granular contents. The aleurone layer and remaining portion of the endosperm cells consist of large rather thin-walled cells with compound starch grains and protein.

Slender Catchfly (*Silene antirrhina* L.).

The small kidney-shaped seeds are rough and brownish in color. The outer epidermal walls are thick, brownish black in color. The underlying parenchyma cells are tangentially elongated with nearly colorless walls. This is followed by an indefinite layer consisting of an inner seed coat and a nucellus. The endosperm consists of thin-walled parenchyma cells with granular contents consisting of starch grains and protein.

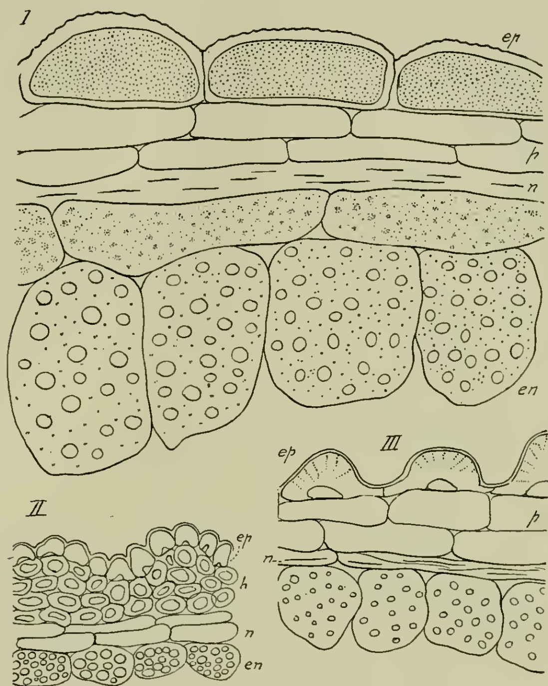

FIG. 412. Microscopic structure of some seeds of the Pink family (*Caryophyllaceae*).
I. Bouncing Bet (*Saponaria officinalis*). II. Catchfly (*Silene antirrhina*). III. Virginia Catchfly (*Silene virginica*).
ep=epidermis. p=parenchyma. n=nucellus. h=hypoderm cells. en=endosperm.
(Drawings by L. H. Pammel.)

The seeds of Virginia Catchfly (*Silene virginica*) are irregular. The outer walls are greatly thickened, irregular, the underlying parenchyma cells being slightly elongated. This layer is followed by the nucellus and the aleurone layer and remaining endosperm cells containing starch grains and protein material.

Silene inflata is described and figured by Harz*.

*Samenkunde 2 :10-79.

RANUNCULACEAE, CROWFOOT FAMILY.

Common Buttercup (*Ranunculus abortivus* L.).

The greenish achenes of the buttercup consist of three distinct layers. The outer epidermal is of elongated, thickish black cells. The cells containing the brown pigment are yellowish brown. The underlying layers of three or four rows of seeds are similar but larger and paler in color. This layer is followed by a thick-walled sclerotic layer containing three or four layers of thick-walled cells with pore canals. The testa consists of an outer layer of thin-walled parenchyma cells; the inner layer consisting of sclerotic parenchyma cells filled with pore canals. The endosperm cells are large or thin-walled and contain protein material. Harz has given an account of the structure of *R. arvensis**.

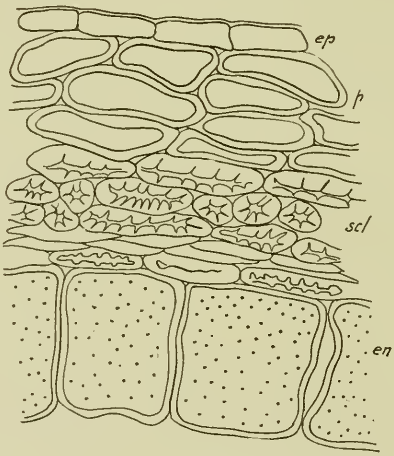

FIG. 413. Microscopic structure of the seed of Buttercup (*Ranunculus abortivus*).
ep=epidermis. p=parenchyma. scl=sclerotic parenchyma. en=endosperm.
(Drawing by L. H. Pammel and Charlotte M. King.)

PAPAVERACEAE, POPPY FAMILY.

Common Poppy (*Papaver somniferum* L.).

Prof. A. L. Winton describes the seeds of this plant as follows:

Testa (S).—Cross sections are prepared after soaking the seed in water that may be cleared with chloral or alkali. After soaking the whole seed for about twenty-four hours in 1 per cent sodium hydrate solution, the first four layers readily separate from the

*Landw. Samekunde 2 :10-64.

fifth. Subsequent treatment with hydrochloric acid dissolves out the calcium oxalate, and staining with chlorzinc iodine or safranin renders the outer layers more distinct. 1. The *Epidermal Cells* (ep) are polygonal and of enormous size, corresponding to the network on the seed. As appears in cross section, the cells are collapsed except in the neighborhood of the radial walls. In surface view the radial walls are sinuous and thin, what are often considered the thick dark walls of this layer being not the walls at all, but the ribs formed by the thickening of the second and third layers. This conclusion is consistent with Meyer's and Hanausek's figures of cross sections, also with Meyer's drawings and Mach's photomicrographs of surface preparations. The statement of Tschirch and Oesterle that the epidermis consists of elongated cells situated over the ribs, with large polygonal cells between, has since been corrected by the authors themselves. Doubtless they mistook some of the cells of the second layer for epidermis. Hanausek's surface view, on the other hand, might convey the impression that the ribs were the cell walls, but his description and cross section clearly show their true nature. 2. *Crystal Layer* (k). On the

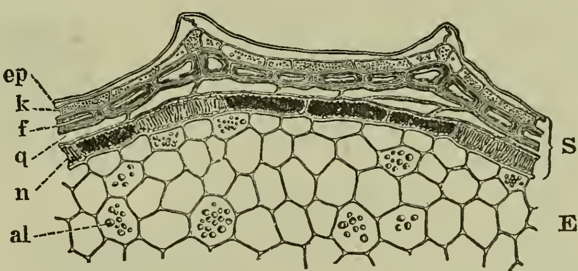

FIG. 414. Poppy Seed (*Papaver somniferum*). Transverse section. s, testa consisting of epidermis ep, crystal layer k, fiber layer f, cross-cells q and netted-cells n; e, endosperm containing aleurone grains al. X 160. (After Winton, Conn. Agr. Exp. Sta.)

ribs, the cells of this layer are more or less tangentially elongated, but between the ribs are isodiametric and polygonal, the elongated cells having longer radial walls than the others, thus contributing to the formation of the ribs. They contain fine, granular crystals of calcium oxalate. Meyer has demonstrated that the blue color of the poppy seed is due, not to a blue pigment, but to the interference of light by the crystals over the brown cells in the background, and is the same phenomenon that causes the apparent blue color of the sky and the iris of the eye. As soon as these crystals are dissolved in hydrochloric acid, the seed appears brown.

3. *Fiber Layer* (f). The fibers of this layer are 15-40μ broad and are parallel to the curved axis of the seed. Seen in cross section, this layer is thickest in the ribs, the walls throughout being distinctly thickened and stratified. In surface view they are rendered more distinct by chlorzinc iodine. 4. *Cross-Cells* (q). The fourth layer consists of moderately thick-walled, transversely elongated, pointed cells arranged side by side in rows. The walls are impregnated with brown material. 5. *Netted-Cells* (n). Owing to the netted-veined, colorless walls and the presence of deep brown contents, these cells are particularly striking. They are arranged transversely and often side by side in rows. The cell contents are insoluble in alkali and do not give the tannin reaction. Some authors designate the cells of this layer "Pigment cells," notwithstanding the fact that in the white poppy they do not contain pigment. Meyer, Tschirch and Oesterle, Vogl, and Hanausek describe an inner layer of thin-walled cells, but I am unable to find such a layer except in the vicinity of the hilum.

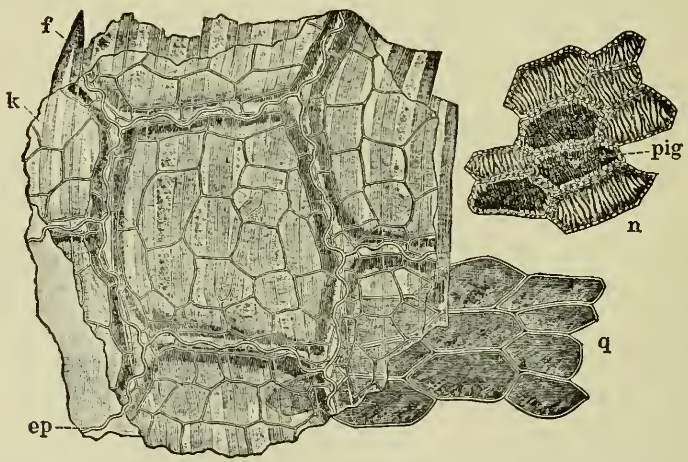

FIG. 415. Poppy seed. Testa in surface view. Significance of letters same as in Fig 414. pig, pigment. X 160.
(After Winton, Conn. Agr. Exp. Sta.)

The *Endosperm* (E) contains aleurone grains up to 3μ in the outer layers and 7μ in the inner layers, each grain containing several globoids and crystaloids.

Embryo.—In the cotyledons there is only one layer of palisade-cells and these cells are only slightly elongated. The aleurone grains are like those of the endosperm.

Prickly Poppy (*Argemone intermedia* Sweet).

The blackish pitted seeds are difficult to study. They consist of nearly colorless epidermal cells, with thick outer walls and cuticle. The cells of the underlying layer are thick-walled, walls and contents blackish, difficult to make out on account of dense

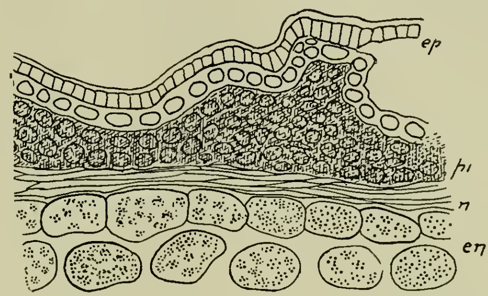

FIG. 416. Rocky Mountain Poppy (*Argemone intermedia*). ep=epidermis with thick outer walls. pi=pigment layer, n=nucellus, en=endosperm.
(Drawing by L. H. Pammel and Charlotte M. King.)

pigment. The nucellus is compressed, colorless. The endosperm of large cells contains oil in large amounts, and protein. The structure seems to differ in a marked degree from *Papaver* as described by Harz and G. Kraus.

CRUCIFERAE, MUSTARD FAMILY.

Virginia Peppergrass (*Lepidium virginicum* L.).

The seed coats consist of three well defined layers. The outer or epidermal cells are tabulated, somewhat compressed. The cuticle forms a continuous layer over these. On the addition of water the epidermal cells elongate and form a mucilaginous mass, showing stratified layers. These are not difficult to make out when the specimen is mounted in water. The cell cavity is very much reduced; that portion of the cell wall in contact with the cell cavity is differentiated from the outer cell wall substance. Long continued addition of water causes the cuticle to break and the exterior becomes very irregular.

The second layer is colored brown, the cell walls are considerably thickened laterally and project upwardly in the shape of cones. A section made through the ends of these seeds shows that the second layer is considerably more developed and there are evidences here of an indistinct layer between the first and second. The layer following this consists of thin-walled parenchyma cells, in some cases considerably elongated but in others short.

The third layer is followed by the endosperm which consists of a layer of rather thick-walled parenchyma cells. These carry granular protein grains. This is followed by one or more layers of elongated cells, in which the cell cavity is very much reduced. These cells reach their highest development between the folds of the caulicle and cotyledon.

The cells of the first layer of the embryo are smaller, quite uniform in size and filled with protein grains and oil.

Small Peppergrass (*Lepidium apetalum* Willd.).

The cuticle forms a continuous layer over the epidermal cells, which are larger than in *L. virginicum.* On the addition of water the cell wall rapidly elongates, emitting a copious mucilage. The cell cavity is very much reduced but longer than in *L. virginicum.* It is surrounded by a denser, more or less differentiated part of the cell wall which is more yellow in color than the remainder of the cell wall. The second layer is of a yellow straw color and consists of very minute cells with small cell cavities.

The cell walls of the third layer are strongly thickened, brown, and serve the same purpose as in the other species. The endosperm consists of thick-walled parenchyma cells.

In the first layer of cells, the cell walls are very much larger and packed with protein grains. The other layers of endosperm consist of small elongated thick-walled cells with a small cell cavity. These attain their greatest development between the caulicle and cotyledon. In the embryo, the cells of the first row are isodiametric filled with protein grains and oil. The outer cells are elongated larger, and also densely packed with the same material.

Shepherd's Purse (*Capsella bursa-pastoris* (L.) Medic.).

The seed coats attain their maximum development in the region of the caulicle. Cuticle covers the epidermal cells, the latter tabular, compressed but in the addition of water elongating, becoming mucilaginous and showing stratification.

The second and third layers are brown with thick cell walls. Fourth layer consists of endosperm, one layer of isodiametric cells filled with protein grains, followed by thick-walled cells reaching

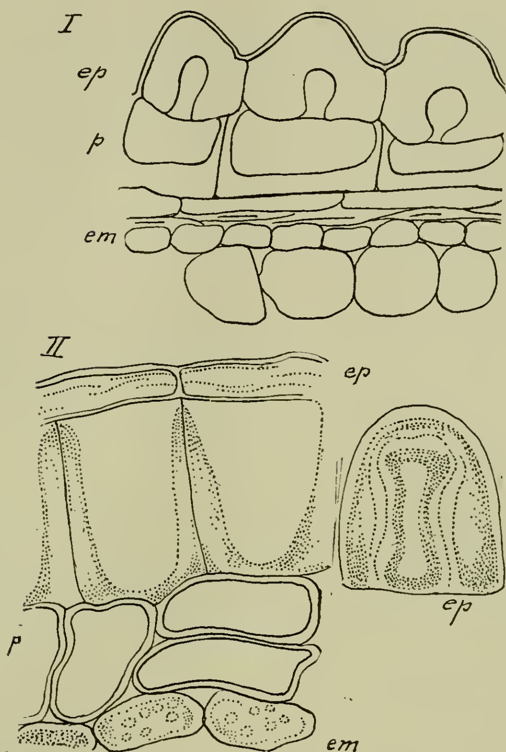

FIG. 417. Microscopic structure of seeds of Mustard family (*Cruciferae*). I. Hedge Mustard (*Sisymbrium canescens*). II. Small Peppergrass (*Lepidium apetalum*). To the right an enlarged epidermal cell with mucilaginous walls. ep=epidermis. p=parenchyma. em=embryo. (Drawing by L. H. Pammel.)

their greatest development between the cotyledon and caulicle. First row of cells of embryo nearly isodiametric, filled with oil and protein grains. Others somewhat larger contain the same substances. Cotyledons incumbent. Central part of caulicle separated from the rest. Cells of caulicle very much larger than cells of cotyledons.

Black Mustard (*Brassica nigra* Koch.).

The cuticle covers the epidermal cells as a continuous layer; when mounted in alcohol the outer layer is very much compressed and shows very slight stratification; the cell walls expand and after it has been moist for a considerable time the cuticle breaks. Stratification is very evident on the addition of water. The second layer consists of rather thin-walled parenchyma. The cells of

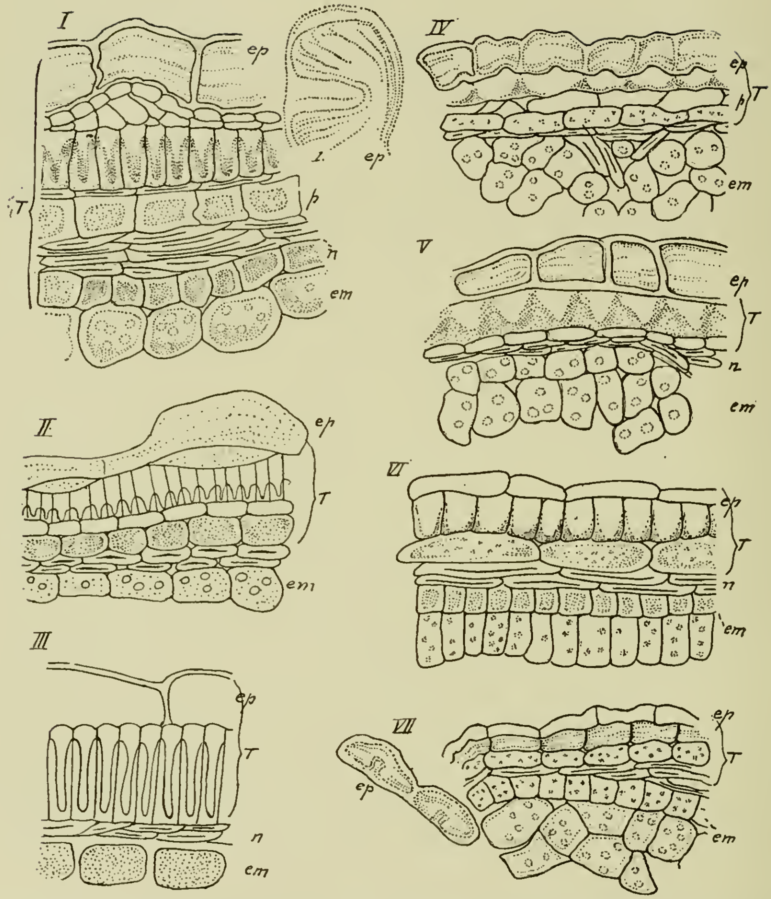

FIG. 418. Microscopic structure of some Cruciferous seeds (*Cruciferae*). I. False Flax (*Camelina sativa*). II. Black Mustard (*Brassica nigra*). III. Common Mustard (*B. arvense*). IV. Winter Cress (*Barbarea vulgaris*). V. Peppergrass (*Lepidium virginicum*). VI. Tumbling Mustard (*Sisymbrium altissimum*). VII. Shepherd's Purse (*Capsella bursa-pastoris*).
t=testa. p=parenchyma cells. n=nucellus. em=embryo.
I, II, III, and IV. Elongated palisade cells below the epidermal layer and parenchyma cells. To the right of I, epidermal cells after the addition of water.

(Drawings by L. H. Pammel.)

this layer differ greatly with reference to their size, being scarcely at all developed in places, in others nearly as large as the cells of the outer layer.

The third layer consists of thick-walled parenchyma cells, densely packed, radially elongated, sides presenting a cone-shaped appearance. Underneath this is a layer of thick-walled parenchyma cells which contain some coloring matter. The endosperm follows this layer. The first layer consists of thick-walled cells, densely packed with albuminous matter. The remaining cells vary in number, are much elongated, thick-walled with a small cavity; these cells extend down between the contiguous portions of the cotyledon or caulicle.

The *Embryo.*—The cells of the first layer surrounding the cotyledon or caulicle are smaller, filled with fat and protein grains. The remaining cells are larger, also filled with fat and protein grains. The central part of the caulicle shows a differentiation of the embryonic vascular portion, consisting of small cells.

Charlock or Common Mustard (*Brassica arvensis* (L.) Ktze.).

The outer layer of cells is compressed, tabular, with stratification not evident, and cuticle well developed, and forms a continuous layer over the outer cells; on the addition of water, the cell walls become mucilaginous, elongate, stratification becomes evident, the cuticle breaks, and an irregular surface is formed. The second layer is but slightly developed, made up of thin-walled parenchyma cells. The cells of the third layer are elongated and thickened laterally. These cells are much longer than in *B. nigra* and brown in color. The fourth layer consists of one to two rows of rather thin-walled cells carrying pigment. Endosperm consists of several rows of cells; first row nearly isodiametric, filled with protein grains. The three or four layers of cells following are thick-walled with a small cell cavity.

Embryo.—First layer of cells nearly isodiametric, those following somewhat larger, filled with protein and fat grains.

Hedge Mustard (*Sisymbrium officinale* Scop.).

Cuticle covering the epidermal cells, the latter tabular, much compressed. On the addition of water the cell walls become mucilaginous with evident stratification. The cells of the second layer are brown and thin-walled, much compressed. On addition of choloral hydrate they expand. Third layer much darker than the second, thick-walled, followed by endosperm, cells elongated, filled with protein grains, followed by elongated thick-walled cells with a small cavity. These reach their highest development between cotyledons and caulicle. First row of cells of the embryo nearly isodiametric, filled with protein grains and oil.

Tumbling Mustard (*Sisymbrium altissimum* L.).

On the addition of water the cell wall of the outer seed coat becomes mucilaginous. Outer epidermal layer covered with cuticle, cells elongated, on the addition of water, walls become mucilaginous and show stratification. Cell walls of second layer thick, light brown, followed by endosperm of two layers of cells, first elongated, thick-walled. Cells of embryo as in *S. officinale.*

Hairy Hedge Mustard (*Sisymbrium canescens* Nutt.).

The testa of the small brownish cells consists of an outer epidermal layer with thick walls. These cell walls become mucilaginous on the addition of water. This is followed by a layer of several rows of brownish cells and a compressed layer, the nucellus. The cells of the outer row of the embryo are smaller than the underlying cells.

Common Winter Cress or Yellow Rocket (*Barbarea vulgaris* R. Br.).

First layer of outer seed coat not well developed, cells elongated in the direction of the seed. Cuticle covers the epidermal cells. On the addition of water a slight mucilaginous modification takes place. Second layer with thick lateral walls and quite large cell cavities, colored brown. Third layer of rather thick-walled parenchyma cells also colored brown, followed by endosperm as is usual in cruciferous seeds.

False Flax (*Camelina sativa* (L.) Crantz.).

Seed coats consisting of four layers. The outer epidermal cells not much longer than wide, on the addition of water become mucilaginous and well stratified. On the addition of chloral hydrate stratification is more evident. The cell walls are differentiated into several layers. The second layer is not always developed. Cells of third layer with thick walls and brown pigment, followed by a narrow layer of thick-walled brown cells. The first row of cells of endosperm, rather thick-walled, filled with protein grains, the other layers of unequal development, cells elongated, thick-walled; followed by cells of embryo; these contain protein grains and fat.

ROSACEAE, ROSE FAMILY.

White Avens (*Geum canadense* Jacq.).

A greater part of the so-called seed is made up of the pericarp consisting of a layer of small epidermal cells with trichomes. The underlying parenchyma cells are large with numerous intercellular spaces. The testa is thin, consisting of an outer pigment layer followed by several rows of thick-walled, colorless cells.

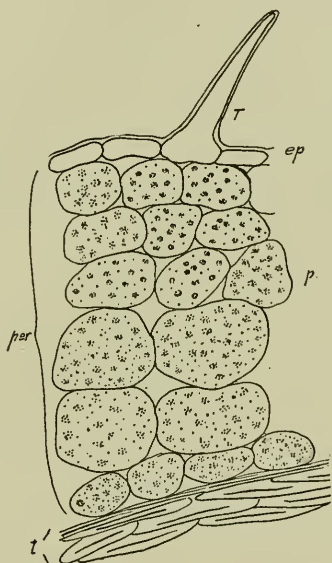

FIG. 419. Microscopic structure of fruit of Avens (*Geum canadense*). ep=epidermis. p=parenchyma. per=pericarp. t=trichome. t^1=testa. (Drawing by L. H. Pammel and Charlotte M. King.)

LEGUMINOSAE,* PULSE FAMILY.

Rattlebox (*Crotalaria sagittalis* L.).

The testa not strongly developed; endosperm 196μ in thickness. From Nadelmann's studies it appears that in *Crotalaria verrucosa* the horny endosperm is well developed, being four and one-half times as wide as the testa. The aleurone layer contains fat and aleurone grains. The cells of the embryo contain protein and fat but no starch.

*The descriptions here given are taken for the most part from a paper by L. H. Pammel, Trans. Acad. Sci. St. Louis, 9.

Malpighian.—The cells are prismatic in surface view, 9.8μ across, with five to six canals. In cross sections they are 84μ long. The cuticle forms a continuous layer, with longitudinal canals projecting into the cells; these extend down through the upper part of the cell wall and the cuticularized substance; this layer is lighter in color than the rest of the cell wall, and separates from the remainder of the cell in the form of a band. The narrow light line occurs close under the cuticularized layer. The cell cavity is narrow and gradually tapers upward; it contains some protein matter. The cell wall consists of cellulose.

Osteosclerid.—The walls are thickened. Cells wide in the lower part and narrowing upwards, with large intercellular spaces. Cells contain protein.

Nutrient.—Consists of radially elongated cells, which are slightly compressed. Walls of medium thickness, slightly colored.

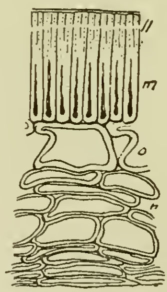

FIG. 420. Microscopic structure of the testa of Rattle-box (*Crotalaria sagittalis*). ll=light line. m=malpighian cells. n=nutrient layer. o=osteosclerid. (Drawing by L. H. Pammel.)

Endosperm.—Not strongly developed. The cells of the aleurone layer large, containing protein. Two layers follow this, the cells very much compressed, and somewhat radially elongated, of thick-walled cells. All of the cells contain protein and fat.

Embryo.—Cells of outer row smaller; those adjoining the endosperm thicker walled, the inner part with thinner walls. The remaining cells of the embryo larger. All of the cells filled with protein. Starch is absent.

Black Medick (*Medicago lupulina* L.).

Testa and endosperm well developed, 245μ in thickness on sides. More than half of this thickness consists of endosperm.

Malpighian.—Cells 40-42μ in length. Cuticle slightly irregular; underneath the cuticle a light colored area with conical projections, as in *Melilotus,* but somewhat more prominent. With chlor-iodide of zinc this rapidly colors blue. It corresponds to the mucilaginous "membrana interna" of Mattirolo and Buscalioni, and, as shown by Schips, is chemically differentiated from the cuticle and remainder of the cell wall. The conical layer is highly refractive. The light line occurs below the conical layer and colors blue soon after the addition of chlor-iodide of zinc. The cell cavity is broadest at the base, gradually tapering upward. A large chromatophore occurs at the base or near the middle of the cell cavity. In colored seed some pigment occurs in the cavity as well as considerable amounts in the walls. Small pore-canals occur in the upper part of the cell wall. The cell walls color blue more slowly with chlor-iodide of zinc than the cuticularized layer.

Osteosclerid.—Cells broad at the base, with conspicuous longitudinal pores; intercellular spaces below the Malpighian cells triangular; walls colored brownish; cells containing pigment and tannin.

Nutrient.—This layer is much compressed, and differentiated into two parts; cells elongated, rather thin-walled; those in the lower portion carry a great deal of pigment, and are much more compressed than the upper portion.

Endosperm.—The endosperm is of unequal development, laterally as much as 150μ in thickness. Harz gives the thickness as 250μ. Cells of the aleurone layer rectangular, thick-walled, and filled with fat and protein grains. This layer is followed by reserve cellulose. The primary wall persists when treated with weak solvents. The walls, except the primary, color blue with chlor-iodide of zinc. The inner portion of the endosperm consists of thick-walled, elongated cells.

Embryo.—Cells of the first row smaller than those below; exterior walls thickened more than the lateral; all of the cell walls consist of cellulose. Cells contain fat and protein grains; starch grains do not occur, though Harz says they are usually abundant. In several specimens examined starch was not found even when potassium hydrate or weak sulphuric acid was used with the iodine.

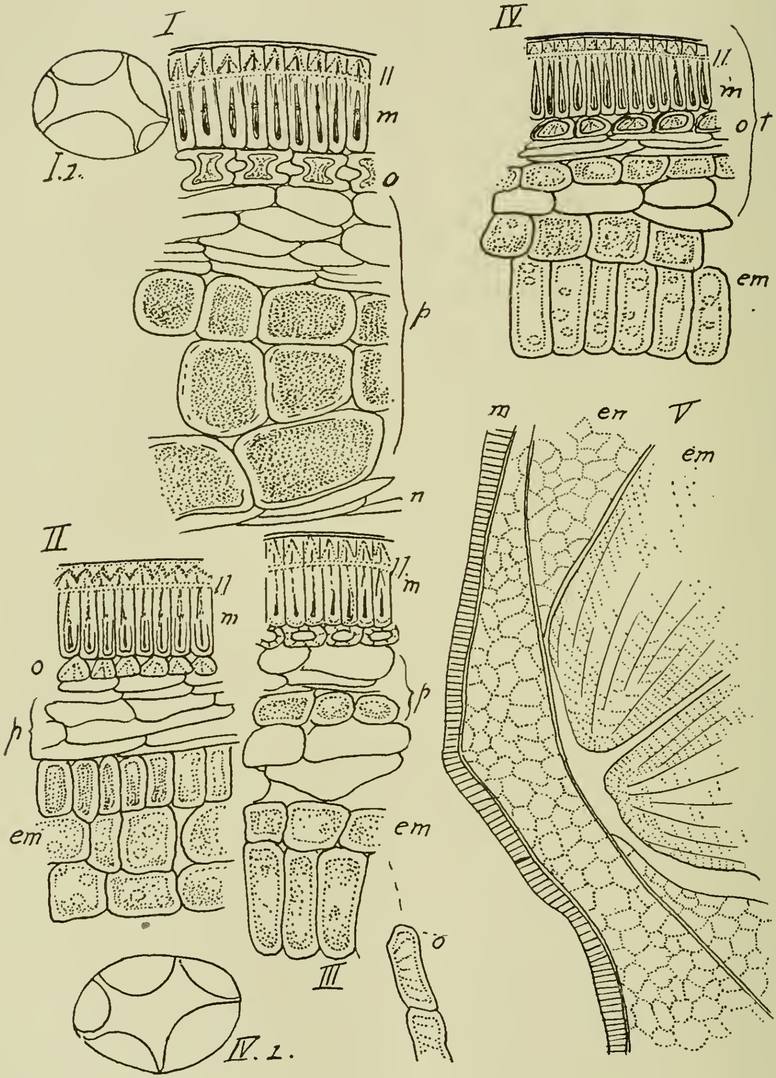

FIG. 421. Microscopic structures of seeds of some leguminous weeds.
I. and V. Yellow Sweet Clover (*Melilotus officinalis*). II. White Sweet Clover (*Melilotus alba*). III. Black Medick (*Medicago lupulina*). IV. Bur Clover (*Medicago denticulata*).
m=malpighian cells. ll=light line of the same. o=osteosclerid. em=embryo t=testa. en=endosperm. p=parenchyma. n=nucellus.
(Drawings by L. H. Pammel.)

Bur Clover (*Medicago denticulata* Willd.).

The seeds of this species agree with those of *M. lupulina*.

Malpighian cells 35-38$^{\mu}$ long; the narrow light line occurs below the conical layer; the chromatophores are absent.

Osteosclerids 16-18$^{\mu}$ long; longitudinal striae well marked. Cross sections show beyond a doubt that these striae are canals. The nutrient layer is much compressed.

Aleurone layer of endosperm as in *M. lupulina*. The mucilaginous reserve cellulose not so strongly developed as in the last species. Treatment with iodine gives no reaction for starch; nor do blue grains appear when treated with weak sulphuric acid and iodine, or potash and iodine. An abundance of fat and protein grains occurs in the cells. Walls of the reserve cellulose color light blue. Malpighian cells a darker blue.

Sweet Clover (*Melilotus alba* Lam.).

Testa and endosperm vary in thickness, average 75$^{\mu}$. Malpighian cells as long as the thickness of the endosperm and remainder of testa.

Malpighian.—Cuticle wavy and well developed; the cuticularized layer below with small, conical projections, those of two adjoining cells meeting at the middle lamella of the lateral walls, giving the layer the appearance of consisting of conelike projections. These cones are also connected with the small pore-canals. This cuticularized layer is highly refractive. The light line consists of a narrow but distinct refractive zone below the conical layer. The refractive zone colors blue with chlor-iodide of zinc. The whole upper part is more or less refractive. The remainder of the cell wall contains pigment and is colored blue with chlor-iodide of zinc; the cuticularized layer as well as the conical layer colors blue. Small canals project into the walls, and in some cases extend beyond the light line. The chromatophores are irregularly distributed in the cell cavity, some near the base, others in the center.

Osteosclerid.—Cells with a broad base and a small triangular intercellular space above; longitudinal pore-canals in the upper part of the cell, but these do not extend its entire length.

Nutrient.—This layer is much compressed; consists of thin-walled cells, divided into two parts; cell walls of lower part thicker. Both layers contain pigment and tannin, the upper more than the lower. Cell walls consist of cellulose.

Endosperm.—The aleurone layer is quite distinct; the cells are rectangular; cell walls made up of cellulose. The walls of the remainder of the endosperm, except where it joins the embryo, are thick, consisting of mucilaginous reserve cellulose. Cells of the internal layer of the endosperm thick-walled, elongated, containing some protein grains and fat.

Embryo.—Cells of the exterior walls of first row thickened; smaller than those below. All of the cells contain fat, protein grains, and small starch grains. Procambial vessels well developed.

Yellow Sweet Clover (*Melilotus officinalis* Lam.).

Testa with endosperm varying from 260-300μ in thickness. The Malpighian cells of this species are longer than in *M. alba*, and also more abundantly supplied with pigment. The conical projections are longer. The osteosclerids are longer and nearly as wide above as below. The longitudinal canals are as conspicuous and well developed as in that species. Cells of the nutrient layer, especially in the lower part, are abundantly supplied with pigment and some tannin. The walls of the aleurone cells are thick; the mucilaginous reserve cellulose and the thick-walled, elongated cells are not essentially different from the last species. It also agrees with it with respect to the embryo.

Hairy Prairie Clover (*Dalea alopecuroides* Willd.) (*Parosela dalea* (L.) Britt.).

Testa and endosperm from 150-265μ in thickness. Variation is mostly due to endosperm, which reaches its greatest development laterally.

Malpighian.—Cells are 36.4μ in length. Cuticle prominent; cuticularized layer not conspicuous; narrow light line near the cuticle; pores prominent, extending into the walls beyond the light line. Cell cavity broad at the base, containing protein grains.

Osteosclerid.—Cells thick-walled, lighter in color than the Malpighian layer. They contain pigment, tannin and protein.

Nutrient.—This layer is compressed and the cells are elongated. Walls color blue with chlor-iodide of zinc. Brown pigment abundant in the vascular region.

Endosperm.—Aleurone cells nearly isodiametric, containing fat, and protein; most of the endosperm consisting of reserve cellulose

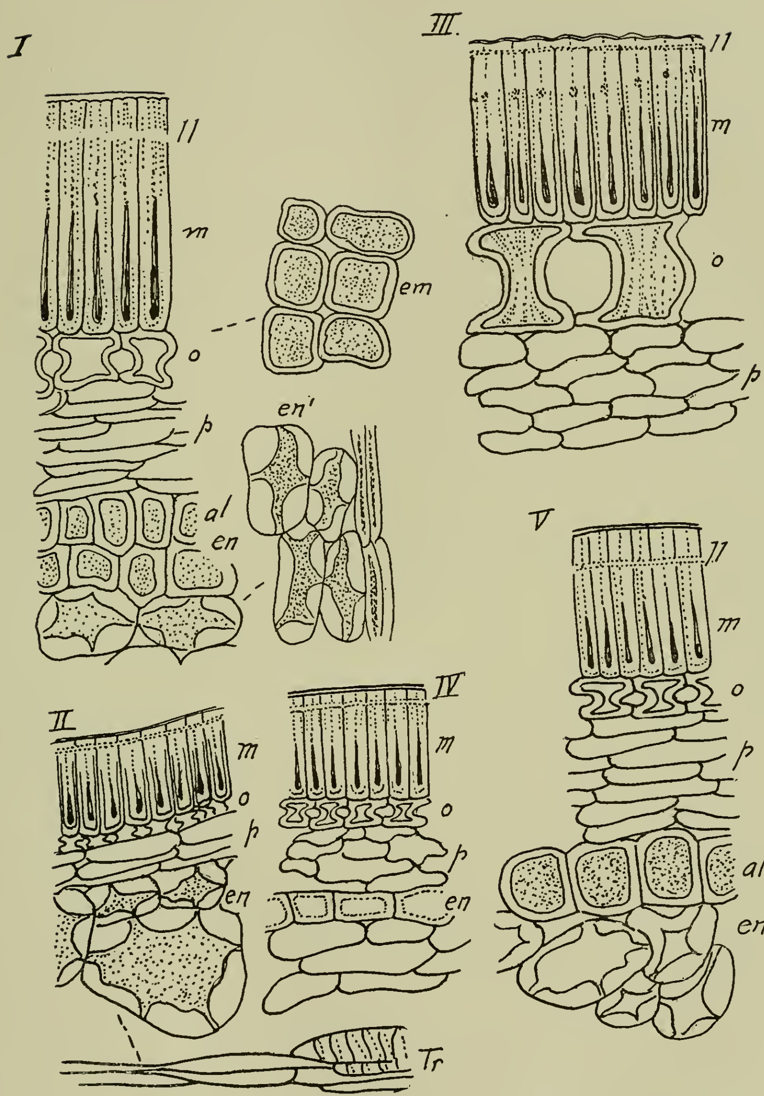

FIG. 422. Microscopic structure of leguminous seeds (*Leguminosae*).
I. Silky Sophora (*Sophora sericea*). II. Parosela (*Dalea alopecuroides*). III. Common Vetch (*Vicia sativa*). IV. Stemless Locoweed (*Oxytropis lamberti*). V. Wild Liquorice (*Glycyrrhiza lepidota*).
m=malpighian cells. ll=light line. em=embryo. o=osteosclerid. p=parenchyma. al=aleurone layer. en=endosperm. en=endosperm reserve cellulose cells. tr=tracheae.

(Drawings by L. H. Pammel.)

with prominent pore-canals; the internal layer consisting of elongated thick-walled cells, with cell cavity much reduced.

Embryo.—First row of cells of embryo smaller than underlying, with thickened outer walls. Cells below with small intercellular spaces. Reserve material consists of fat and protein grains; starch is absent.

Stemless Loco Weed (*Oxytropis lamberti* Pursh.).

Testa and endosperm 170-175μ. This, the so-called loco weed, is said to cause disturbances in animals, but alkaloids have not been found in the seed or any other part of the plant.

Malpighian.—Cells 40-42μ long. Cuticle somewhat uneven; the narrow well marked cuticularized layer colors blue with chlor-iodide of zinc; the light line occurs below the cuticularized layer, and this also colors blue; the remainder of the cell wall takes on a darker blue color. Cells contain an abundance of pigment, tannin, and some plastic material.

Osteosclerid.—Cell walls thickened, not prominently I-shaped, but with an elongated intercellular space.

Nutrient.—Layer consists of thin-walled elongated cells from ten to twelve rows. Pigment more abundant in lower than in upper part. Walls color blue with chlor-iodide of zinc.

Endosperm.—The aleurone layer consists of thick-walled cells; the underlying thick-walled cells of the reserve cellulose become mucilaginous on the addition of water. The internal part consists of thick-walled, elongated cells. The cells contain protein.

Embryo.—Cells of the first row smaller, with thick exterior walls; cells below not so compact and with thinner walls. Cell walls color blue with chlor-iodide of zinc. Starch is absent but cells contain fat and protein.

Bush Clover (*Lespedeza capitata* Mx.).

Testa and endosperm 90-100μ thick. Light line occurs close under the cuticle. A large spherical chromatophore occurs in the pigmented Malphigian cells which is variable as to its position in the cell. The long pores extend to the middle of the cell. The osteosclerids are short. The nutrient layer is compressed, containing much pigment. Endosperm as in *L. stuvei;* the aleurone cells are thick-walled, and the reserve cellulose is mucilaginous. Embryo as in the other species containing fat and protein but no starch.

Common Vetch (*Vicia sativa* L.).

This species has been studied by Harz, Tschirch and Oesterle, Beck, and Sempolowski. Testa irregular, with small projections, 126μ thick. Endosperm reduced to a single layer. The presence of endosperm has been indicated by the above writers. Beck speaks of an aleurone spot (Aleurone fleck) in the epidermal cells of the cotyledons of this and other species of the genus *Vicia.*

Malpighian.—Cells 72-75μ long, pointed at the upper end; cuticle very irregular because of the projections; cuticularized layer most prominent in the depressions; pores project into the walls below the light line, and partly connect with the cell cavity; the upper part of the cell is not pigmented, or very little. The light line occurs just above the pigmented part of the cell. Cell cavity is large at the base, narrows upward, becoming much constricted below the light line, and above widens again. Small lateral projections or pores extend into the wall at right angles to the cavity. A large chromatophore, some pigment, and small granules occur in the cavity. The walls in lower part of cell are colored bluish brown.

Osteosclerid.—Cells are thick-walled, 13-16.8μ long, longitudinally striated. Upper and lower cross-bars nearly equal; the intercellular spaces elongated. Tschirch and Oesterle state that this layer is not very strongly developed, but in specimens which I have examined it is well developed. These cells are more or less variable, as indicated by Harz, who states that they are from 11-13μ long.

Nutrient.—This layer is differentiated into two parts; the upper consists of thin-walled, elongated cells with a yellowish pigment; the cells of the lower part are larger, thin-walled and elongated, containing a brown pigment.

Nucellus.—This consists of a narrow zone of compressed cells.

Endosperm.—Occurs in the form of thick-walled elongated cells with a narrow cell cavity. Usually only one or two rows of cells.

Embryo.—The outer row of cells of the cotyledon is continuous. The exterior walls are thickened: cells below are more loosely arranged; small intercellular spaces in the angles of the cells; the epidermal cells contain fat and protein, the others in addition an abundance of spherical or elliptical starch grains measuring 25 x22.5μ to 50x25μ. Palisade cells wanting.

Wild Liquorice (*Glycyrrhiza lepidota* (Nutt.) Pursh.).

Testa and endosperm 490-500μ thick. Endosperm variable in different parts of the seed, but usually well developed.

Malpighian.—Cells 70-75μ long. Cuticle somewhat irregular; the light colored cuticularized layer is followed by a narrow but sharply marked zone, the light line; cell cavity is large at the base, gradually tapering upward. Pore-canals extend into wall beyond the light line. Cells contain pigment and some plastic material.

Osteosclerid.—The I-shaped cells are thick-walled, with small projections somewhat similar to those shown for *Ervum lens* by Mattirolo and Buscalioni. The intercellular space is elongated. The cells attain their greatest development in the hilar region. All of the cells carry some pigment and plastic material.

Nutrient.—This layer is much compressed and thin-walled; cells number from four to six rows. Pigment is most abundant in the lower part of the layer.

Endosperm.—Aleurone layer consists of nearly isodiametric thick-walled cells. The mucilaginous reserve cellulose is variable in quantity. Cell walls differentiated into primary, secondary and tertiary. Internal part of the endosperm consists of thick-walled, elongated cells. All of the cells contain protein grains.

Embryo.—Cells of the outer row smaller than those within; exterior walls thickened, those below more loosely arranged than the epidermal; more compact and with thicker walls than those of *Astragalus mexicanus.* Cells contain fat and protein grains but no starch.

LINACEAE, FLAX FAMILY.

Common Flax (*Linum usitatissimum* L.).

The shining, brownish seeds consist of an outer epidermal layer of thick-walled cells; walls colorless and stratified; these become mucilaginous on the addition of water. The cell cavity is very small, the underlying layer consists of yellowish parenchyma cells. The third, called the fiber layer by Winton, consists of sclerotic parenchyma cells with pore-canals, the sclerotic parenchyma followed by a layer of colorless cross-cells with thin walls. The parenchyma cells of the pigment layer follow; these cells are squarish, pigment yellowish brown. The endosperm follows the

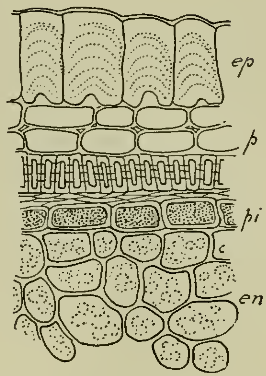

FIG. 423. Microscopic structure of the seed of common Flax (*Linum usitatissimum*).
ep=epidermis. p=parenchyma, underneath thick-walled sclerenchyma cells and the pigment layer. pi=pigment layer. en=endosperm.
(Drawing by L. H. Pammel and Charlotte M. King.)

pigment layer and consists of 2-6 layers of cells, the walls being thicker than those of the embryo, and containing fat and aleurone grains. The epidermal cells of the embryo are squarish, the cells underneath on the upper face of the cotyledon are palisade-like. All of the cells contain fat and protein.

GERANIACEAE, GERANIUM FAMILY.

Carolina Cranesbill (*Geranium carolinianum* L.).

The testa of the smooth small seeds consists of an outer epidermal layer, the cell walls not greatly thickened; underlying it is a single row of elongated parenchyma cells followed by the Malphigian cells; the light line is narrow and occurs in the middle of the cell; this is followed by a layer of much larger cells with thick walls. The inner seed coat is much compressed and consists of several rows of small cells and a single row of large cells. The walls in both cases are not greatly thickened. The nucellus is much compressed. The cells of the endosperm are not much longer than broad. The cells of the outer row or the aleurone layer are much smaller than those of the second layer.

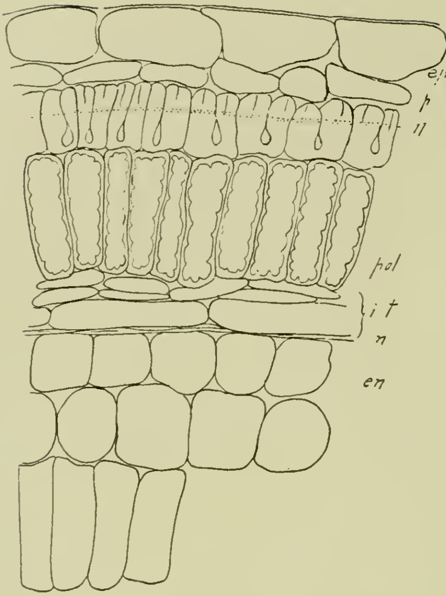

FIG. 424. Microscopic structure of the seed of common Geranium (*Geranium carolinianum*).

ep=epidermis. p=parenchyma, malpighian cells below. ll=light line of malpighian cells. pal=palisade cells. it=inner testa. n=nucellus. en=endosperm.

(Drawing by L. H. Pammel and Charlotte M. King.)

EUPHORBICEAE,* SPURGE FAMILY.

Flowering Spurge (*Euphorbia corollata* L.).

The outer layer of the seed coat is mucilaginous; the walls of the cells are thickened and colorless; showing stratification upon addition of water; the cell contents are dark in color. The granular layer beneath the mucilaginous cells is well developed; the contents give a blue reaction to iodine. Underneath the granular layer is a row of slightly elongated thin-walled parenchyma cells; beneath these are the long palisade-like cells, in which are pores of less prominence than in *E. marginata* and others. Next lie two compressed layers of thin-walled parenchyma cells.

Spotted Spurge (*Euphorbia preslii* Guss.).

The outer layer of cells are darkened; these cells are not mucilaginous. The palisade-like cells are present, as in all the species.

*The descriptions here given are from a paper by L. H. Pammel, Trans. Acad. Sci. St. Louis. 5:543. The literature will be found in this paper.

Prostrate Spurge (*Euphorbia maculata* L.).

The walls of the outer cells are dark in color; these cells are but slightly mucilaginous. The granular layer is not pronounced. The palisade-like cells resemble those of the other species.

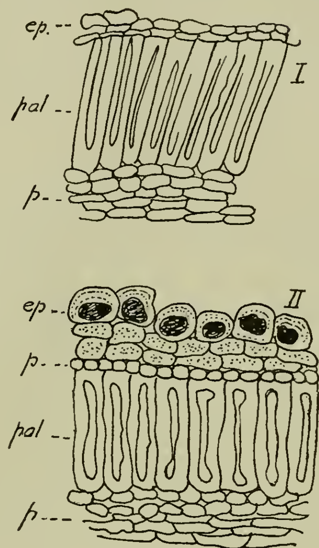

FIG. 425. Microscopic structure of the seeds of the Spurge family (*Euphorbiaceae*).
I. Cypress Spurge (*Euphorbia cyparissias*). II. Flowering Spurge (*Euphorbia corollata*).
ep=epidermis, in figure II cell-walls mucilaginous. pal=palisade cells. p=parenchyma cells.
(Drawing by L. H. Pammel.)

Yellow Spurge (*Euphorbia cyparissias* L.).

The seed shows the usual palisade-like cells with the overlying and underlying thin-walled parenchyma cells.

MALVACEAE, MALLOW FAMILY.

Velvet Weed, Butterprint (*Abutilon theophrasti* Medic.).*

The outer layer *a*, of the first integument is transformed into a strongly refractive layer. The second layer is composed of radially elongated cells. The seed hairs arise from a single cell and are large and conspicuous. The hairs are spindle-shaped and thin-walled; they occur mostly at the ends of the seed and are more or less pressed to it. There is little or no coloring matter in this in-

*From Rolfs, P. H., Bot. Gaz. 1892 :33-39.

tegument excepting in the base of the hair cells. The palisade cells, *c,* are narrow for their length. The cell cavity is not prominent and the nodosity is inconspicuous. The light line is narrow and occurs near the outer end of the palisade layer. The subpalisade portion, *d,* is made up of two layers of light brown cells. They are symmetrical and elongated tangentially.

Measurements, seed coats, 147μ; outer integument, 13μ; palisade layer, 96μ; subpalisade, 38μ.

Shoo-fly (*Hibiscus trionum* L.).

P. H. Rolfs has made a study of *H. militaris,* the microscopic structure of which species closely resembles that of *H. trionum.* The dark grayish seeds are roughened with tubercular processes, which contain the "seed hairs." The seed hairs consist of cells somewhat longer than broad beginning with a broad base, extending into a several-celled trichome, the terminal portion larger than remainder of cell. These hairs contain a yellow pigment. The Malpighian cells occupy about one-half the thickness of the testa, the cuticle is well developed, the light line is near the upper portion of the cell. The cell cavity is spindle-shaped and near the middle of the cell. The remainder of the testa consists of a subpalisade portion of parenchyma cells carrying a brownish pigment; underneath it, larger thin-walled cells; walls brownish, a compressed narrow, brownish layer, the nucellus, *n.* This is followed by the squarish cells of the endosperm.

Common Mallow (*Malva sylvestris* L.).

The surface of *M. sylvestris* is rough in appearance. The second layer, *b,* of the outer integument, *a,* has been compressed into a thin layer and seems to have no definite arrangement. The outer layer, *a,* has been elongated radially. In places, these elongated cells have divided forming a double layer of cells. There is no brown coloring matter in this integument nor is there any between the integuments. The palisade cells, *c,* are clear; the walls thick. The cell cavity occupies about one-third the length of the cells, the lower end reaching to the middle. The nodosity is prominent. Below the cavity the cells are clear, almost transparent. The subpalisade portion, *d,* is usually made up of two layers, at some places only one, of large dark brown cells.

Measurements, seed coats, 122μ; outer integument, 27μ; outer layer of same, 22μ; inner layer of same, 5μ; palisade layer, 70μ; subpalisade, 25μ. (P. H. Rolfs.)

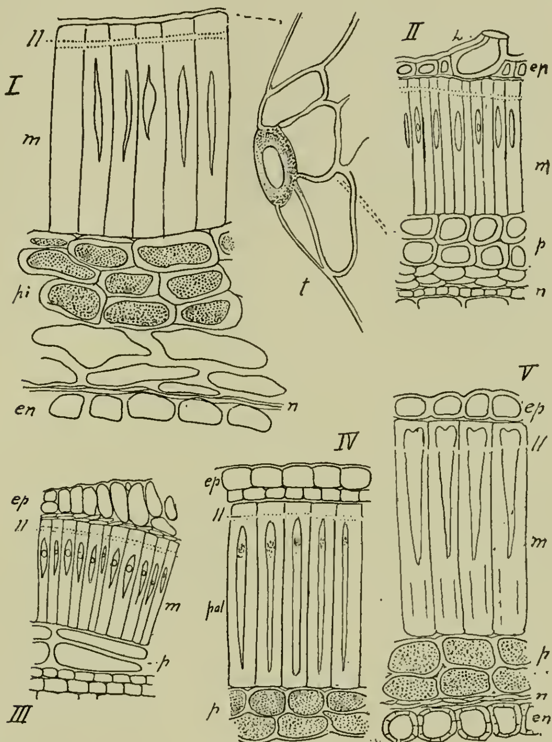

FIG. 426. Microscopic structure of the seeds of some Malvaceous weeds. I. Shoo-fly (*Hibiscus trionum*). II. Indian Mallow or Butterprint (*Abutilon theophrasti*). III. Mallow (*Malva sylvestris*). IV. Sida (*Sida spinosa*). V. Cheeses or common Mallow (*Malva rotundifolia*).
ep=epidermal cells. m=malpighian cells. ll=light line. pi=pigment layer. p=parenchyma cells. pal=palisade or malpighian cells. n=nucellus. en=endosperm. h=trichome. t=plant hair or trichome surface view
(Drawings by P. H. Rolfs.)

Cheeses or Mallow (*Malva rotundifolia* L.).

The roughened, somewhat velvety, dark grayish seeds consist of an outer row of rather large, rather thick-walled cells, walls colorless. This layer is followed by the very long Malpighian cells, which are longer than the cells of the rest of the testa, light line near the upper part of the cell, lower portion of cell slightly yellowish. Cavity spindle-shaped near the middle. The dark brownish pigment cells of two or three rows. Adjacent to the pigment layer is the colorless compressed nucellus and the squarish endosperm cells.

Sida (*Sida spinosa* L.).

The brownish seeds are minutely roughened. The Malpighian cells occupy more than one-half of the thickness of the testa, the cuticle is well developed, the light line occurs near the upper end of the cells. The cell cavity is spindle-shaped near the lower end of the cell. The subepidermal layer contains the brownish pigment, the walls of these cells are thickened; the parenchyma cells of the layer underneath are colorless, the walls are less thickened; a narrow pigment layer follows. The cells of the endosperm are thick-walled containing protein grains.

ONAGRACEAE, EVENING PRIMROSE FAMILY.

Evening Primrose (*Oenothera biennis* L.).

The small, irregular, winged seeds are rough. The epidermal cells, *ep,* of the testa are small, thick-walled with minute pore canals; the underlying parenchyma cells, *p,* are large, thick-walled and with small pore canals; these cells reach their greatest development where the wings occur. The remaining portion of the testa consists of four or five layers of cells more or less rectangular. The nucellus and the endosperm much compressed, outer epidermal cells of the embryo, *em,* thin-walled, a little longer than wide.

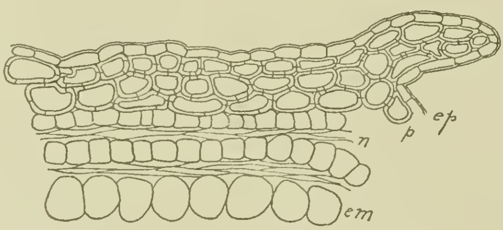

FIG. 427. Microscopic structure of the seed of Evening Primrose (*Oenothera biennis*).

ep=epidermis of thick-walled cells. p=thick-walled parenchyma underneath thinner-walled parenchyma. n=nucellus and below a few layers of cells of the endosperm.

(Drawing by Charlotte M. King and L. H. Pammel.)

UMBELLIFERAE, PARSLEY FAMILY.

Sweet Cicely (*Osmorrhiza longistylis* (Torr.) D. C.).

The epidermal cells are longer than broad, the outer walls are thickened, five to six rows of thin-walled parenchyma cells occur underneath the epidermal layer; the ribs contain the vascular elements, thick-walled sclerenchyma cells; the testa consists of a layer of thin-walled parenchyma cells, *p*, followed by a layer tangentially elongated and another of large parenchyma cells, p^1, and the compressed nucellus, *n*.[1] The endosperm consists of large thin-walled cells.

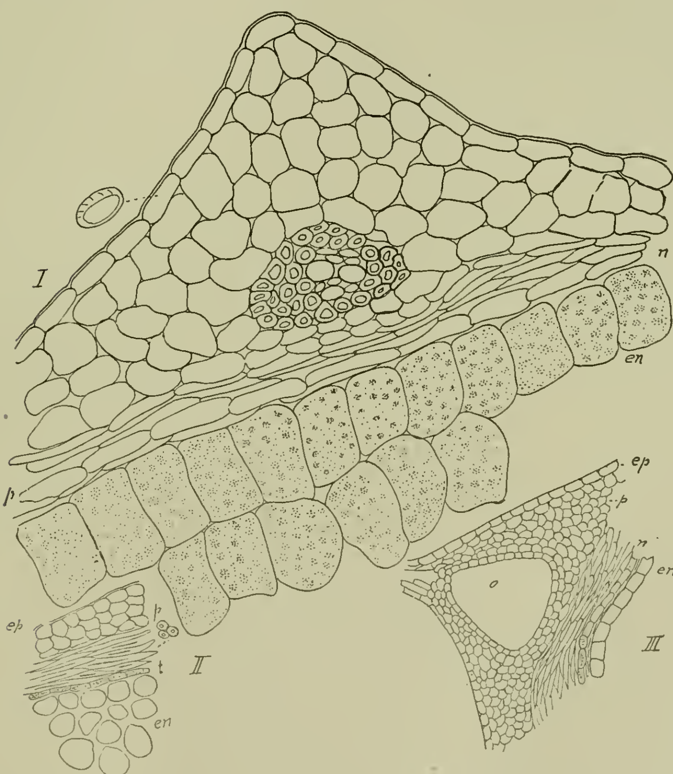

FIG. 428. Microscopic structure of some Umbelliferous weeds.
I. Sweet Cicely (*Osmorhiza longistylis*). II. Cow Parsnip (*Heracleum lanatum*). III. Wild Carrot (*Daucus carota*). Underneath, parenchyma cells, thick-walled sclerotic parenchyma, sectional view to the right.
n=nucellus. p=parenchyma. t=testa. en=endosperm. ep=epidermis. o=oil duct.

(Drawings by L. H. Pammel.)

Wild Carrot (*Daucus carota* L.).

The cremocarp consists of an outer epidermis of cells somewhat longer than broad; the underlying cells are of similar structure except the cells near the inner epidermis, which are much longer than wide; a large oil duct occurs in each rib. The testa consists of a single layer of parenchyma cells and a few rows of compressed elements, probably the nucellus. The endosperm of thin-walled parenchyma cells contains protein.

Cow Parsnip (*Heracleum lanatum*).

An outer epidermis with outer walls thickened. The underlying parenchyma cells similar, followed by a layer of thick-walled sclerenchyma cells. The testa of single layer of cells. The endosperm cells contain protein.

ASCLEPIADACEAE, MILKWEED FAMILY.

Milkweed (*Asclepias syriaca* L.).

The flattened reddish brown seeds consist of an epidermis of isodiametric cells; the outer walls wavy, and thickened; each cell with a projecting point, outer walls colorless, contents brownish; the epidermis is followed by 10-14 rows of thin-walled parenchyma cells containing a brownish pigment. This layer is followed by

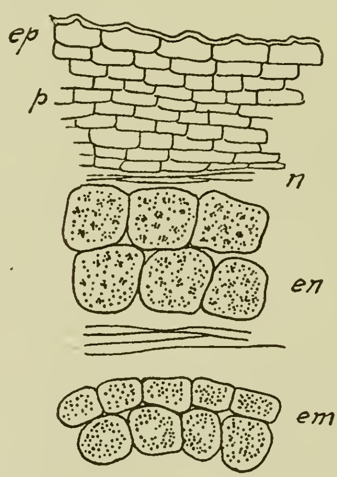

FIG. 429. Microscopic structure of the seed of Milkweed (*Asclepias syriaca*). ep=epidermis. p=parenchyma. n=nucellus. em=embryo. (Drawing by L. H. Pammel and Charlotte M. King.)

the compressed perisperm, brownish yellow in color. The endosperm consists of thickish-walled, colorless parenchyma cells, the outer row smaller than the underlying, the inner layer of smaller elongated cells. The contents consist of protein and fat. The inner epidermal cells of the embryo are smaller than the endosperm cells; they contain protein and fat.

CONVOLVULACEAE, CONVOLVULUS FAMILY.

European Bindweed (*Convolvulus arvensis* L.).

The testa consists of an outer row of short or elongated cells *p* with thick walls and brownish contents. This is followed by a layer of small cells with colorless walls. Contents brownish. The Malphighian cells *m* are situated underneath. This is followed by a layer of parenchyma cells consisting of 8-12 rows of cells. The endosperm consists of thick-walled colorless cells. The walls in part mucilaginous.

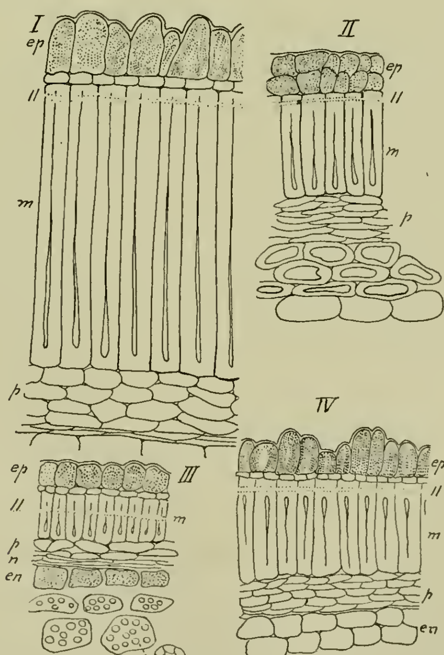

FIG. 430. Microscopic structure of the seeds of *Convolvulaceae*.
I. Morning-glory (*Convolvulus sepium*). II. Cultivated Morning-glory (*Ipomoea purpurea*). III. Dodder (*Cuscuta epithymum*). IV. Bindweed (*Convolvulus arvensis*).
ep=epidermis. m=malpighian cells. ll=light line. p=parenchyma. n=nucellus. en=endosperm.
(Drawings by L. H. Pammel and Charlotte M. King.)

Wild Morning Glory (*Convolvulus sepium* L.).

The testa of the seed of the common morning glory consists of an outer layer of elongated cells containing the blackish pigment followed by the Malpighian cells with small cell cavity and prominent light line. The colorless parenchyma cells are thick-walled followed by a compressed indistinct layer, the compressed nucellus and the endosperm cells.

Cultivated Morning Glory (*Ipomoea purpurea* (L.) Roth.).

The black-brownish seeds are rough. The testa consists of a superficial layer of cells with granular brownish contents. The Malpighian cells *m* occur underneath; the light line is near the upper part of the cell, cell cavity small. The cells of the parenchyma layer are compressed. The cells of the endosperm are thick-walled and somewhat mucilaginous.

Dodder (*Cuscuta epithymum* Murr.).

The small seeds are minutely roughened and velvety. The outer layer of the testa consists of large cells with yellowish contents, the following layer consists of thick-walled cubical or prismatic cells *p,* the colorless Malpighian cells *m* follow. They are elongated with a small cell cavity. The layer following consists of compressed cells, tangentially elongated. The endosperm layer consists of an outer aleurone layer of nearly square cells. The cells below are irregular. The endosperm cells contain compound or simple starch grains and protein.

BORAGINACEAE, BORAGE FAMILY.

Wild Comfrey (*Cynoglossum virginianum* L.).

The rough fruits are covered with hooked appendages, the sides roughened with small colorless points; the epidermal layer is irregular and prominent, in some cells developed into short trichomes, whose walls are greatly thickened. The epidermal walls and contents are blackish, the underlying sclerotic parenchyma cells have thick walls and are blackish. The parenchyma cells of the testa are thinner walled and colorless, followed by the compressed layer of the nucellus *n.* The endosperm cells are longer than broad, colorless, contain protein and fat.

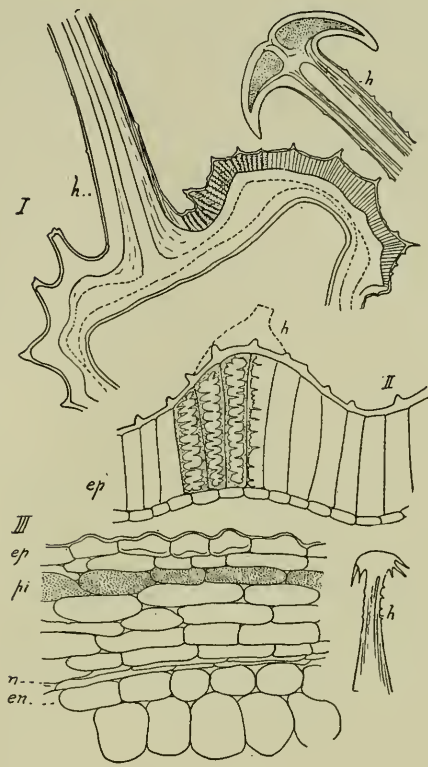

FIG. 431. Microscopic structure of some fruits of the Borage Family (*Boraginaceae*).

I. Stickseed (*Lappula echinata*) part of fruit or bur. II. Stickseed (*Lappula echinata*). Enlarged view of epidermal cells showing irregularities in cell wall and cavity. III. Wild Comfrey (*Cynoglossum virginianum*).
ep=epidermal cells. n=nucellus. pi=pigment layer. en=endosperm. t=trichomes.

(Drawings by L. H. Pammel and C. M. King.)

Stickseed (*Lappula echinata* Gilibert).

The fruits are rough and provided with hooked appendages, the cells of the appendages are elongated, thick-walled, the walls colorless; the cells of the epidermis toward the exterior are very irregular with projecting rounded or sharp points, walls colorless. The epidermal cells are elongated with central cell cavity and prominent pore canals at right angles with the cell cavity, these having the appearance of a series of cells one above the other. The epidermal cells contain a brownish pigment, the underlying parenchyma cells are thinner walled and also contain a brownish pigment. The testa is thin, consisting of thin-walled parenchyma cells with granular contents.

VERBENACEAE, VERVAIN FAMILY.

Hoary Vervain (*Verbena stricta* Vent.).

Epidermal cells thick-walled; outer cells colorless. Underneath this lie several layers of pigmented cells, slightly longer than broad. This layer is followed by rather thick-walled, colorless cells, with small cell cavity; one or two rows toward the middle are thick-walled and smaller. Next follow the cells of the embryo.

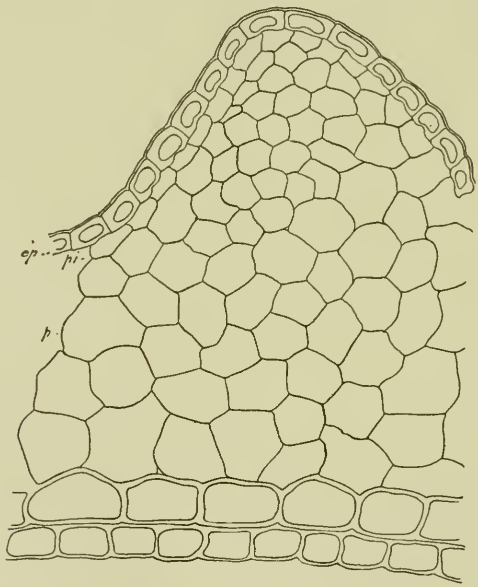

FIG. 432. Miscroscopic structure of seed and fruit of Vervain (*Verbena stricta*). ep=epidermis, thick-walled. p=parenchyma layer. pi=pigment layer of small parenchyma cells. The two inner layers of cells of the testa. (Drawings by L. H. Pammel and Charlotte M. King.)

LABIATAE, MINT FAMILY.

Catnip (*Nepeta cataria* L.).

The small dull brown seeds are finely roughened. The pericarp consists of an epidermal layer with thin cuticle, on the addition of water becoming mucilaginous. This layer is followed by underlying parenchyma cells, then the Malpighian cells with conspicuous light line. The cells are colored yellowish brown; underlying this, the testa, consisting of a single layer of cells, thin-walled. The nucellus of whitish, elongated, rather thick-walled cells, the endosperm differentiated into an outer layer of larger parenchyma and a compressed inner layer of thick-walled cells. The epidermal cells of the embryo nearly isodiametric, contain protein and fat. The epidermal cells of the upper epidermis nearly like the lower, palisade parenchyma underneath.

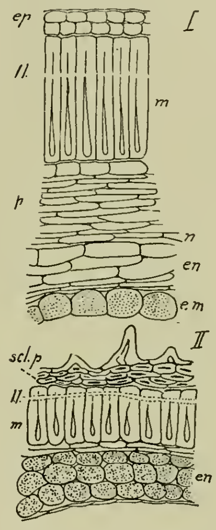

FIG. 433. Microscopic structure of seeds of the Mint Family (*Labiatae*). I. Catnip (*Nepeta cataria*). II. Giant Hyssop (*Agastache scrophulariaefolia*). ep=epidermis, underneath, parenchyma cells in I and sclerotic parenchyma in II, the epidermal cells irregular showing some trichomes. scl=sclerotic parenchyma. en=endosperm. m=malpighian cells. n=nucellus. ll=light line. p=parenchyma. em=embryo.
(Drawings by L. H. Pammel and C. M. King.)

Giant Hyssop (*Agastache scrophulariaefolia* (Willd.) Ktze.).

The small pubescent nutlet consists of the epidermal cells of the pericarp with small unicellular thickened trichomes; cells contain a brownish pigment; the cells of the layer underneath are thick-walled, cell wall and cavity contain a brownish pigment. The Malpighian layer follows, the cells being longer than wide, the light line near the upper part of the cell. These cells are yellowish. The testa is compressed and consists of elongated cells, brownish in color. The endosperm varies in thickness, the cells are in some cases elongated, in others squarish, and contain fat and protein material.

SOLANACEAE, NIGHTSHADE FAMILY.

Horse Nettle (*Solanum carolinense* L.).

The testa consists of an outer row of cells whose walls are mucilaginous; the underlying cells are thick-walled with intervening air spaces broad below and narrow above. The cells of this layer contain the yellow pigment. The underlying parenchyma layer is compressed, composed of colorless cells which are longer than wide; the layer adjacent to the endosperm is compressed and not clearly defined. The cells of the inner portion of the endosperm are smaller and contain protein. Cells of embryo are small and contain protein.

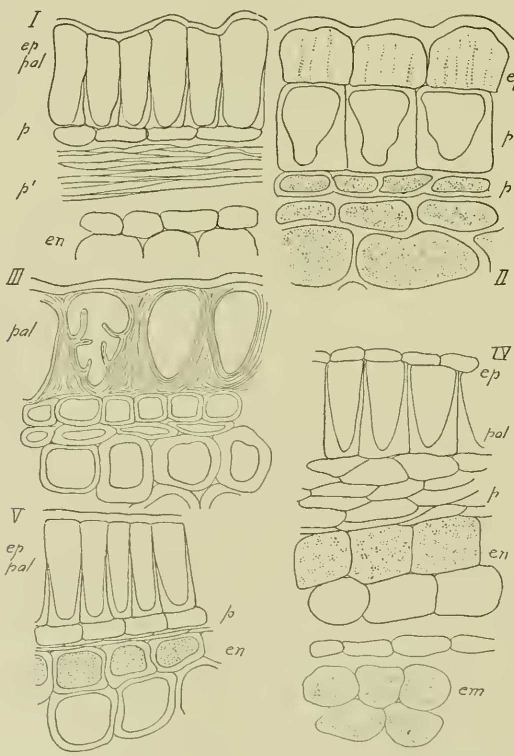

FIG. 434. Microscopic structure of the seeds of some Solanaceous weeds. I. Jimson Weed (*Datura stramonium*). II. Black Nightshade (*Solanum nigrum*). III. Buffalo Bur (*Solanum rostratum*). IV. Horse Nettle (*Solanum carolinense*). V. Ground Cherry (*Physalis pubescens*).
ep=epidermis. en=endosperm. pal=palisade cells. em=embryo. p=parenchyma. p^1= elongated parenchyma cells.
(Drawings by L. H. Pammel and C. M. King.)

Buffalo Bur or Spiny Nightshade (*Solanum rostratum* Dunal).

The black seeds are irregular on the surface, which is mucilaginous; the underlying layer consists of thick-walled cells with large cavities into which thickened processes extend; the third layer is also pigmented and consists of squarish cells or elongated, compressed elements. The endosperm is composed of thick-walled cells, the outer nearly square, the others elongated. Starch absent; protein present. The cells of the embryo are smaller, thin-walled and contain protein and fat.

Black Nightshade (*Solanum nigrum* L.).

The surface of the yellowish seeds is slightly irregular. The superficial layers consist of mucilaginous, parenchyma cells, followed by large parenchyma cells with thickened folds. These cells are, however, variable as to structure and are sometimes short with folds not evident. The elongated, thick-walled portion of the testa contains the yellowish pigment. The cell cavity is triangular. The second layer of parenchyma cells is compressed.

Jimson Weed (*Datura stramonium* L.).

The blackish seeds are rough, surface irregular, cells and walls of epidermis *ep* thick; the underlying thinner-walled cells *p* are small, longer than broad, followed by an indistinct layer p^1, whose walls are not clearly defined. The layer adjacent to the endosperm consists of somewhat larger cells also thin-walled. The endosperm cells *e* are large, containing protein.

Ground Cherry (*Physalis pubescens* L.).

The epidermal cells are thick-walled, the outer walls colorless. These cells contain the pigment. The parenchyma cells of the second layer are elongated; an indistinct compressed layer follows. The outer row of the endosperm cells are smaller, containing protein.

A discussion of the seed coats of this family is to be found in Harz, Samenkunde, 2 996-1025.

SCROPHULARIACEAE, FIGWORT FAMILY.

Mullein (*Verbascum thapsus* L.).

The minute, roughened seeds are irregular. The epidermal cells are dark colored, longer than broad and thick-walled. The epidermal layer is followed by one or more layers of parenchyma cells, more numerous in the micropilar region; an indistinct and compressed layer with large intercellular spaces follows, these corresponding to the irregularities on the surface, smaller intercellular

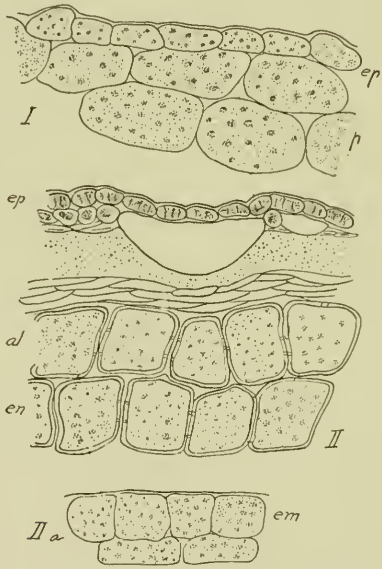

Fig. 435. Microscopic structure of the seeds of the Figwort family (*Scrophulariaceae*).
I Moth Mullein (*Verbascum blattaria*). II. Common Mullein (*Verbascum thapsus*).
ep=epidermis. p=parenchyma. al=aleurone layer. en=endosperm. em=embryo.
(Drawings by L. H. Pammel and Charlotte M. King.)

spaces occurring between the larger. The nucellus is compressed, showing remnants of cell walls. The endosperm consists of an outer aleurone layer, the walls with pore canals; this is followed by cells of the same character. The cells of the embryo are smaller. The testa of *Verbascum blattaria* in an undeveloped seed consists of the epidermal cells with chlorophyll and the underlying much larger cells also with chlorophyll.

PLANTAGINACEAE, PLANTAIN FAMILY.

Common Plantain (*Plantago major* L.).

The small, yellowish brown seeds consist of an epidermal layer of thick black-brownish seeds. The walls on the addition of water become mucilaginous and expand. The cell cavity is small. The epidermal layer is followed by several layers and small parenchyma cells. These cells are usually somewhat compressed and brownish in color. The pigment layer and endosperm consist of an outer layer of aleurone cells smaller than the underlying cells. These cells contain protein grains and starch; the walls have small pore canals.

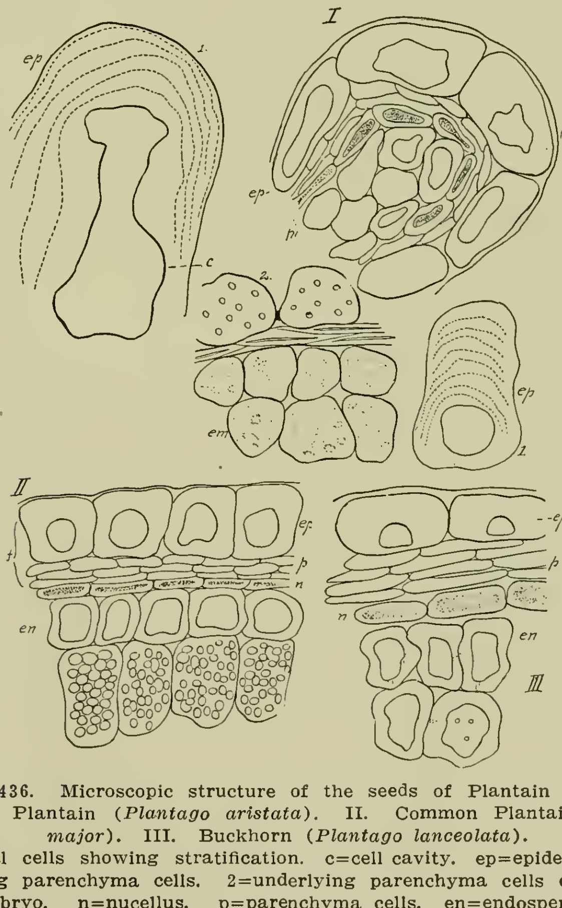

FIG. 436. Microscopic structure of the seeds of Plantain family. I Bracted Plantain (*Plantago aristata*). II. Common Plantain (*Plantago major*). III. Buckhorn (*Plantago lanceolata*).
1=epidermal cells showing stratification. c=cell cavity. ep=epidermis. pi=underlying parenchyma cells. 2=underlying parenchyma cells of the testa. em=embryo. n=nucellus. p=parenchyma cells. en=endosperm.
(Drawings by L. H. Pammel and C. M. King.)

Buckhorn (*Plantago lanceolata* L.).

The smooth, brownish, elongated seeds consist of epidermal cells with a small cavity and thick walls; the outer walls become mucilaginous on the addition of water. The underlying cells are thin, blackish, elongated, followed by a brown pigment layer as in the last species. The aleurone cells and remaining endosperm cells are of about the same shape and size; the walls are provided with small pore canals.

Bracted Plantain (*Plantago aristata* Mx.).

The seeds of this are similar in structure to those of *P. lanceolata*. The walls of the epidermal cells are mucilaginous. The underlying parenchyma cells and the underlying pigment layer are followed by the endosperm and embryo. The cells of the nucellus are narrow, elongated, and thick-walled. The cells of the embryo are isodiametric and are thin-walled. Several species of the genus have been studied by Harz*. Numerous earlier papers and references will be found in Pammel's article in Transactions St. Louis Academy of Science, 9 :91.

RUBIACEAE, MADDER FAMILY.

Bedstraw (*Galium aparine* L.).

The dry fruit of the common bedstraw is provided with hooked prickles. The epidermal cells are somewhat elongated, brownish. The trichomes consist of single hooked cells with pitted walls. The underlying thin-walled parenchyma cells are elongated. Harz observed mucilaginous cells in this portion of the pericarp. The testa is very much reduced, consisting of several layers of thin-walled cells with granular contents. The endosperm consists of an aleurone layer, thick-walled cells followed by a thick-walled irregular layer of cells with pore canals. Contents consist of protein grains.

*Samenkunde 2 ; 983.

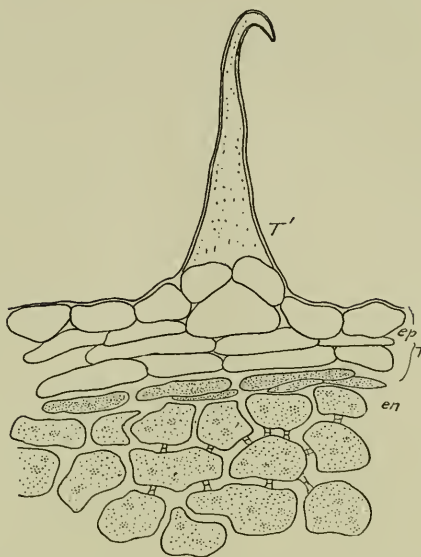

FIG. 437. Microscopic structure of fruit of Bedstraw (*Galium aparine*). ep=epidermis. t=testa. t^1 =trichome. en=endosperm. (Drawing by L. H. Pammel and Charlotte M. King.)

CUCURBITACEAE, GOURD FAMILY.

Wild Cucumber (*Sicyos angulatus* L.).

The testa of the brownish seeds consists of elongated epidermal cells with narrow cell cavities; walls thickened, with pore canals. The underlying portion consists of a layer of one or two rows of cells with thin walls, and protein contents; the remaining portion of the testa is composed of thin-walled cells with large intercellular spaces. The related species, *Echinocystis lobata*, contains a thick, pigment layer of brownish sclerotic parenchyma followed by a thinner layer of thick-walled cells with blackish brown pigment. In this species, as in *Sicyos angulatus,* frequently portions of the fruit adhere to the surface. The seed coats of this family have been described by Harz.

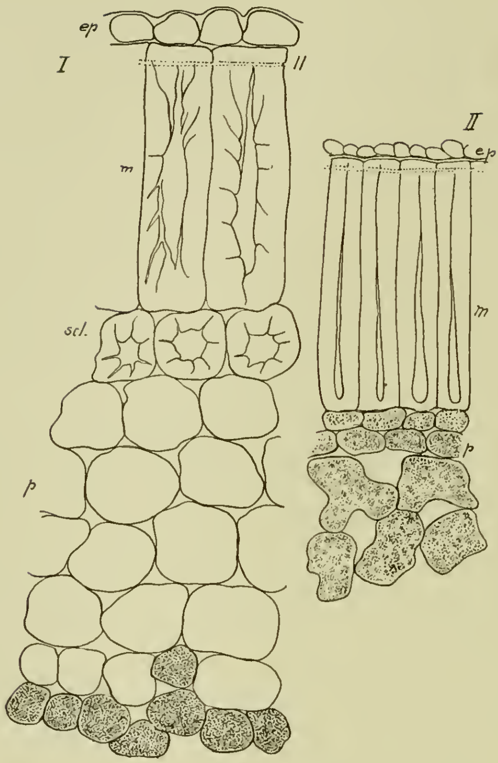

FIG. 438. Microscopic structure of seeds of some cultivated weeds. I. Wild Cucumber or Wild Balsam Apple (*Echinocystis lobata*). II. Bur Cucumber (*Sicyos angulatus*).
ep=epidermis. ll=light line. p=parenchyma. m=malpighian layer. scl=sclerotic cells.
(Drawings by L. H. Pammel and C. M. King.)

COMPOSITAE, COMPOSITE FAMILY.

Large Ragweed (*Ambrosia trifida* L.).

The so-called "seed" consists of an involucre of rather thick-walled sclerotic parenchyma cells, occurring underneath the epidermis; some of these cells are radially elongated, others are spherical in cross section, showing numerous pore canals. The internal layer of the involucre is composed of nearly isodiametric, thick-walled, sclerotic cells. The testa consists of a layer of brownish colored cells followed by a layer containing black pigment. Next within lies a layer of thick-walled, small, nearly colorless cells, then the compressed layer of the nucellus, followed by the nearly square cells of the embryo.

Common Sunflower (*Helianthus annuus* L.).

The microscopic structure of the fruit and seed has been studied by Hanausek, Harz, Winton and Moeller. The obovoid achenes are more or less four-sided. The pericarp in some varieties is nearly black, in others it is striped with white and black. The pericarp consists of thin porous walls which are dark colored in the black seeded varieties, although in the varieties with striped seeds only a part of the cells are colored. Some of the cells are elongated, forming duplex hairs, which are attached to what Hanausek called the "foot cell." The underlying hypodermal cells of 4-6 rows of cells are thick-walled and porous, the cells arranged in rows. These contain the blackish pigment, pitchlike in character. The third layer consists of thick-walled sclerotic parenchyma cells. These cells are more or less isodiametric. This layer contains the fibrovascular bundles which occur adjacent to the thin-walled parenchyma cells. Extending into the sclerotic parenchyma are radial rows of thinner-walled parenchyma cells. This layer is followed by large thin-walled parenchyma cells. The testa consists of thin-walled loose parenchyma cells. The outer or epidermal cells are roundish and have obscurely beaded walls; the spongy parenchyma follows and contains the fibrovascular bundles. The spongy parenchyma is followed by the rectangular cells of the inner epidermis. The endosperm consists of one or two rows of aleurone cells. The epidermal layer of the embryo consists of small, rather thin-walled cells of the cotyledons and underneath this on the upper surface are several rows of palisade cells. These cells contain irregular spherical aleurone grains larger than those in the epidermal cells.

Crownbeard, (*Verbesina helianthoides* Mx.).

The microscopic structure of the achene includes a series of small, rather thick-walled epidermal cells, followed by elongated or short, rather thick-walled parenchyma cells. The pigment layer is composed of thick-walled cells, whose walls contain a blackish pigment. The testa consists of two layers; an outer of elongated, thick-walled cells and an inner layer of shorter cells also colorless. The cells of the embryo are much larger and contain protein grains.

Boot-jack, Spanish Needle (*Bidens discoidea* (T. & G.) Britton).

The pericarp consists of an outer epidermal layer underlaid by a similar layer of elongated, thick-walled cells; between which are thinner-walled parenchyma cells. The outer layer of the testa is composed of nearly isodiametric cells, followed by larger thick-walled parenchyma cells; cells of the lower portion compressed. The endosperm is much reduced, of elongated cells; embryo with row of outer cells longer than broad.

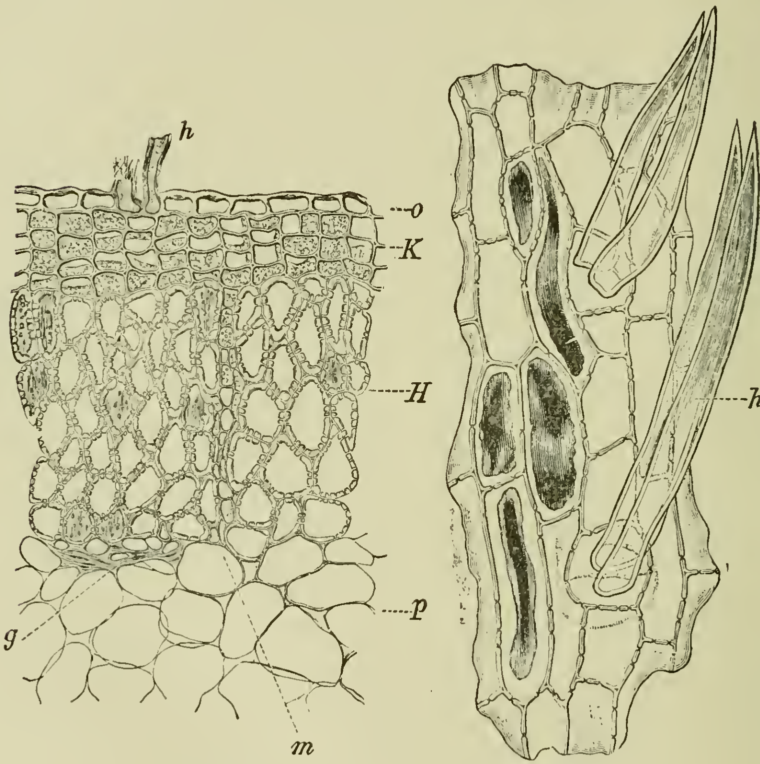

Fig. 439A Fig. 439 B

FIG. 439. Sunflower (*Helianthus annuus*).
A. Cross section of outer layers of pericarp. o, epicarp with h, hairs; K, hypoderm; H, fiber bundles separated by m, parenchyma; p, parenchyma with g, fibro-vascular bundles. X 160.
B. Epicarp with h, twin hairs, in surface view.
After Winton.

Burdock (*Arctium lappa* L.).

The brownish mottled fruits consist of a thick-walled pericarp, the outer epidermal layer of thick-walled cells, walls colorless or but slightly colored; the underlying layer of six or eight rows of thick-walled cells, not as thick, however, as the epidermal cells. The first layer carries the brownish or blackish brown pigment.

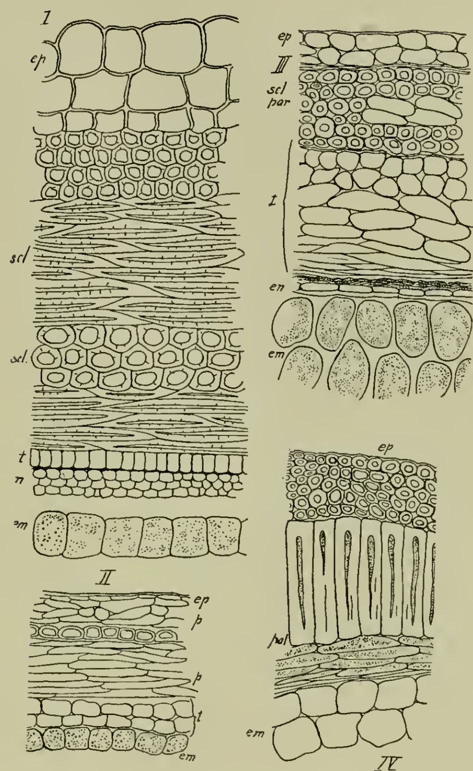

FIG. 439A. Miscroscopic structure of some weeds of the Sunflower family (*Compositae*).

I. Small Ragweed (*Ambrosia artemisiaefolia*). II. Verbesina (*Verbesina helianthoides*). III. Spanish Needle (*Bidens discoidea*). IV. Burdock (*Arctium lappa*).

ep=epidermis. scl=sclerotic parenchyma. t=testa. n=nucellus. en=endosperm. em=embryo. pal=palisade cells.

(Drawings by L. H. Pammel and Charlotte M. King.)

The pigment layer is followed by elongated sclerotic parenchyma with a narrow cell cavity; cells with granular contents. The testa is thin, cells elongated, cell wall thickened slightly, tinged with yellow. The testa is followed by remnants of the nucellus. The parenchyma cells of embryo follow the nucellus.

Wood or Field Thistle (*Cirsium discolor* (Muhl.) Spreng.).

The microscopic structure of the yellowish gray seeds shows a clear relationship to *Arctium;* the outer epidermal layer of the pericarp consists of thick-walled colorless cells, the walls bright and lustrous; the pigment layer underneath the walls, not nearly as thick-walled as the epidermal, pigment yellowish. The elongated sclerotic parenchyma cells are yellowish white or nearly colorless; this layer is followed by the parenchyma cells of the testa and remnants of the nucellus. The parenchyma cells of the embryo with numerous small intercellular spaces contain protein and fat. The fibrovascular bundles are located one at each end of the achene.

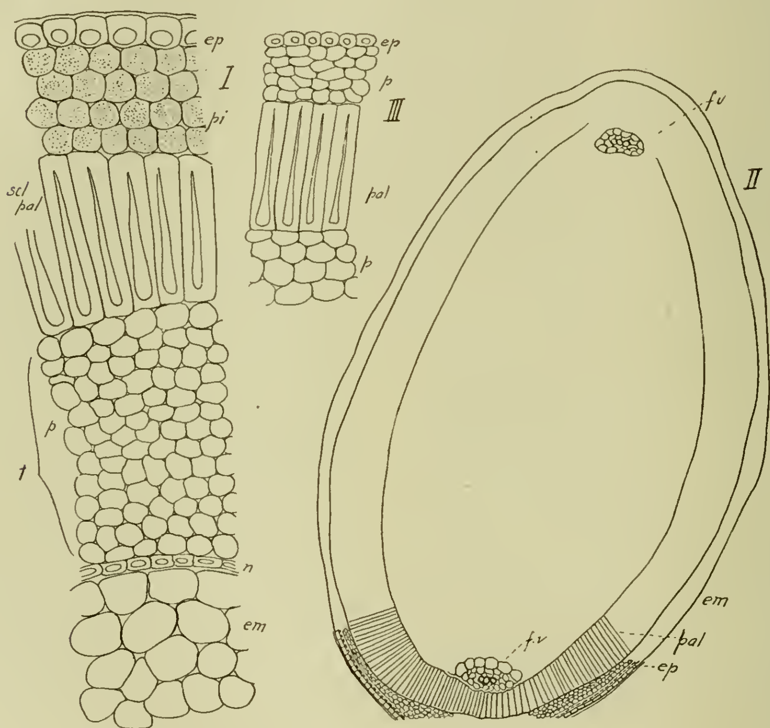

FIG. 440. Microscopic structure of the seeds of Thistles (*Cirsium*). I. and II. Common Wood Thistle (*Cirsium discolor*). III. Iowa Thistle (*Cirsium ioense*).

ep=thick-walled epidermal cells. pi=pigment layer. scl=sclerotic palisade cells with narrow cell-cavity. p=parenchyma cells of testa. t=testa. n=nucellus. em=embryo. fv=fibro-vascular bundles.

(Drawings by L. H. Pammel and Charlotte M. King.)

Iowa Thistle (*Cirsium ioense* (Pammel) Fernald).

The microscopic structure of the seeds is similar to that of preceding, comprising a thick-walled epidermal layer with bright colored walls and underlying pigment layer, an elongated sclerotic parenchyma and the testa of small parenchyma cells.

Chicory (*Cichorium intybus* L.).

The microscopic structure of the pericarp and seed of chicory has been given by Harz and Lavialle. The pericarp consists of epidermal cells whose outer walls are irregular and cuticularized. This is followed by a variable number of rows, usually 10-15, of sclerotic parenchyma, some of the cells of which as observed by

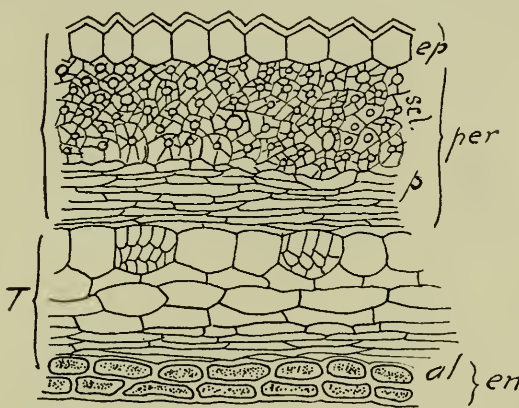

FIG. 441. Microscopic structure of the seed of Chicory (*Cichorium intybus*). ep=epidermis. scl=sclerotic parenchyma. per=pericarp. t=testa. al=aleurone layer. en=endosperm.
(Drawing by Charlotte M. King and L. H. Pammel.)

Kraus, contain crystals of calcium oxalate. Beneath are 6-8 rows of thin-walled, elongated parenchyma. The testa consists of a layer of large epidermal cells, followed by smaller thin-walled parenchyma, the inner portion much compressed. The aleurone layer is of elongated cells containing aleurone grains.

Dandelion (*Taraxacum officinale* Weber).

Harz has given an account of the structure of the pericarp and seed. The epidermal cells are irregular, many of the cells prolonged into one-celled trichomes, the ribs forming tubercular processes. The underlying portion containing the thinner-walled parenchyma and the sclerotic parenchyma cells of the ribs. This is followed by several rows of compressed, elongated, thin-walled parenchyma cells. The testa consists of the epidermal layer of elongated, spirally thickened walls, followed by a compressed layer of parenchyma cells. The endosperm of one or two rows of aleurone cells.

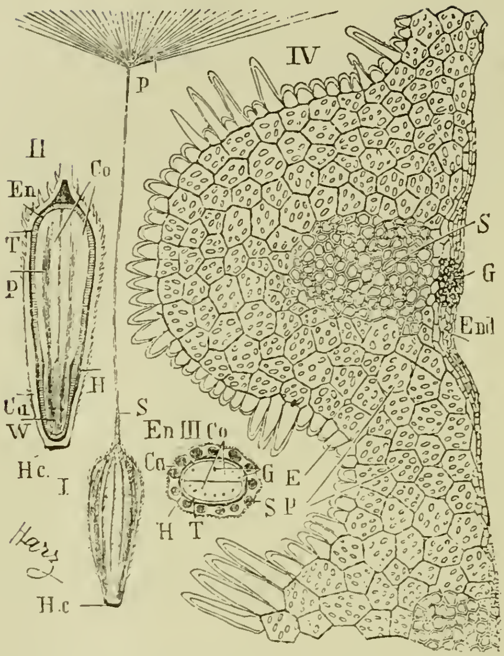

FIG. 442. Dandelion (*Taraxacum officinale*).

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CHAPTER IV.

MORPHOLOGY OF LEAVES AND FLOWERS

By

J. N. MARTIN

CHAPTER IV.

LEAVES.

INTRODUCTORY STATEMENT.

Leaves are distinguishable into primary and secondary. The primary leaves arise directly from the first cells produced by the division of the fertilized egg and in seed plants are called cotyledons. They are usually transient, and not rarely are so distorted by acting as storage places for reserve food that they do not function as foliage leaves at all. The secondary leaves arise upon the sides of the stem and are the ordinary foliage leaves of the plant. They are very important organs in connection with the work of nutrition.

PARTS OF A LEAF.

In the typical foliage leaf there are three parts—the expanded portion which is called blade or lamina, the leaf stalk (petiole), and a pair of appendages at the base of the petiole known as stipules.

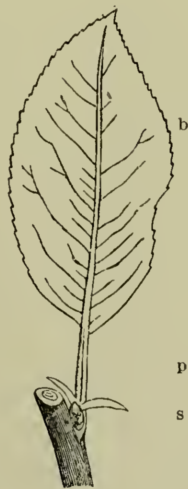

FIG. 443. Apple leaf; b, blade; p, petiole; s, stipules. (After Thomé.)

In some cases, as in the Hare's-ear mustard, (*Conringia orientalis*) and in the upper leaves of Canada thistle (*Cirsium arvense*) the petiole is absent and the blade is directly attached to the stem. Such leaves are designated as sessile.

FIG. 444. Sessile leaf of Thistle. (After Thomé.)

The stipules are small leaf-like structures which appear at the place where the leaf is attached to the stem. They are very often absent but are conspicuous in the cinquefoils, vetches and other members of the rose and pulse families.

VEINING.

The blade of the leaf is traversed by a frame work of fibrovascular bundles known as veins. In the leaves of grasses, sedges, and rushes, the veins run more or less parallel from the base to the tip of the leaf. These leaves are the *parallel-veined* type. In the leaves of most of our common weeds, the veins are branched so as to form a network. These are the *netted-veined type.*

Palmate and pinnate veining.—Netted-veined leaves are palmately veined when the primary ribs radiate from the base of the petiole as in the great ragweed. If there is only one midrib from which smaller ribs extend both ways, as in dandelion, dock, goldenrod, etc., the veining is said to be pinnate (meaning featherlike).

LEAF ARRANGEMENT.

Sometimes as in dandelion and evening primrose, the stem does not appear above ground or is late in appearing and the leaves at the surface of the ground are called *radical* leaves in distinction to the stem or *cauline* leaves.

Fig. 445I

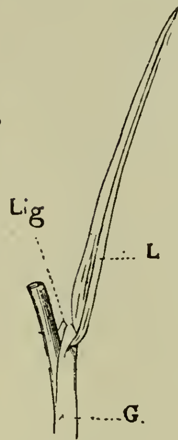

Fig. 445II

FIG. 445. I. Vetch. (*Lathyrus aphaca*), showing opposite leaves; r, tendril; b, flower; f, fruit. Stipules performing the function of leaves.
II. Grass type of leaf; L, leaf blade; G, leaf sheath; Lig, ligule. (After Thomé.)

Leaves are usually arranged so as to secure the best exposure to the light. In the milkweed there is a pair of leaves at each node and the two leaves are on opposite sides of the stem. Here the leaves are said to be *opposite*.

FIG. 446. The clinging stem of the Bindweed, showing the alternate leaves. (After Thomé.)

In the asters, ironweed, goldenrods, lamb's quarter, etc., there is only one leaf at each node, and they are spoken of as *alternate.* In some cases several leaves appear at each node in a whorl. Such examples of *whorled* or verticillate leaves are found in the bedstraws and Joe Pye weed.

BRANCHING.

The outline of a blade is extremely various. When the general outline is completely filled out and the margin represents an even line, the leaf is said to be *entire.* Examples of such leaves are found in water pepper (*Polygonum hydropiper*), mild water pepper (*P. hydropiperoides*), Pennsylvania smartweed (*P. pennsylvanicum*), etc.

Fig. 447. Leaf of the Privet plant showing entire margin.

To designate the amount and character of the branching, the following terms are used:

Fig. 448I Fig. 448II Fig. 448'II Fig. 448IV

Fig. 448. I. Triangular. lobed leaf of the Notch-weed. II. The reniform or kidney-shaped leaf of Ground Ivy, illustrating wavy margin. III. Arrow-shaped leaf of Bindweed. IV. Spear-shaped leaf of Sorrel. (After Thomé.)

Wavy margin, when the margin forms a wavy line bending slightly inward and outward in succession, as in the bitter dock (*Rumex obtusifolius*).

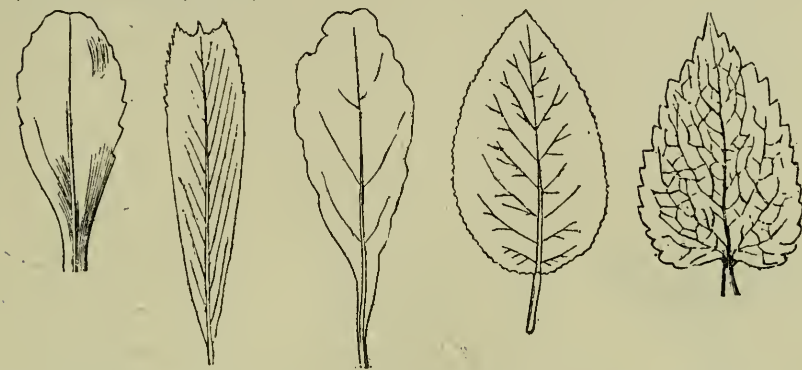

Fig. 449 I Fig. 449 II Fig. 449 III Fig. 449 IV Fig. 449 V

FIG. 449. I. Leaf of Daisy, spatulate in shape with a serrate margin. II. Spiny-pointed, serrulate leaflet of alfalfa. III. Wavy-margined leaf of Pigweed (*Amaranthus*). IV. Ovate, dentate leaf of Snowball. V. Serrate leaf of Hen-bit.

(After Thomé.)

Toothed or *dentate,* when the margin is cut into sharp teeth and the teeth point out, as in the lower leaves of the daisy fleabane (*Erigeron annuus*).

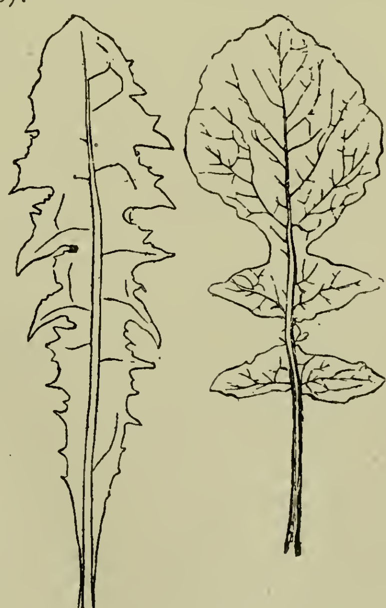

FIG. 450. Cleft and pinnatifid leaves of Wild Lettuce.
(After Thomé.)

Serrate, when the teeth point forward, as in the common sunflower (*Helianthus annuus*).

Serrulate, when the margin is finely serrate as in milk purslane (*Euphorbia maculata*).

Crenate, when the teeth are broad and rounded as in the common mallow (*Malva rotundifolia*).

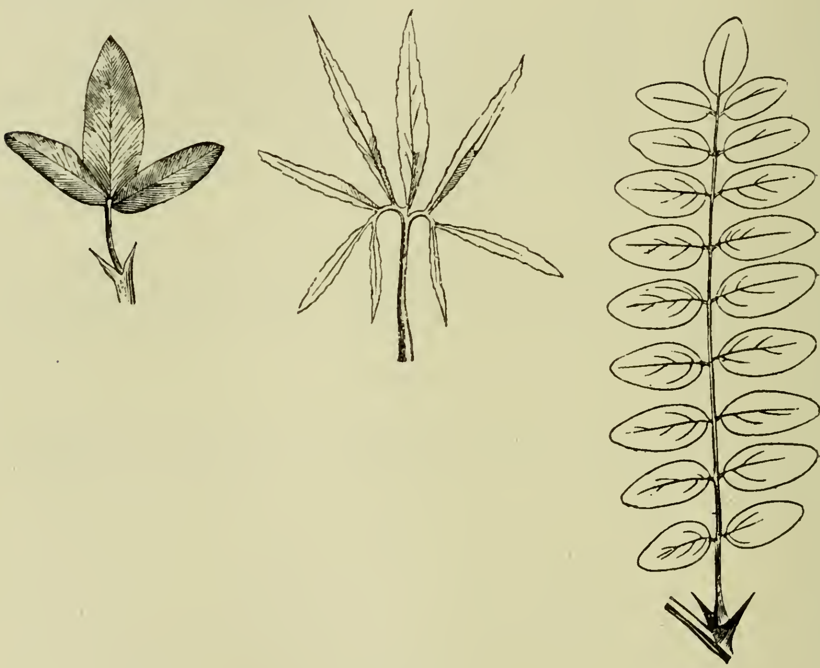

Fig. 451 I Fig. 451 II Fig. 451 III

Fig. 451. Compound leaves. I. Leaf of Clover with three leaflets. II. Pedately divided leaf of Dragon Root. III. Pinnate leaf of Locust with 19 leaflets.

(After Thomé.)

Lobed, when the leaf is deeply cut, as in the great ragweed. The projecting portions are then called lobes. When the incisions are sharp the term *cleft* is often used; the leaf is *pinnatifid* when the incision extends almost to the midrib, as in the prickly lettuce (*Lactuca scariola*); it is *pinnate* when the incisions have extended to the midrib and each separated portion takes the character of a leaf. Each of the smaller portions is a leaflet, and the leaf is now considered compound. The spotted cowbane (*Cicuta maculata*), spring vetch (*Vicia sativa*) and cinquefoil (*Potentilla monspeliensis*) are good examples.

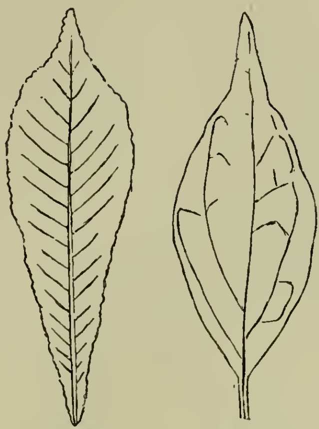

FIG. 452. I. Wedge-shaped leaflet of Horse Chestnut. II. Pointed leaf of the Wall Pellitory.
(After Thomé.)

All of the above marginal characters may characterize the lobes of a simple leaf or the leaflets of a compound leaf.

LEAF STRUCTURE.

Before considering the work of the leaf it will be necessary to become acquainted with its structure.

The leaf is covered with an epidermis which is composed of compact layers of cells, so modified as to protect the more delicate inner parts. The epidermis may be peeled off as a delicate transparent skin. A microscope shows that this transparent skin is made up of many cells, so closely fitted together as to make a continuous sheet or covering. Many slitlike openings between two crescent-shaped cells (*guard cells*) appear quite evenly distributed in the epidermis. The opening and guard cells constitute the stoma (plural stomata) which really means mouth. These numerous openings are passage ways into the interior of the leaf and permit interchange of gases between outside air and the air in the leaf interior. The guard cells can change their shape and so vary the size of the opening. In horizontal leaves the stomata are chiefly and sometimes exclusively on the lower surface, a fair average number being about 62,500 to the square inch.

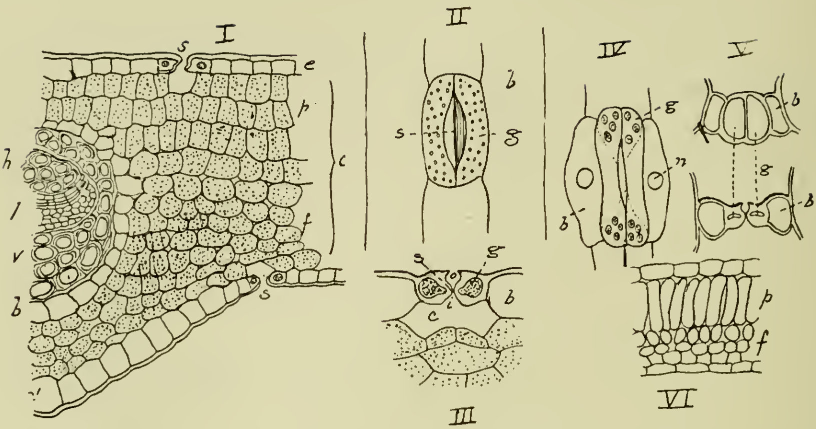

FIG. 453. I. A cross section of a leaf of Peppergrass (*Lepidium*) showing the upper epidermis (e), the lower epidermis (ê), stoma (s), the chlorenchyma (c) consisting of closely placed palisade cells (p) and more loosely placed spongy tissue (f), and a vascular or conductive tract (v) with bundle sheath (b), hadrome or xylem (h), and leptome or phloem (l).
II. Surface view of stoma from Easter Lily; g, the kidney-shaped guard cells enclosing the stomatal aperture (s); b, the subsidiary cells.
III. Cross section of stoma; g, guard cell; s, central slit; o, outer slit; i, inner vestibule; c, stomatal cavity; b, subsidiary cell.
IV. Surface view of a grass stoma (*Poa pratensis*) showing the guard cells (g), with their dumb-bell-shaped lumina; b, subsidiary cells with prominent nucellus (n).
V. Median cross section and cross section through end of stoma of *Poa annua;* g, guard cell lumina; b, lumina of subsidiary cells.
VI. A cross section of a leaf of blue violet (*Viola cucullata*) showing a single row of elongated palisade cells (p), and the loose spongy tissue (f). (Drawings after Cowles modified by Charlotte M. King.)

A cross section of a leaf will show the interior filled with a mass of thin walled cells containing green bodies (*chloroplasts*). This inner mass of thin walled cells is called the *mesophyll* and is the food making tissue of the leaf. In the leaves of most weeds the cells just under the upper epidermis are much elongated and stand at right angles to the epidermis. These elongated cells are known as the *palisade-cells*. Between the palisade-cells and lower epidermis is the *spongy tissue* made up of irregularly shaped cells, so loosely joined as to form a system of intercellular spaces which permit the circulation of gases through the interior of the leaf. In the lower epidermis are seen the stomata with the air chambers beneath. Scattered through the mesophyll are the cross sections of veins and veinlets which form the frame work of the leaf and conduct materials to and from the green working cells.

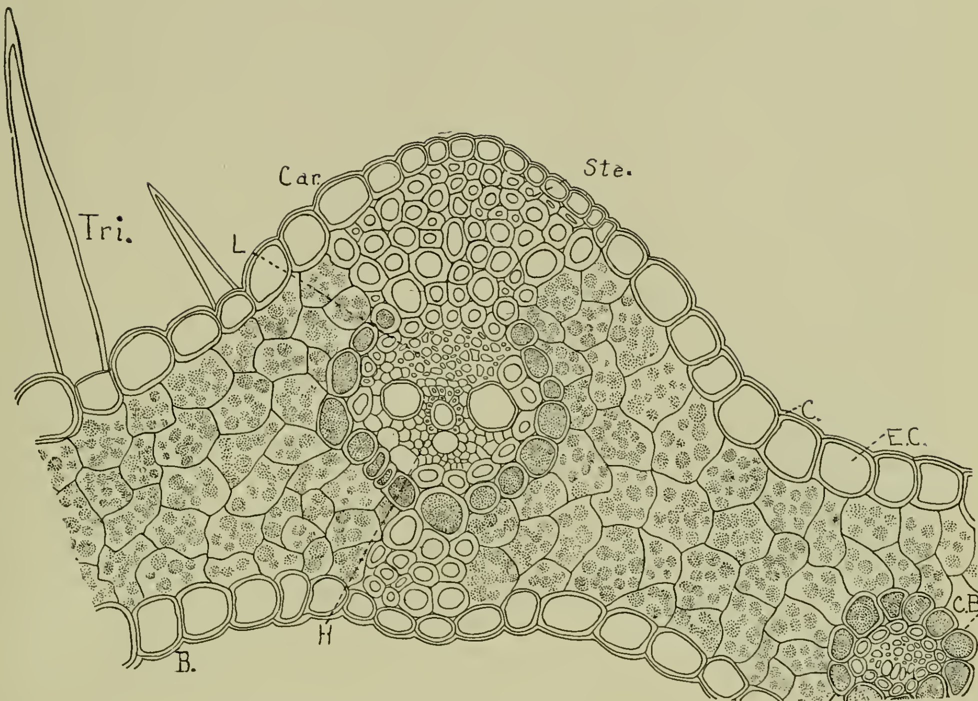

FIG. 454. Section of leaf of *Bromus mollis*. Car, mid-nerve; L, leptome; H, hadrome; B, bulliform cells; Ste, stereome; CB, chlorophyll bearing parenchyma; EC, epidermal cells; Tri, trichone. (Sirrine and King.)

FUNCTION OF LEAVES.

Photosynthesis. This is the process by which sugar and starch are produced for the plant. It is really a process of food manufacture by which raw materials are made into plant food and is an exceedingly important one, for upon it depends the lives of all plants and animals.

If an active leaf be submerged in water in the sunlight, bubbles will be seen continuously forming on the leaf surface and rising through the water. If light is excluded, the action will cease, and by increasing and decreasing the amount of light, it will be found that the process varies with the amount of light. An examination of this gas will show that it is oxygen. It has also been found that at the same time the oxygen is given off by the leaf, carbon dioxide (CO_2) is taken in, and that the outgo of oxygen and intake of carbon dioxide have a close relation.

The formula for sugar shows that it is composed of three elements, carbon, hydrogen, and oxygen. These elements are furnished by the carbon dioxide (CO_2) which is taken in from the air, and the water (H_2O) which is taken from the ground by the roots and conducted to the leaf tissue by the vascular bundles of the plant. Although CO_2 and H_2O furnish the necessary elements for sugar and starch, these are only the raw materials and some agent or factory is needed to cause these elements to combine and to combine in the right proportions. These factories are the chloroplasts, which give the green color to the entire leaf. The green pigment (chlorophyll) is the active agent of the chloroplast in the manufacture of sugar. The process by which these raw materials are combined is not well understood, and it seems that several simpler products are formed before sugar is produced. We know that CO_2 plus H_2O forms carbonic acid (OH. COOH). The carbonic acid is probably reduced to formaldehyde (H. COH). If six molecules of formaldehyde were properly combined we would have one of the simple sugars ($H_6C_6O_6H_6$) or better written ($C_6H_{12}O_6$). Two molecules of the simpler sugars combined with one molecule of water eliminated will give cane sugar—$C_6H_{12}O_6$ plus $C_6H_{12}O_6$=Cane sugar $C_{12}H_{22}O_{11}$ plus H_2O. By a further synthesis starch is produced.

When formaldehyde is produced as described above, oxygen is eliminated and this forms the escaping bubbles from the submerged leaf.

In this process of photosynthesis, the chloroplasts constitute the factory, carbon dioxide and water furnish the raw materials, sugar and starch are the products, and sunlight is the necessary condition without which the machinery will not run.

Respiration. Plant cells as well as animal cells have much work to do and in order to perform work, energy is needed. Plant cells transform material into cell walls, increase and repair protoplasm, divide and do many other things which require energy. This work never ceases as long as the plant lives. The external indication of it is the absorption of oxygen and the giving out of carbon dioxide. This exchange is spoken of as respiration. It will be noted at once that this is exactly the reverse of what takes place in photosynthesis. During the day both carbon dioxide and oxygen are being both absorbed and eliminated. Photosynthesis and respiration are independent processes and must not be confused.

Transpiration. We are familiar with the fact that the air is continually taking up water in the form of vapor. A dish filled with water and exposed to the air in the laboratory or out of doors will soon become dry. We hang wet clothes upon the line so that the air will take up the water which they contain. When we look into the physics of this process, we find that the water is really the active agent, and that it is continually changing into vapor and passing into the air. This process of changing into vapor we call evaporation, and its rate depends upon temperature, the amount of moisture already present in the air, and atmospheric pressure. This same process of evaporation goes on in the leaf, for the air surrounds the leaf and fills the intercellular spaces within. This continuous loss of moisture from the leaves is called *transpiration.*

As seen in photosynthesis, water must be present in the leaf cells in sufficient quantity or the process of food making will be hindered. Water is further needed for dissolving and transporting food materials. It is evident that transpiration is continually diminishing this quantity of water which is so necessary and if the supply, which is furnished from the ground through the roots and stems, does not equal the loss, disaster will come to the plant. So far transpiration seems to be only a detriment to the plant. It is thought to be of use in that it increases the flow of the water from the soil and through the plant and thus increases the amount and better distributes the salts secured from the soil.

It is remarkable how well most weeds can thrive, when economic plants are suffering severely from transpiration. This may be due to protective modifications which cut down transpiration or to the ability to supply the loss through a more efficient root system.

One of the harmful effects of weeds is the taking from the soil of the water which economic plants need. According to careful estimates a sunflower (*Helianthus annuus*) six feet high transpires on the average about 1 quart per day. A grass plant has been found to give off its own weight of water every twenty-four hours in hot, dry summer weather. This would make about 6½ tons per acre or more than one thousand gallons every twenty-four hours for ordinary grass fields, or rather about 200 gallons for a plot about the size of a city lot. From the above figures we can form some notion of the immense loss of water from the soil through weeds, and see how weeds can retard the growth of economic plants.

LEAF PROTECTION.

Such an important organ as the leaf, with its delicate active tissue well displayed, is exposed to numerous dangers. Chief among these dangers are excessive transpiration and intense light. By regulating the opening in the stomata which are the chief passageways

Fig. 455 I Fig. 455 II

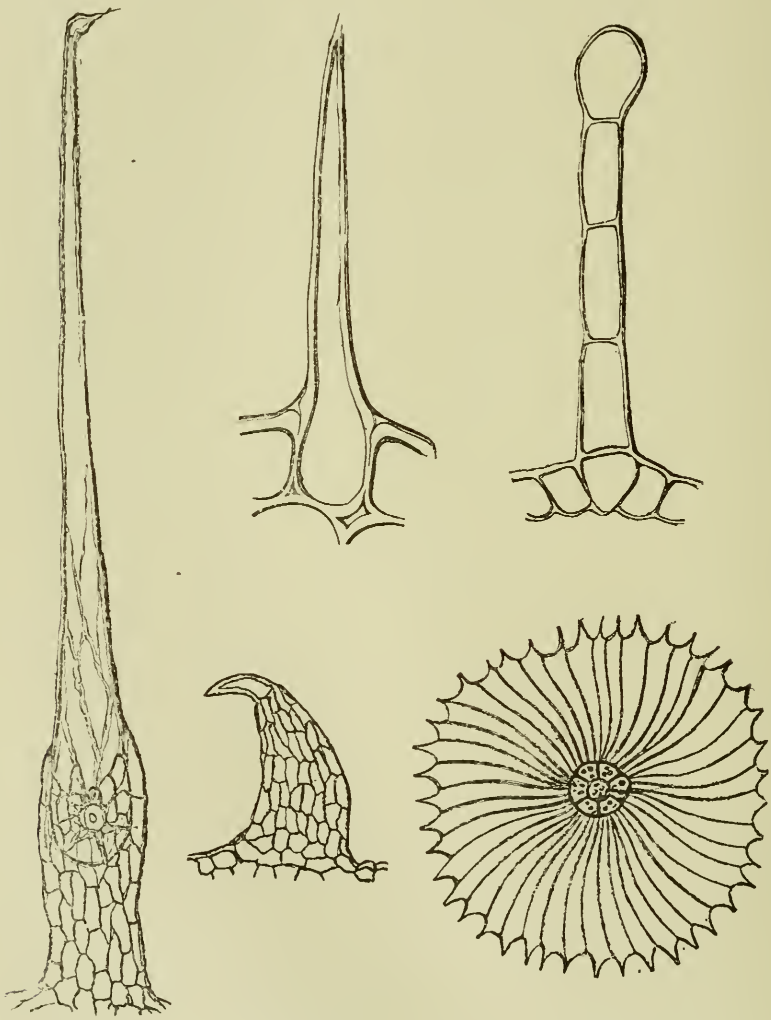

Fig. 455 V Fig. 455 IV Fig. 455 III

FIG. 455. Some protective structures of leaves and stems. I. One-celled hair of the Pelargonium. II. Multicellular hair of Geranium. III. Scale of Oleaster (*Elaeagnus*). IV. Prickle from common Hop. V. Stinging hair of Nettle.

(After Thomé.)

for the escaping moisture, the leaf is able to check transpiration. The various epidermal modifications which are quite common among the weeds afford protection. In some cases this consists of a waxy layer on the outside of the epidermis as in some milkweeds and some species of wild lettuce. This layer of wax prevents the escape of moisture, and protects the chlorophyll-bearing tissue of the leaf from the intense light rays.

Another very common protective structure upon the leaves is to be found in the great variety of hairs developed by the epidermis. In the mullein the hairs are so prominent that they form a felt-like covering. Among the cinquefoils and thistles, the hairs are usually not branched as in the mullein and the covering is not so dense.

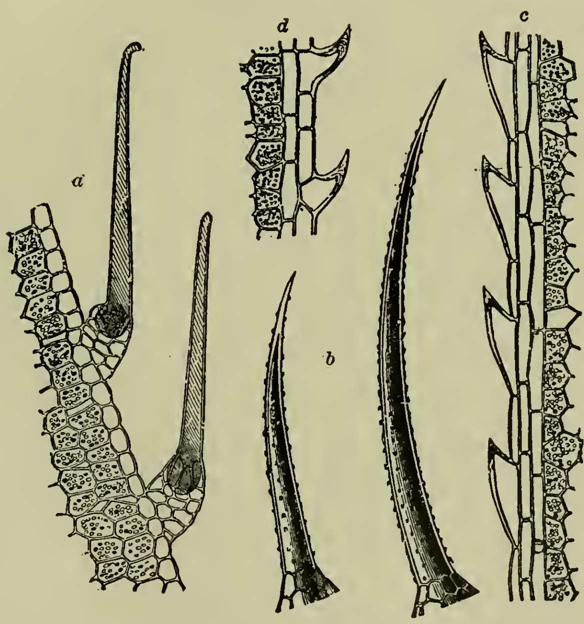

FIG. 456. Urticating hairs and cutting leaves. a, urticating hair of Nettle; b, bristle of Bugloss; c, barbed margin of a leaf of Sedge; d, barbed margin of a leaf of Grass.

All stages from those in which the hairs are very small, giving the leaf a downy appearance, up to the extreme case in the mullein, can be found among the weeds.

FLOWERS.

A satisfactory definition of a flower has not yet been agreed upon by botanists. For this reason it seems better to describe a flower rather than attempt to define it.

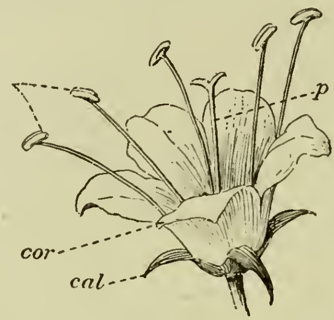

FIG. 457. Complete flower; cal, calyx; cor, corolla; p, pistil, and s, stamens. (After Thomé.)

A complete flower consists of four cycles or sets of organs—sepals, petals, stamens and pistils. The sepals taken together constitute the calyx; the petals taken together constitute the corolla.

Since the cells of the stem most active in forming new organs lie in the tip, it seems most natural that the organs appearing last, would be at the stem tip and that the age of organs would increase as their distance from the stem tip. According to this scheme, the succession of floral sets would be sepals, petals, stamens and pistils. This is probably the order of succession in many flowers, but many exceptions have been found. In shepherd's purse (*Capsella*) the petals are last to appear, while in the dandelion and other composites the sepals are last to appear.

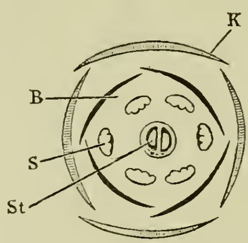

FIG. 458. Diagrammatic cross section of a perfect flower. St, ovary showing two cells; S, stamens; B, corolla; K, calyx. (After Thomé.)

Since the work of the flower is to produce seed, and seed forming is due to the co-operation of the stamens and pistils, these are known as the essential organs of the flower. A flower is a perfect flower if it contains both of the essential organs. The simplest

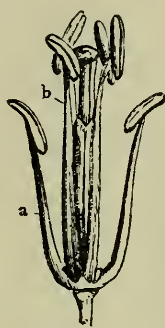

FIG. 459. Essential organs of the flower of the Black Mustard. a, two short stamens; b, four long stamens. Pistil is enclosed by the stamens; the filiform body is the filament of the stamen; the enlarged portion of the stamen is called the anther.
(After Thomé.)

flower would have one stamen or one pistil and no corolla or calyx. Imperfect flowers are designated as staminate when they contain stamens, but no pistils; pistillate when they contain pistils but no stamens. The term "bisexual" is applied to the flower which contains both stamens and pistils. This is the most common type of flower.

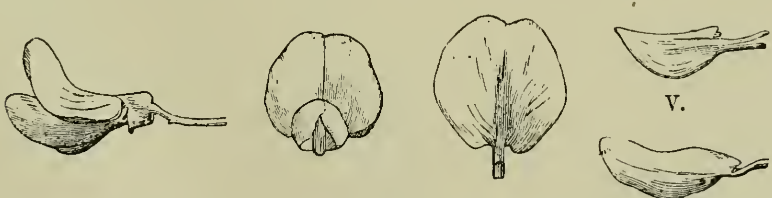

FIG. 460. Irregular flower of a leguminous plant, dissected so as to show the difference in shape and size of petals.
(After Thomé.)

Plants, such as ragweed and corn, which have pistillate and staminate flowers (i. e., pistils and stamens in separate flowers but both kinds of flowers on the same plant) are monoecious (one household). Such plants as the red campion (*Lychnis dioica*), mulberry, willows and poplars, which bear the pistillate flowers on one plant and staminate on another are dioecious (two households). A plant

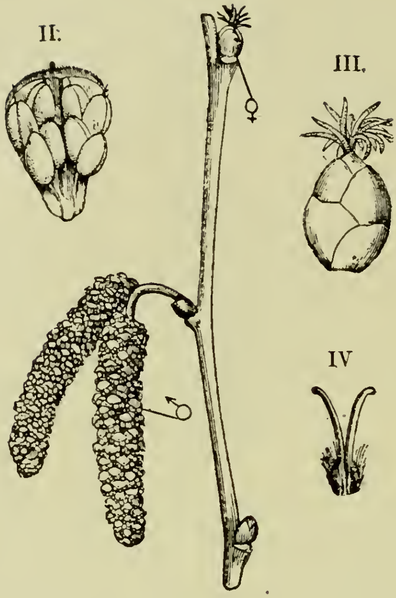

FIG. 461. II. Staminate flower of the Hazel showing the stamens and bracts. III. Pistillate flower showing pistils and enclosing bracts. IV. Style and two stigmas. Catkin at middle of stem containing the staminate flowers; female flower at top of stem. The Hazel is a monoecious plant.
(After Thomé.)

which bears some perfect flowers and some staminate or pistillate only, is polygamous.

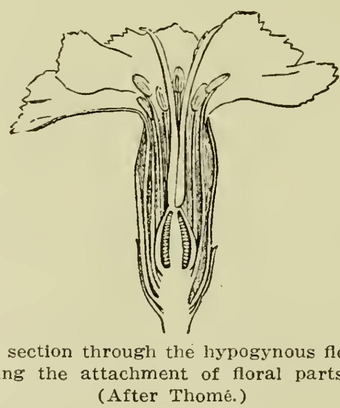

FIG. 462. Longitudinal section through the hypogynous flower of the Pink, showing the attachment of floral parts.
(After Thomé.)

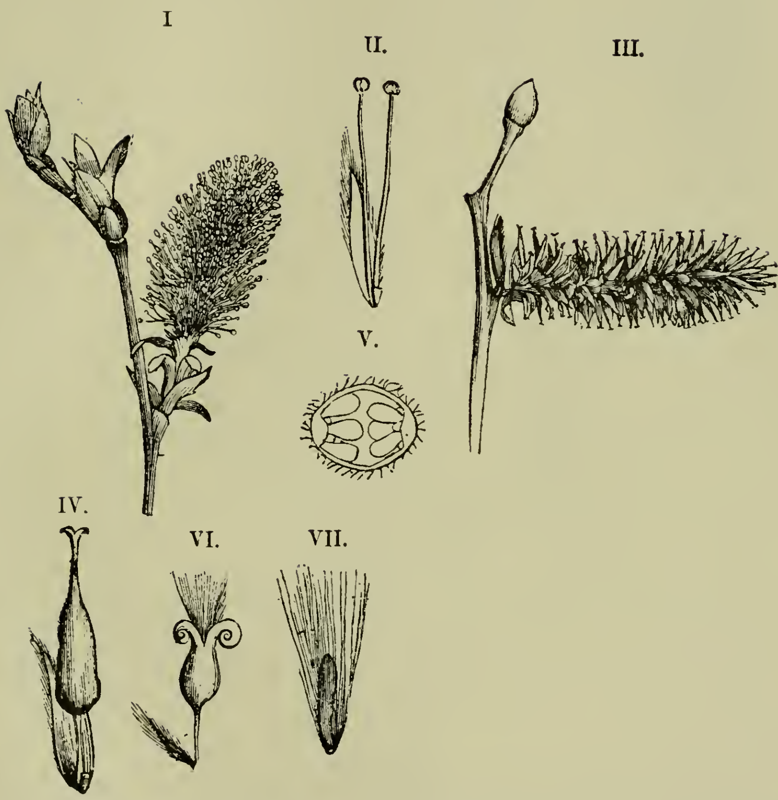

FIG. 463. I and III. Staminate and pistillate catkins of the Willow. II and IV. Staminate and pistillate flowers. V. Cross section of ovary showing the one cell, two placentae and ovules. VI and VII show opening of pod and character of the seed. Since the male and female catkins are borne on different trees, this plant is dioecious.
(After Thomé.)

Fig. 464 I Fig. 464 II Fig. 464 III Fig. 464 IV

FIG. 464. Flowers with petals joined (gamopetalous). I. Globularia. II. Jasmine. III. Borage. IV. Ground Ivy. (After Thomé.)

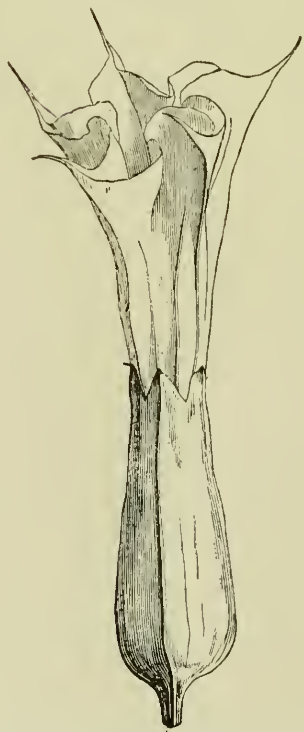

FIG. 465. Gamosepalous and gamopetalous flower of Jamestown or Jimson Weed. (After Thomé.)

FLORAL ENVELOPES AND THEIR CHARACTERS.

The sepals and petals constitute the two floral envelopes. The envelopes, taken together, are sometimes called the perianth. This is especially true in the lily family where the two envelopes do not differ much in shape and color. Floral envelopes are not essential and one or both may be absent. If only one is absent, it is the corolla, and the flower is apetalous. In the grasses and sedges there is no true perianth but the essential organs are enclosed by chaff-like bracts and glumes.

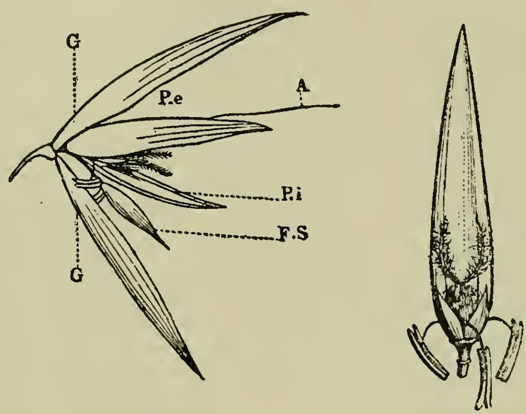

Fig. 466 I Fig. 466 II

Fig. 466. I. Flower of oats showing the grass type of floral envelopes. G, empty glume; Pe, lemna bearing an awn A; pi, palea; F. S., sterile flower. Between lemna and palea are pistil and stamens.
II. Flower with lemna removed, showing palea and the small bracts (lodicules) at the base of the pistil and stamens.
(After Thomé.)

Stamens.—The stamens surround the pistils and their number is various. They may be opposite the petals or alternate with them. In the mustards and buttercups the stamens are inserted on the receptacle. When they are inserted on the corolla as in the morning-glory, they are epipetalous. Stamens are usually distinct or free from each other. When they are united by their filaments into one set, as in the mallow family, lupines and lobelia, they are monadelphous (one brotherhood). If united into two sets as in clover, they are diadelphous (two brotherhoods). More sets would be designated by tri-, tetra-, etc.

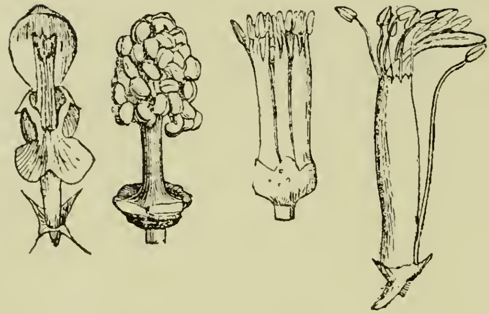

Fig. 467 I Fig. 467 II Fig. 467 III Fig. 467 IV

FIG. 467. I. Flower of Ground Ivy with stamens differing in length. II. Mallow with monadelphous stamens. III. Orange with polydelphous stamens. IV. Clover with diadelphous stamens.
(After Thomé.)

Relation of the attachment of floral envelopes and stamens to the pistil.—An examination of the floral sets in shepherd's purse (*Capsella*) or mustard (*Brassica alba*) will show that sepals, petals and stamens are inserted on the receptacle below the ovary. This flower is hypogynous (i. e., parts under the pistil). When the petals and stamens are joined to the calyx, the flower is perigynous (i. e., parts around the pistil). In such flowers as the evening primrose and those of the composites, the calyx is adherent to the ovary and the corolla seems to arise from the top of the ovary. Such a flower is said to be epigynous (parts on the pistil).

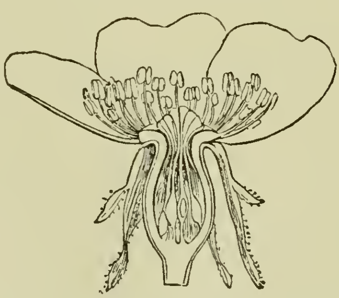

FIG. 468. Perigynous flower of the Rose.
(After Thomé.)

Arrangement of flowers (inflorescence).—Flower arrangement is of three classes; namely, indeterminate, when the flowers arise laterally and successively as the floral axis elongates; determinate, when the flowers arise from the terminal buds and thus check the elongation of the floral axis; and mixed, when these two are combined.

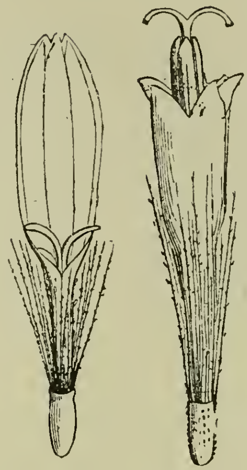

FIG. 469. Strap-shaped and tubular flowers from the head of Squaw Weed (*Senecio*). The corolla and calyx appear to arise from the top of the ovary. Such a flower is epigynous and the free portion of the calyx is called pappus.
(After Thomé.)

Flowers may arise singly, as in silverweed (*Potentilla anserina*), and are then designated as solitary. If in the axils of ordinary leaves, they are axillary and solitary.

A raceme is that indeterminate inflorescence in which the flowers are stalked and arranged along the sides of a floral axis. The shepherd's purse has the raceme type of inflorescence. New flowers are continuously arising at the top as the floral axis elongates.

FIG. 470. Solitary, funnel-shaped flower of field Bindweed.
(After Thomé.)

If the inflorescence is of the raceme type with the exception that the flowers have no stalks, as in the plantain, we have the spike.

Fig. 471 I

Fig. 471 II

Fig. 471 III

Fig. 471 IV

Fig. 471. Types of inflorescence. I. Raceme of Currant. II. Umbel-like inflorescence of Cherry. III. Head of Clover. IV. Umbel of Parsley.

If the lowest pedicels or flower stalks are elongated (or the upper ones remain short) so that the cluster is convex or nearly flat on top, we have the corymb type of inflorescence.

In the wild carrot, common yarrow, and parsley family in general, the axis of the corymb is so much shortened that all pedicels seem to start from the same point and resemble the rays of an inverted umbrella. This is the umbel.

In the clover (*Trifolium procumbens*) the flower axis is short and the pedicels of the flowers are either short or absent. This causes the flowers to be crowded into a roundish cluster which is called a head.

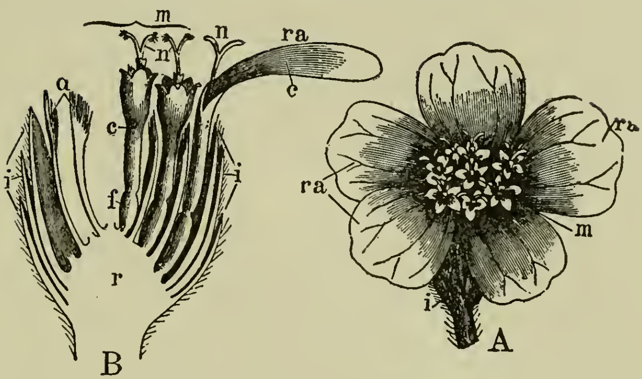

Fig. 472. Close head of a composite. (After Thomé.)

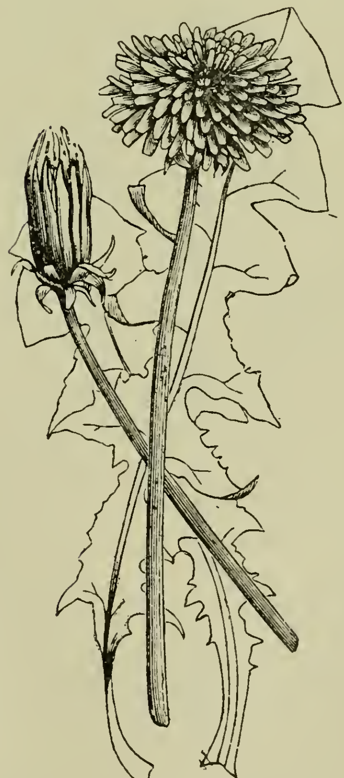

Fig. 473. Close head of the Dandelion. (After Thomé.)

The flower axis is so much shortened in the dandelion, sunflower and composites in general, that it may be a concave, flat, or conical surface. The flowers are crowded upon this surface, and the entire group is surrounded by one or more rows of leaf-like bracts which form the involucre. This is the close head or composite type of inflorescence.

FIG. 474. Milkweed with flowers in umbels.

In many cases, as in field sorrel and in five-finger (*Potentilla norvegica*), the oldest flower of the floral axis is terminal and all later flowers must arise from axils below. This is the determinate type of inflorescence and this type of flower cluster is called a cyme.

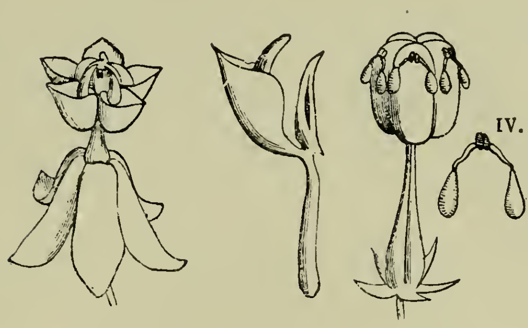

FIG. 475. Flower of Milkweed, showing the peculiar hooded and horned stamens. I. Flower. II. Stamen. III. Pistil with adhering pollen masses. IV. Pollen masses or pollinia.

(After Thomé.)

THE DEVELOPMENT OF A STAMEN AND ITS FUNCTION IN SEED PRODUCTION.

Every one knows that the pollen produced by the stamens has an important part to play in seed production. It is for this reason that the stamen is considered one of the essential organs of the flower.

There is so little variation in the general development of stamens in the higher seed plants that the history of a stamen from any weed will suffice for all.

A mature stamen consists of a stalklike portion, the filament, and the pollen-bearing portion, the anther, which is borne on top of the filament. The filament may be variously modified or even wanting.

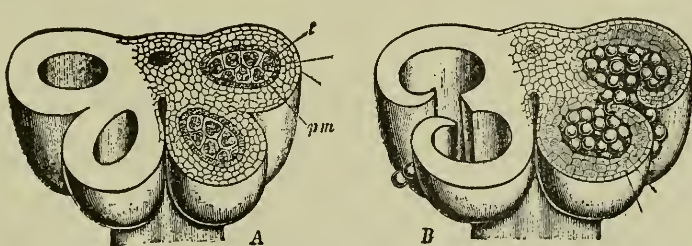

FIG. 476. Cross section of anther showing pollen sacs. A. pm, pollen mother cells; t, food cells. B. Pollen grains mature and being shed.

(From Coulter, after Baillon & Luerssen.)

An anther appears distinctly four lobed. If a cross section of a young anther be made, four distinct regions will be found, one in each lobe or a pair on each side of the axis. These four distinct regions are conspicuous because the cells contained are larger and have a denser content. Each of these cells will produce four pollen grains and for this reason are called pollen mother cells.

Surrounding each group of pollen mother cells is usually one layer of cells whose content is quite dense. These are sacrificed as food material for the pollen mother cells and are designated as tapetal cells.

After the pollen grains are formed, they lie loose in these cavities. Each cavity is considered as a case or angium and since a pollen grain is a spore, this case is called a sporangium.

The partition between each pair of sporangia usually breaks down, and two spore-containing cavities are formed. These are generally called pollen sacs. The pollen sacs are now ready to open or dehisce as the process is called. This is due to especially modified cells, which produce such strains through the variation of moisture, that usually longitudinal slits or terminal pores are produced.

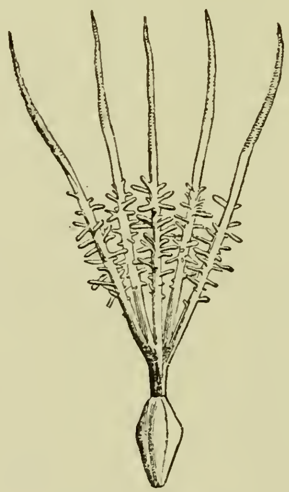

FIG. 477. Thrift. ov, ovary; s, style; st, papillary stigmas. (After Thomé.)

The pollen is now either by wind, insects, or water carried to the stigma of the pistil where it begins the performance of its important function. This process of transference is pollination. An examination of a pollen grain at the time of pollination will usually show that it has two nuclei; one of these has to do with the production of a tube which traverses the tissues of the pistil and furnishes a passage way to the embryo sac which contains the cells to be fertilized. The other nucleus of the pollen grain produces two small nuclei which are called sperms. These sperms pass down the pollen tube to the embryo sac and fertilize the egg and endosperm nucleus.

THE PISTIL AND ITS FUNCTION IN SEED PRODUCTION.

A flower may have one or more pistils which occupy the center of the flower. They are the last to appear, since the order of development is usually sepals, petals, stamens, and pistil.

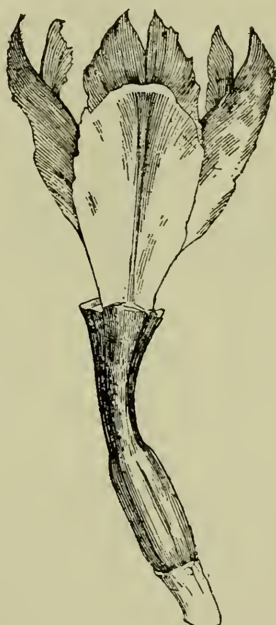

FIG. 478. Iris with petal-like stigmas. (After Thomé.)

A complete pistil consists of three parts—the expanded base which bears the seed and is called ovary (or "egg-case"); the expanded portion at the top, or the stigma; the portion that connects the ovary and stigma, the style.

The style is not an essential part of the pistil and may be absent without disturbing the function of the pistil.

The stigma has on its surface many minute papillae which retain the pollen and excrete a sweetish, sticky fluid which serves as a nourishment and stimulant for the pollen grain.

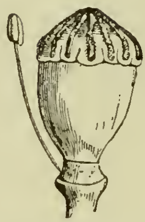

FIG. 479. Corn-poppy with a shield-shaped stigma capping the ovary. (After Thomé.)

If we cut a cross section of the ovary of the May apple, we find within, a cavity bearing on one side a projection to which are attached the small, somewhat globular bodies or ovules. This cavity

FIG. 480. Pistil of Thistle. (After Thomé.)

within the ovule is usually called a cell by manuals, but a better term is loculus, since the term "cell" is universally used to designate the unit of tissues. The thickened portion to which the ovules are attached is the placenta.

The pistil of the May apple is a simple pistil and according to the older views concerning the pistil, it is a carpel. The older view was, that the carpel is a modified leaf. If one will imagine a leaf folded and the margins joined so as to enclose a loculus and then the outer part modified so as to form a style and stigma, the conception of a carpel will be clear. An examination of the pistil of oxalis will reveal five styles and stigmas, and one ovary with

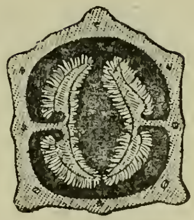

FIG. 481. Cross section of the ovary of Gesneria showing one cell and two parietal placentae.
(After Thomé.)

five loculi. This indicates that the pistil of oxalis consists of five carpels whose ovaries have united to form one with five loculi. This uniting may even extend to the styles and stigmas. A pistil that is made up of more than one carpel is compound.

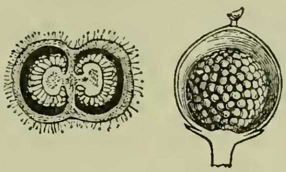

FIG. 482. I. Cross section of the compound pistil of Snapdragon, showing the two cells and the axillary placentae. II. Longitudinal section of an ovary with a free central placenta.
(After Thomé.)

Ovule.—The ovule is the most essential part of the pistil because it is the forerunner of the seed. The ovule consists of a central portion, the nucellus, which is enclosed by one or two jackets which are called the integuments. The integuments do not entirely close at the outer end of the nucellus and this small opening left is the micropyle through which the pollen tube usually passes. In the interior of the nucellus is a region which resembles a large cavity since it contains no cell walls. This is the embryo sac. At about the time the flower opens the embryo sac contains seven cells. The two which have an important future history are the egg and endosperm cells.

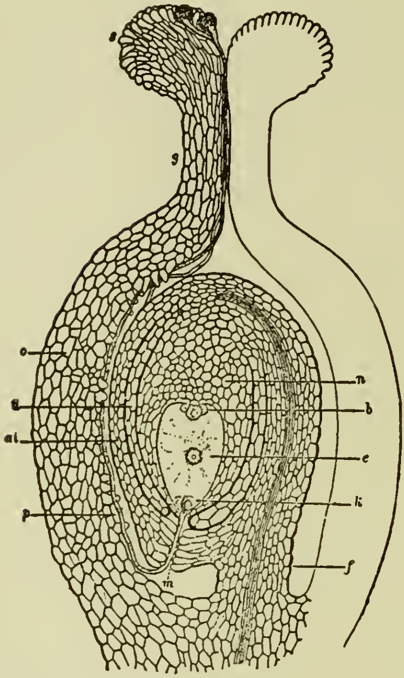

FIG. 483. Diagrammatic representation of fertilization of an ovule. i, inner coating of ovule; o, outer coating of ovule; p, pollen tube proceeding from one of the pollen grains on the stigma; c, the place where the two coats of the ovule bend. (The kind of ovule here shown is inverted, its opening m being at the bottom, and the stalk f adhering along one side of the ovule.) a to e, embryo sac, full of protoplasm; a, so-called antipodal cells of embryo sac; n, central nucleus of the embryo sac; e, nucleated cells, one of which, the egg cell, receives the male nucleus of the pollen tube; f, funiculus or stalk of ovule; m, micropyle or opening into the ovule.

(After Luerssen.)

The egg is in the end of the sac nearest the micropyle, in the most convenient position for the entering pollen tube. The endosperm cell is near the center of the embryo sac. The embryo sac is now mature and awaits the entrance of the pollen tube.

Fertilization.—The pollen tube traverses the tissues of the stigma and style and finds its way to the micropyle. It passes through the micropyle, penetrates the tissues of the nucellus, and pierces the membrane of the embryo sac. The two sperms, which have had a rather long journey through the pollen tube, now enter the embryo sac. One finds its way to the egg and soon fuses with the egg nucleus. The other fuses with the nucleus of the endosperm

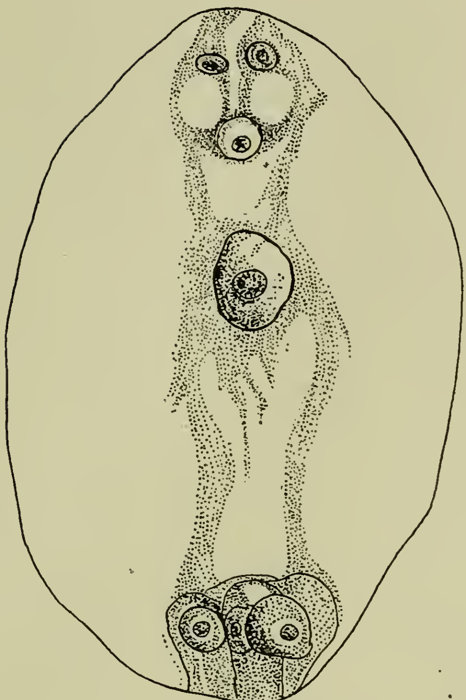

Fig. 484

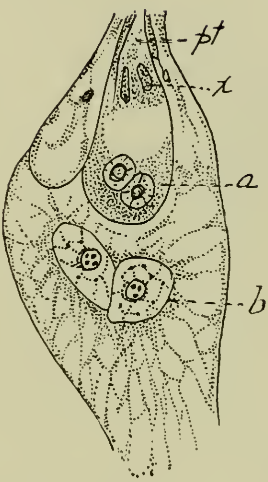

Fig. 485

Fig. 484. Embryo sac of Buttercup (*Ranunculus multifidus*). Near the center is the large endosperm nucleus. The egg is the inner one of the three cells at the upper end of the sac and lies between the inner ends of the two synergids. The three antipodals are shown closely crowded at the lower end of sac.

(After Coulter.)

Fig. 485. Fertilization in the Fleabane (*Erigeron*) ; pt, pollen tube with two densely staining bodies (x) ; a, male cell fusing with egg; b, male cell fusing with endosperm nucleus.

(After Land.)

cell. This process in which the sperms or male nuclei fuse with the nuclei of the egg and endosperm cell is fertilization, and both fusions are designated as double fertilization.

THE DEVELOPMENT OF THE EMBRYO AND SEED.

When the fertilized egg germinates, a filament of cells, the suspensor, is usually found. At the end of the suspensor the embryo is developed which, when mature, is more or less surrounded by nourishing endosperm which has resulted from the growth and division of the endosperm nuclei.

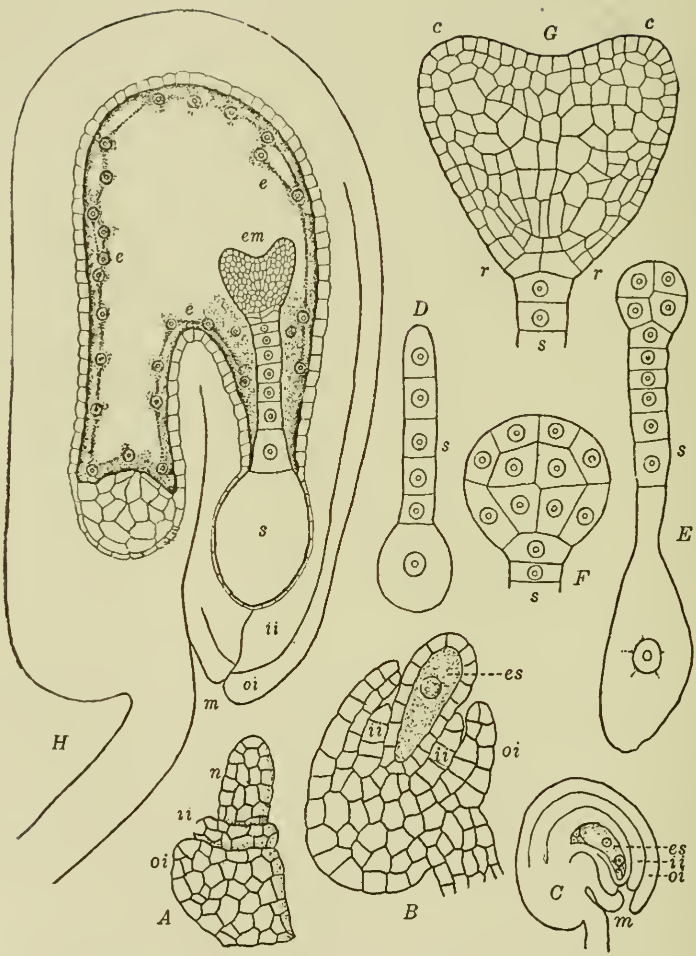

Fig. 486. Development of the ovule and embryo of the Shepherd's Purse (*Capsella*). A, young ovule, showing origin of two integuments at base of nucellus, n. B, outer integument growing beyond the inner, and the ovule beginning to bend over; es, embryo sac. C, diagram of a later stage with mature embryo sac. D, development of the suspensor s. E, early division of the terminal cell (embryo cell). F, later stage, showing the differentiation of an outer cell layer in the embryo, which is to become the epidermis. G, the two cotyledons c and the root region r now clearly defined. H, lengthwise section of an ovule, showing the position of an embryo in an embryo sac; em, embryo; s, suspensor; e, endosperm; ii, inner integument; oi, outer integument; m, micropyle.

(A, B. C, adapted after Campbell. Ginn & Co.)

The two groups of higher seed plants, or Angiosperms, differ widely in the structure of the embryo. In the group including the grasses, rushes, sedges and such plants as wild onion (*Allium canadense*) the globular embryo soon develops into an axis with the root tip at one end and one cotyledon at the other. The stem tip arises from the side of the axis as a lateral member. This group of plants is designated as Monocotyledons (one cotyledon).

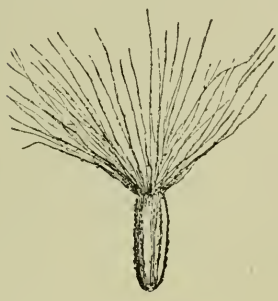

Fig. 487 I

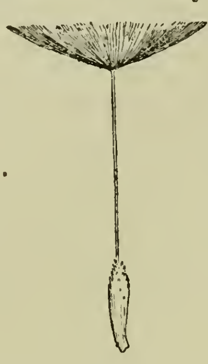

Fig. 487 II

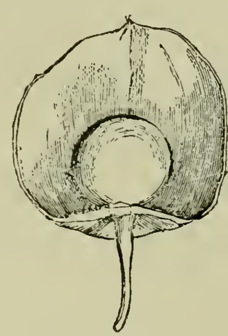

Fig. 488

FIG. 487. I. Fruit of Squaw-weed (*Senecio*). II. Fruit of Dandelion. Each is crowned with pappus which aids in distribution.
(After Thomé.)

FIG. 488. The fruit of the Winter Cherry (*Physalis*) with a portion of the inflated calyx removed to show the enclosed berry.
(After Thomé.)

In the other group, to which a large number of the weeds belong, the axis of the embryo develops a root tip at one end, a stem tip at the other, and a pair of cotyledons, one on each side of the stem tip. Since two is the prevailing number of cotyledons, the term Dicotyledons is applied to this group.

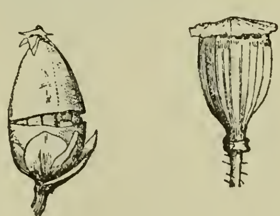

Fig. 489

Fig. 490

FIG. 489. I. Fruit (pod) of Plantain with upper portion of pod breaking and falling off to allow seeds to escape. II. Pod of Poppy opening by a lid.
(After Thomé.)

FIG. 490. Fruit of Mallow which separates into as many one-seeded carpels as there are styles.
(After Thomé.)

Seed.—The seed is the matured ovule. It contains the young plant or embryo which is the essential part of the seed since it is through the later development of this young plant that new individuals are produced. Accompanying this maturing of the ovule, various other changes take place which give distinguishing features to different seeds. Frequently the endosperm grows so extensively as to absorb and replace the cells of the nucellus and thus comes to occupy all the space within the coats of the integuments, as in the morning-glory, onion, etc. The embryo may remain comparatively small as in the morning-glory or onion, or it may in turn absorb and replace all the cells of the endosperm and so come to occupy the space within the integuments, as in the bean and clover. Sometimes some of the nucellus and endosperm remain. The integuments also undergo various changes during the formation of the seed, often becoming hard or papery or provided with hairs, hooks or spines, or becoming smooth or pitted.

Fig. 491 I

Fig. 491 II

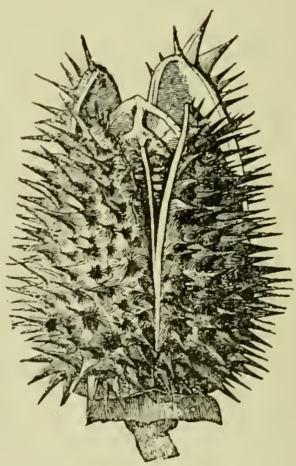

Fig. 492

Fig. 491. I. Immature pistils of Geranium. II. Mature pistil and carpels with their long styles are separating from the elongated axis. (After Thomé.)

Fig. 492. Burry fruit of Jamestown or Jimson Weed (*Datura*) showing method of dehiscing. (After Thomé.)

Fruit.—A fruit is a ripened ovary alone or a ripened ovary plus closely related parts such as calyx, involucre, and receptacle. In the beggar-ticks (*Bidens*) the ovary becomes tough and invests the seed, while the awns which represent the calyx become barbed and aid in distribution. In the buttercups the ovary invests the seed while the style forms a hook. The involucre in the clotbur and ragweed remains around the pistils and becomes more or less spiny. In the nightshade (*Solanum nigrum*) the ovary becomes fleshy and the fruit is called a berry.

CHAPTER V.

SCATTERING OF WEEDS

ADA HAYDEN

CHAPTER V.

SCATTERING OF WEEDS.

There is much to be observed as to how particular plants spread from one location to another, but from the hosts of observations that have been made the following means are recognized as agents of conveyance to the disseminules of plants to suitable habitats.

Physical forces:
- Wind
- Water
- Snow and wind

Animals:
- Man, furred animals and birds

Mechanical adaptations:
- Explosive devices
- Hygroscopic movement
- Burial

In comparing the amount of seed produced by a plant with the number of plants maturing from that seed, it is evident that relatively few plants reach locations favorable to existence. Wind transported fruits may be recognized by their appendages in the form of wings, comas of hair and bristly parachutes. Water carried fruits are characterized by lightness, inflated coverings and corky buoys. Seeds disseminated by animals are characterized by hooked and clawed appendages or spines which become attached to pelts or fabrics or have succulent portions which are edible. Scattering by mechanical devices is illustrated by the forcibly splitting pod, the twisted pod, the spearlike fruited grasses whose twisted awns aid in entering the earth and the cleistogamous flowered plant which buries its seeds in the earth.

Birds destroy large quantities of weed seeds. Mr. H. W. Henshaw* states that a ring-necked pheasant's crop from Washington contained 8,000 seeds of chickweed and a dandelion head. Birds of the sparrow family, according to the same authority, feed largely on the seeds of weeds. The tree sparrow consumes one-fourth ounce of weed seeds per day. The tree sparrows on this basis annually consume 875 tons of weed seeds in Iowa. These birds save the farmers of the United States on this basis $89,260,000 annually.

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*Henry W. Henshaw. Fifty Common Birds of the Farm and Orchard. Farmers' Bull. U. S. Dept. Agr. No. 513.

Fig. 493A Fig. 493B Fig. 493C

Fig. 493. A. Seed of common Field Sorrel (*Oxalis corniculata*) with two capsules from which the seeds are shot out. B and C. Common Dock (*Rumex crispus*). Fruit scattered by the water. The wings surrounding the fruit and tubercle make the fruit admirably adapted to floating on the water. Section of the fruit showing wings and tubercle shown in C.
(Drawings by Ada Hayden.)

Parts of the fruit which serve as disseminating mechanisms.—The stimulus of fertilization not only gives rise to the development of a seed but causes parts of the seed or seed-case to develop in many instances into a special contrivance for its dissemination. A fruit, botanically speaking, is a ripened ovary, including any closely attached parts, for example: the milkweed pod filled with seeds bearing tufts of hairs; the dandelion fruit with its parachute-like pappus.

Parts which serve as dissemination mechanisms:

Ovary wall.

a. Fleshy, often attractively colored—cherry, horse nettle, black nightshade.
b. Bursting—touch-me-not.
c. Inflated—sedge.
d. Corky tubercles—dock.
e. Winged—maple.

Calyx.

a. Capillary hairs—dandelion.
b. Spined—buffalo bur.

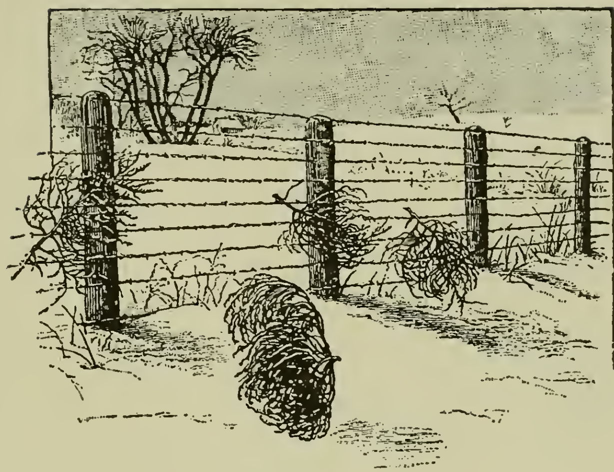

Fig. 494A

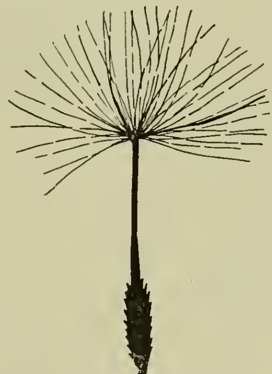

Fig. 494B

FIG. 494. Scattering of seed by wind. A. The Iowa Tumble Weed (*Amaranthus graecizans*). The weeds piled up against the fence; the Russian Thistle and other weeds are scattered in a similar way. B. Achene of Red-seeded Dandelion.
(A, after Bergen's Botany—Ginn & Co.; B, drawing by Ada Hayden.)

Seed coat or its appendages.

a. Coma of hairs—milkweed.

b. Mucilaginous—peppergrass.

c. Contractile seed coat—oxalis.

Receptacle.

a. Fleshy—rose.

Bracts—basswood.

Involucre.

a. Spiny—burdock, cocklebur.

The dissemination of weeds is not unlike that of other plants. Weeds are commonly recognized as plants out of place, plants which are detrimental to the growth of crops or otherwise injurious. While ash or maple seeds are not usually placed in this category; if, in their seedling stage they monopolize a piece of soil, for example a lawn newly planted with grass, absorbing the nutriment and crowding the plants desired in this location, these invaders have earned for themselves the title "weed." The epithet

Fig. 495A Fig. 495B

FIG. 495. Seeds and fruit scattered by the wind. A. Basswood (*Tilia americana*), a light bract to which is attached a stalk bearing the fruits. B. Milkweed (*Asclepias syriaca*) pod and seeds.
(Drawings by Ada Hayden.)

"weed" brings to mind the obnoxious characters of the plants so designated, yet weeds have just as respectable lineage as the palm, olive, lily or laurel, and in their systematic relationships they show by their structure that they are members of the first families of the plant kingdom. Thus the notable rose family, which serves the world with the apple, the plum, the cherry, the quince, the peach and the pear, claims among its numbers the aggressive little cinquefoil (*Potentilla fruticosa*), an invader of pastures and tilled lands, the thorny prairie rose (*Rosa pratincola*) and the prickly black raspberry (*Rubus occidentalis*), which without invitation entrench themselves upon the territory and contend with the agriculturist as to what shall occupy the soil. Families such as the goosefoot (*Chenopodiaceae*) and the buckwheat (*Polygonaceae*) are recognized as cohorts of marauders thronging the highways, forging into fields, contesting with crops and contributing little beauty and few representatives of economic value. The great cosmopolitan sunflower family (*Compositae*) contributes numerous species of economic reputation as well as a goodly number of widely recognized but combated species.

A large number of plants may be identified with their families by their type of fruit structure only. Families which have little variation in fruit structure have few agents of dissemination, while families with considerable variation have usually several agents, as in the sunflower family in which the calyx is represented by bristles forming a parachute in the dandelion, lettuce or the

Fig. 496A Fig. 496B

FIG. 496. Fruit scattered by the wind and animals. A. To the right scattered by the wind: a, achene of Goldenrod (*Solidago rigida*); b, Blue Flowered Lettuce (*Lactuca floridana*), the bristly hairs called the pappus. To the left scattered by animals: a, an achene, commonly called a seed, of Bootjack or Beggar-ticks (*Bidens frondosa*); b, Spanish Needle (*Bidens bipinnata*).
B. Anemone (*Anemone cylindrica*).
(Drawings by Charlotte M. King, Ia. Agr. Exp. Sta.)

Canada thistle, or terminating in teeth as in Bidens or becoming a spiny involucre as in the cocklebur and the burdock. Some representatives of this family, for example the ragweed, have no special means of transportation and the seeds fall in great quantities near the mother plant where they germinate in large numbers if not distributed by wind-driven snow or by chance inclusion with agricultural seeds. The seeds of the milkweed family

Fig. 497. Seeds and fruits scattered by the wind. A. Seeds of Catalpa (*Catalpa speciosa*) with winged appendages. B. Key fruits of Soft Maple (*Acer saccharinum*) are carried by the wind and in falling drop into the mud or soft grass of the lawn.
(Drawings by Ada Hayden.)

(*Asclepiadaceae*) are provided with tufts of hair which serve to float the seeds in the air as they escape from the pods. The oxalis family (*Oxalidaceae*) have seeds whose outer seed coat separates from the seeds shooting them from the bursting pods. The geranium family (*Geraniaceae*) have contractile pods which shoot the seeds several feet from the plants. The mustard family (*Cruciferae*) have pods which burst but do not scatter the seeds far. Many species of this group have seeds with mucilaginous coats which, when in contact with damp surfaces, adhere to them. Peppergrass is a well known example. This family has also some

Fig. 498A Fig. 498B Fig. 498C

Fig. 498. Weeds scattered by animals. A. Buffalo Bur (*Solanum rostratum*). B. Pitchforks (*Bidens frondosa*), the downwardly barbed points admirably suited for animal dissemination. C. Carrot (*Daucus carota*).
(Drawings by Ada Hayden.)

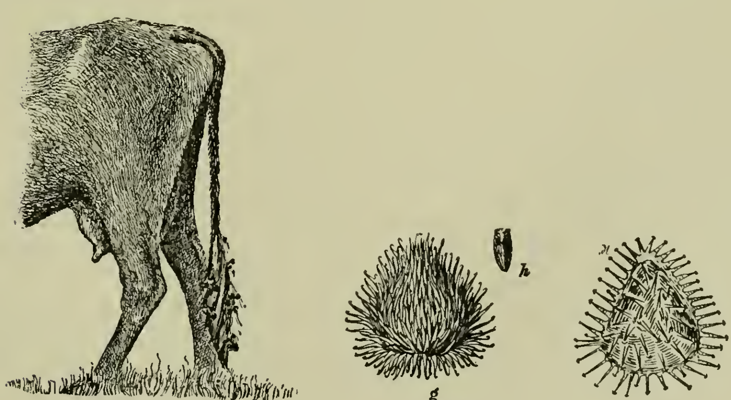

Fig. 499A Fig. 499B Fig. 499C

Fig. 499. A. Cow with attached Burdock. B. Burdock enlarged. C. Comfrey (*Cynoglossum*) enlarged.
(A, after Bailey, Macmillan & Co.; B, after Dewey, U. S. Dept. Agr.)

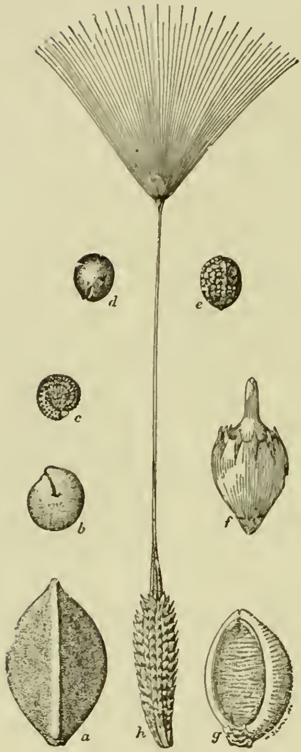

Fig. 500A

Fig. 500B

FIG. 500. A. Weed seeds eaten by birds. a. Wild buckwheat (*Polygonum convolvulus*); b and d, Amaranth or Pigweed; c, Chickweed; e, Spotted Spurge; f, Ragweed; g, Foxtail; h, Dandelion.
B. Seeds of sedges carried by water.
(A, after Dewey, U. S. Dept. of Agr.; B, drawing by Ada Hayden.)

tumble weeds among which are several mustards like tumbling mustard. The seeds of the sedge family (*Cyperaceae*) are commonly surrounded by inflated sacs or bear tubercles which enable them to be carried by water. Grasses (*Gramineae*) show considerable variation in means of dissemination. Some grasses, for example Stipa, have sharp fruits with twisted awns a prominent factor. While dissemination is a prominent factor in the distribution of plants, the factor of adaptation to habitat is no less important for if a plant cannot adapt itself to the conditions in the habitat where the seed falls the transportation is of no avail so far as its development is concerned. Canada thistle produces some seed in northern Iowa, where habitat conditions are more favorable than in southern Iowa.

FIG. 501. Birds scatter the seeds of the Wild Black Cherry (*Prunus serotina*). 1, flowering branch; 2, fruit; 3, fruiting branch; 4, cross section of fruit; 5, flower; 6, branch with buds.
(After Cheney in Green's Forestry of Minn.)

From an ecological point of view weeds are plants which adapt themselves readily to ordinary agricultural conditions and since most crops are grown under mesophytic conditions, most weeds are mesophytes which adapt themselves to definite habitat conditions such as cultivated field or uncultivated field and are readily transferred with agricultural seeds, hence the association of certain weeds exclusively with certain crops, for example, among the common clover field weeds are buckhorn, wild carrot and plantain. These are not found in corn fields where cocklebur, horse nettle, morning-glory and sandbur flourish. Many of the most obnoxious

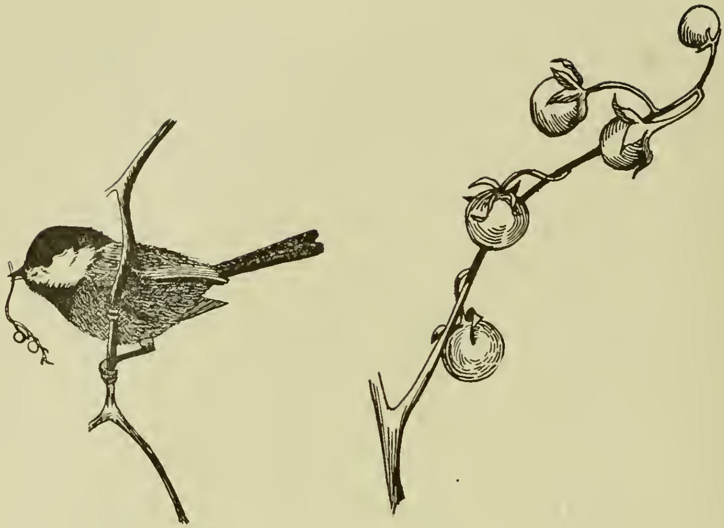

Fig. 501A I

Fig. 501A II

FIG. 501-A. I. Chicadee carrying fruit. II. Berries of Horse Nettle; carried by birds.

FIG. 502. Mixture of weed seeds commonly found in low grade Alsike Clover seed: a, Alsike Clover; b, White Clover; c, Red Clover; d, Yellow Trefoil; e, Canada Thistle; f, Dock; g, Sorrel; h, Buckhorn; i, Rat Tail Plantain; k, Lamb's Quarters; l, Shepherd's Purse; m, Mayweed; n, Scentless Camomile; o, White Campion; p, Night-flowering Catchfly; q, Ox-eye Daisy; r, Small-fruited False Flax; s, Cinquefoil; t, two kinds of Peppergrass; u, Catnip; v, Timothy; x, Chickweed; y, Canada Blue Grass; z, Clover Dodder; 1, Mouse Ear; 2, Knotgrass; 3, Tumbling Amaranth; 4, Rough Amaranth; 5, Heal-all; 6, Lady's Thumb (enlarged).

(Hillman, U. S. Dept. Agr.)

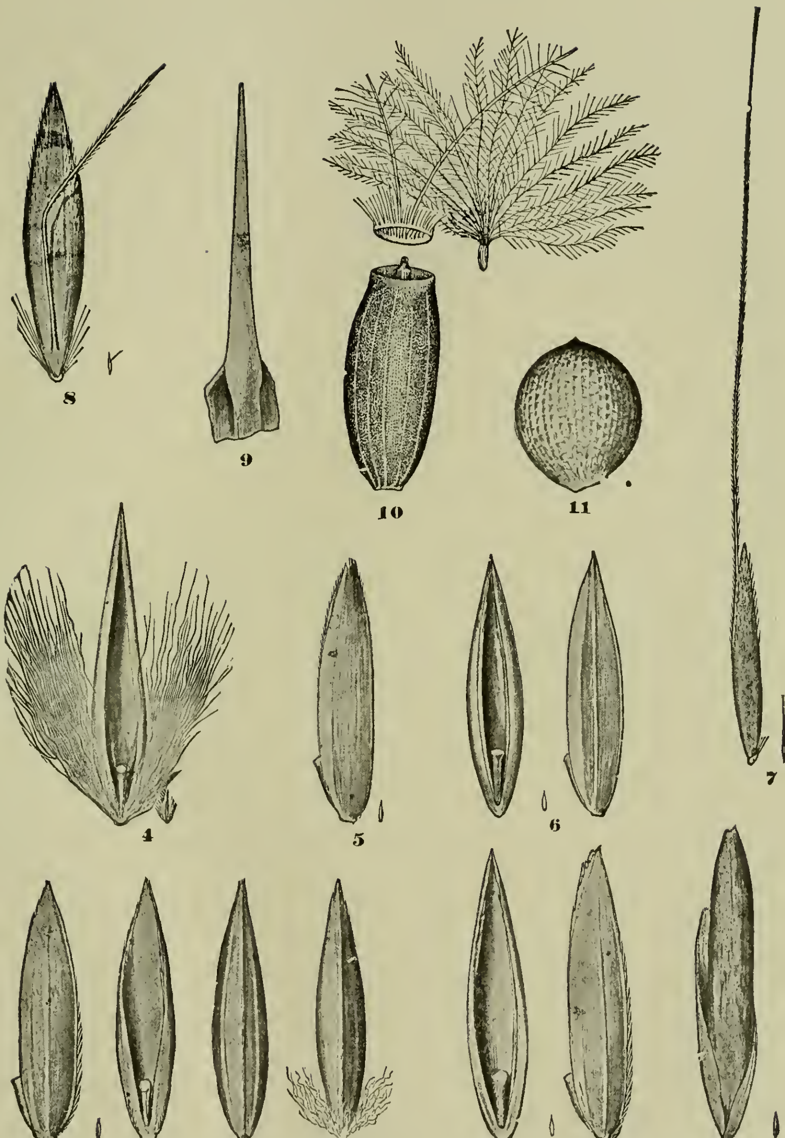

FIG. 503. Seeds of Poas with impurities. 1, Kentucky Blue Grass rubbed and unrubbed; 2, Wood Meadow Grass (*Poa nemoralis*); 3, Ergot, a fungus; 4, Texas Blue Grass (*P. arachnifera*); 5, Canadian Blue Grass (*Poa compressa*); 6, Rough Stalked Meadow Grass (*Poa trivialis*); 7, Silky Bent Grass (*Apera spica-venti*); 8, Wood Hair Grass (*Deschampsia flexuosa*); 9, spine of Canada Thistle; 10, Canada Thistle; 11, caryopsis of Stink Grass (*Eragrostis major*).

(U. S. Dept. Agr.)

weeds have not prominent dissemination mechanisms but are transferred with agricultural seeds, as carrot, buckhorn, dodder, sheep sorrel, yellow trefoil, quack grass and pigeon grass. The separation of impure seed from agricultural seed necessitates the recognition by their morphological characters of obnoxious seeds.

An economic consideration of dissemination of weed seeds and their control involves (1) familiarity with the morphology of the fruit and seed; (2) the limitation of the habitat in which the weed is able to thrive; (3) recognition of the avenues and agents of distribution.

CHAPTER VI.

ROOTS AND ROOT-STOCKS OF WEEDS.

J. C. CUNNINGHAM

CHAPTER VI.

ROOTS AND ROOT-STOCKS.

The study of root systems is accompanied with more or less difficulty and expense, and this, no doubt, accounts for the small amount of work done along this line.

Two methods have been employed to obtain the complete root system of growing plants. That used by Ten Eyck is perhaps the most satisfactory, although tedious and expensive. It consists of excavating about a plant and enclosing the whole mass of earth containing the roots in a cage of wire netting. Steel rods are thrust through the cage horizontally to prevent the roots from breaking. The soil is then carefully washed away leaving the roots very nearly in their natural position.

The other method, employed by a Russian investigator, Rotminstror, has given quite satisfactory results. The plants are grown in soil made up of top- and subsoil. This is placed, the subsoil below and the topsoil above, in boxes 1 in. wide, 20 to 40 in. deep and 20 to 40 in. long. These boxes are placed in the ground level with the surface. The plants are then grown in these boxes and removed when desired, the soil carefully washed away and the entire plant transferred to paper.

FIG. 504. Root-stocks or rhizomes of Quack Grass (*Agropyron repens*). These root-stocks are sometimes more than four feet long. (Photographed by Stevens.)

The pictures shown here are of plant roots obtained by the first method, the wire cages being omitted.

The roots of weedy plants vary widely in form, structure, and in longevity. Their function is three- and sometimes fourfold: First, to absorb water and dissolved mineral matter; second, to anchor the plant in the soil; third, to act as a storehouse for reserve food, and fourth, may serve to propagate the plant.

Fig. 505. Roots of White Sweet Clover (*Melilotus alba*). Plants with several strong branching roots.
(Photographed by Stevens.)

ROOT FORMS.

Root forms may be divided into four general types: First, the primary; in this case a single, usually enlarged central root is developed. From it grow the smaller lateral roots. The burdock (*Arctium lappa*), is of this class. Second, multiple primary, in which the embryonic root almost immediately breaks up into many usually enlarged and fleshy roots. Sweet clover (*Melilotus alba*), Fig. 505, offers a good example of this type. Third, tuberous or those that develop an enlarged portion at the end of a somewhat smaller one. Fourth, fibrous in which a mass of small roots develop usually just below the stem as in most of the grasses and in the plantains.

Besides the forms already mentioned we find various types of aerial roots, or those that develop on the plant above ground. The aerial roots of the ivy become finger-like and cling to objects to assist the plant in climbing; those of the mistletoe and the dodder become parasitic by pushing their aerial roots into the tissues of the host plant and drawing nourishment from it.

In performing the four functions mentioned above the roots of a single plant may occupy considerable area. Dr. Pammel has prepared the following table showing the depth and spread of the root system of a number of our noxious weeds.

Weed	Depth	Spread
Buckhorn	2– 8 in.	24 sq. in.
Plantain	3–13 "	30 " "
Wild hemp	1– 6 "	10 " "
Evening primrose	3– 5 "	30 " "
Beggar ticks	3– 5 "	40 " "
Dog fennel	2– 3 "	4 " "
Nigger head	3– 6 "	20 " "
Goldenrod	5 "	70 " "
White vervain	2– 4 "	36 " "
Canadian lettuce	5– 7 "	144 " "
Field thistle	8 "	50 " "
Burdock	40 "	150 " "
Black nightshade	1– 4 "	88 " "
Pennsylvania smartweed	1– 4 "	45 " "
Lady's thumb	1– 4 "	90 " "
Yellow oxalis	1– 2 "	24 " "
Prickly lettuce	½– 2½ "	6 " "
Cocklebur	4–10 "	425 " "
Greater ragweed	4 "	48 in. long
Rough pigweed	7–14 "	144 sq. ft.
Horseweed	7–14 "	144 sq. in.
Tumbleweed	2– 8 "	60 " "
Small ragweed	8– 9 "	60 " "
Spanish dagger	5– 8 "	42 " "

The amount of reserve food stored within weed roots depends to a considerable extent upon the length of time they continue to live.

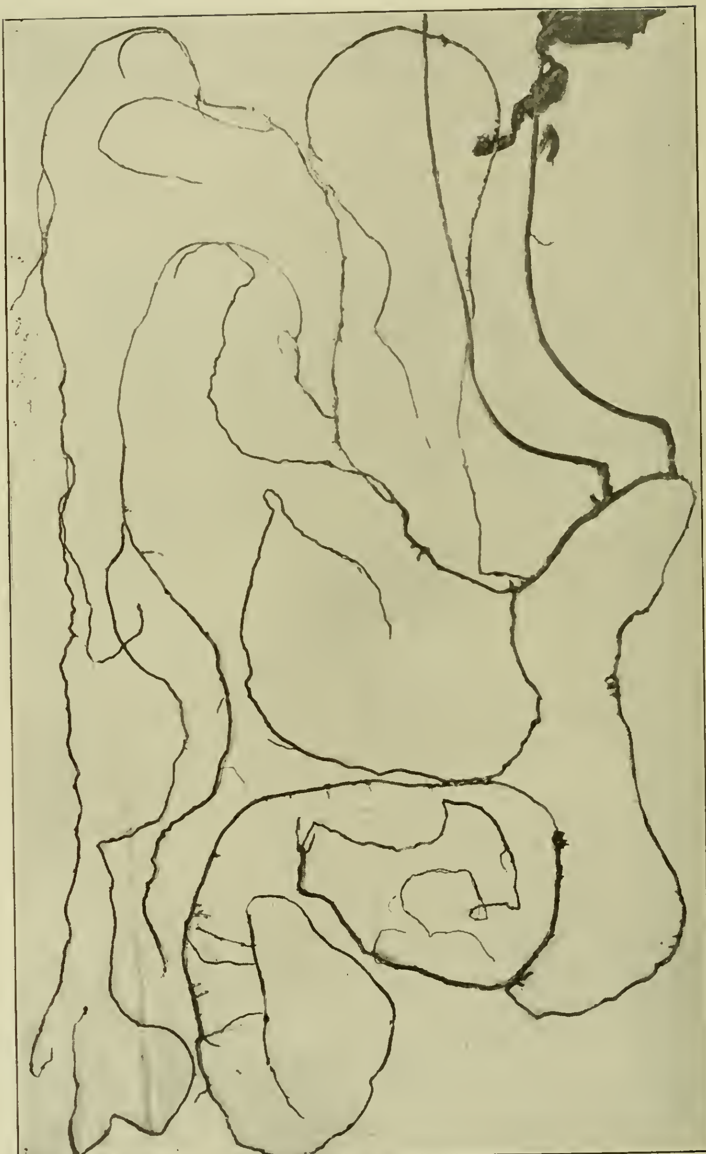

FIG. 506. Roots of Common Milkweed (*Asclepias syriaca*). These roots are sometimes more than 14 feet long. Buds are numerously produced on the root. More than 100 were found on the roots of this plant.
(Photographed by Colburn.)

Roots may be classified according to their length of life, and this is, perhaps, the most practical knowledge to possess concerning weeds. Without this knowledge no intelligent or successful method of eradication can be adopted.

First we have the annuals or those which complete their growth and mature their seed in one year. These plants produce an enormous amount of seed, sometimes as high as 50,000 to a single plant. The root system is simple, although it may extend to a considerable distance horizontally. Such plants are easily destroyed by cultivation unless they root from the joint as in the case of the crab grass (*Digitaria sanguinalis*).

FIG. 507. Roots of Curled Dock (*Rumex crispus*). (Photographed by Stevens.)

Second are the winter annuals. These plants may begin their growth in the spring, in which case they become annuals. Many of the seeds, however, germinate in the fall and throw up a rosette of leaves and thus pass the winter stage. In the spring stems are thrown up from these leaves and seed is produced. Our common shepherd's purse (*Capsella bursa-pastoris*) is an example.

The third class is the biennials or those which expend their energy the first season in forming a root system, usually fleshy, and the second season in maturing seed. We have numerous examples among the garden crops, such as the beet, turnip, carrot, etc., while among the weedy plants we have the burdock (*Arctium lappa*), the sweet clover, figure 505, the wild parsnip and others. If these plants are prevented from forming seed the second year they perish.

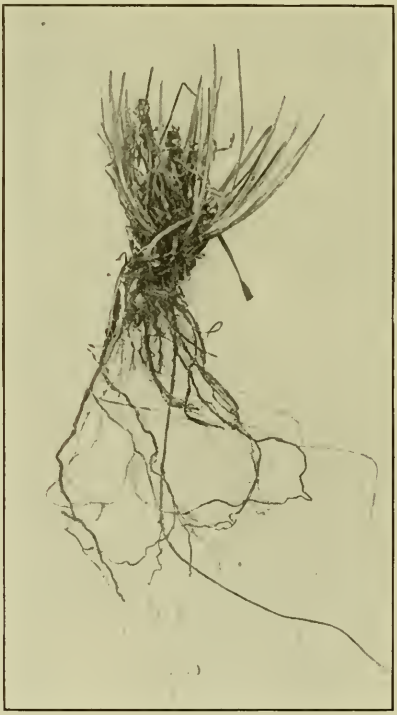

FIG. 508. Roots of Buckhorn (*Plantago lanceolata*). This perennial weed is easily destroyed by cultivation.
(Photographed by Colburn.)

In the fourth class belong the perennials which live year after year and for this reason become our most noxious weeds. When the roots once become well established it is very difficult to eradicate them, as is shown by the lawns, fields and pastures which are infested with such weeds as dandelions, quack grass, Canada thistle,

FIG. 509. Fibrous roots of Buckhorn.
(Photographed by Gardner.)

docks and wild morning-glory. These plants do not, as a rule, produce large quantities of seed but depend upon the roots or stems as a means of propagation. Thus if a field infested with quack grass or morning-glory is plowed or disked the roots or rhizomes are broken up and each piece may produce a new plant.

Some roots which do not spread extensively through the soil but form new plants from offshoots from the crown, such as the docks and wild gourds, form heavier roots from year to year for the following reason: The root growth is most active at the apex of the main roots. This resumption of growth starves many of the older roots, as we find few lateral on these older portions, and it thus extends the root system.

In the annuals there is little need for a large amount of reserve food within the roots for the elaborated food is used up largely as it is manufactured. The life of the plant ceases when seed is produced. In the biennials, however, large quantities of reserve

FIG. 510. Biennial root of Young Bull Thistle (*Cirsium lanceolatum*) after one year's growth.
(Photographed by Charlotte M. King.)

food are stored in the roots. The same is true of the perennials although to a less marked degree than of the biennials.

By studying the root system in the late fall we may determine roughly whether the weed is an annual, a biennial or a perennial. That is to say, dead small fibrous or primary roots and seed production indicate an annual; large fleshy roots and no seed production a biennial; reserve food within the roots beside seed production a perennial.

PROPAGATION OF WEEDS BY ROOTS AND STEMS.

Prof. Hitchcock says that weeds may be propagated by seed and buds or by vegetative sprouts. The layman is inclined to call all parts of the plant below ground root. It may be, however, a stem called a root-stock or rhizome. Microscopical examination is often necessary to determine which is root and which is stem.

FIG. 511. Underground rhizomes of common Morning-glory (*Convolvulus sepium*).
(Photographed by Stevens.)

ROOTS.

Adventitious buds are produced at indefinite points along the roots and from them stems and plants develop. A number of our noxious weeds are propagated by these running or creeping roots, such as: milkweed (*Asclepias cornuti*), bindweed (*Convolvulus arvensis*), sheep sorrel (*Rumex acetosella*), Indian hemp (*Apocynum cannabinum*), perennial ragweed (*Ambrosia psilostachya*), pasture thistle (*Cirsium undulatum*).

The weeds mentioned above are comparatively shallow rooted. A few weeds are propagated by buds which come from deep vertical roots. Among them we find the following: horse nettle (*Solanum carolinense*), ground cherry (*Physalis* sp.), Canada thistle (*Cirsium arvense*).

UNDERGROUND STEMS OR RHIZOMES.

These underground stems are usually found at a short distance beneath the surface. Along these stems are found nodes with leaf scales at definite intervals. From these nodes roots develop which penetrate the soil and leafy stems which develop above ground. Some of the weeds so propagated are as follows: quack grass

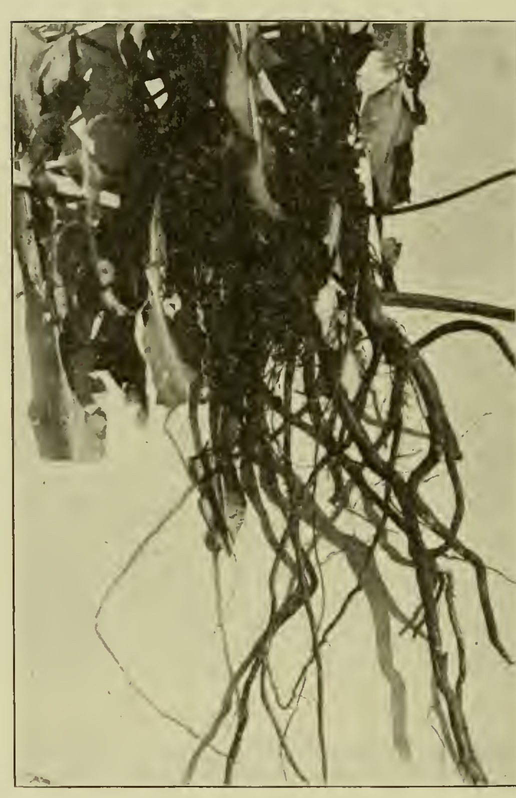

FIG. 512. Roots of Sour Dock (*Rumex crispus*).
(Photographed by Stevens.)

(*Agropyron repens*), morning-glory (*Convolvulus sepium*), smartweed (*Polygonum muhlenbergii*), poison ivy (*Rhus toxicodendron*), nettle (*Urtica gracilis*), wild rose (*Rosa arkansana*).

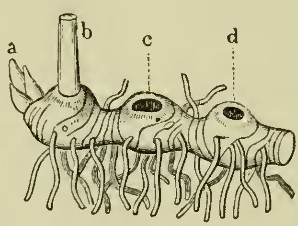

FIG. 513. Rhizome of Solomon's Seal; a, leaf bud; b, old stem; c, d, old stem scars.
(After Thomé.)

FIG. 514. European Morning-glory or Bindweed (*Convolvulus arvensis*). In gardens and fields.
(After Clark and Fletcher.)

Crowns or Short Offshoots.

A long list of weeds produce heavy crowns near the surface of the soil. Stems spring from these crowns year after year. Parts of the crown may become separated from the parent plant and thus form an independent plant. Among the weeds so propagated we find the dandelion (*Taraxacum officinale*), white vervain (*Verbena urticaefolia*), plantain (*Plantago lanceolata*), catnip (*Nepeta cataria*), curled dock (*Rumex crispus*), smooth dock (*Rumex altissimus*), rib grass (*Plantago lanceolata*), ox-eye daisy (*Chrysanthemum leucanthemum*).

CHAPTER VII.

NUMBER AND KINDS OF WEEDS ON DIFFERENT SOILS.

CHAPTER VII.

NUMBER AND KINDS OF WEEDS IN DIFFERENT FIELDS.

During the season of 1912 Mr. Robert H. Birlingmair counted the weeds appearing on various fields under different conditions, for this purpose four feet each way being measured off and the different weeds noted. The results were as follows:

FIELD 1.*

Weed	Date					
	Mar. 29	Apr. 6	Apr. 13	Apr. 20	Apr. 27	May 4
Peppergrass**	24	14	8	0	1	—
Dandelion	6	3	—	—	—	—
Tall fivefinger	3	1	2	—	—	1
Small ragweed	—	—	—	1	31	10
Blue grass	20	—	51	—	3	24
Bracted vervain	10	—	—	—	—	—
Mustard	1	—	—	—	—	—
Daisy fleabane	—	8	1	—	—	—
Pigweed	—	—	—	1	—	—
Spotted spurge	—	—	—	—	282	460
Horseweed	—	—	—	—	4	6
Pennsylvania smartweed	—	—	—	—	4	1248
Ground cherry	—	—	—	—	2	2
Green foxtail	—	—	—	—	—	84
	—	—	4	—	—	—
	—	—	—	—	—	2

*On corn land that was in blue grass sod last year.
**A winter annual.

FIELD 2.*

Weed	Date					
	Mar. 29	Apr. 6	Apr. 13	Apr. 20	Apr. 27	May 4
Yellow foxtail	—	—	—	—	—	10
Daisy fleabane	—	—	—	—	—	—
Horseweed**	143	65	—	1	34	72
Vervain	—	—	32	—	—	—
Plantain	—	—	—	11	—	—
Pennsylvania smartweed	—	—	—	—	1	—

*On timothy meadow.
**Winter annual.

FIELD 3.*

Weed	Mar. 29	Apr. 6	Apr. 13	Apr. 20	Apr. 27	May 4
Small ragweed	--------	--------	1	1	--------	--------
Pennsylvania smartweed	--------	--------	--------	2	--------	1
Green foxtail	--------	--------	--------	--------	--------	1

*On corn land that had been fall plowed. Field worked up and sowed to small grain just before April 27.

FIELD 4.*

Weed	Mar. 29	Apr. 6	Apr. 13	Apr. 20	Apr. 27	May 4
Small ragweed	--------	--------	10	3	8	--------
Lamb's quarters	--------	--------	--------	--------	1	3
Pennsylvania smartweed	--------	--------	21	78	99	77
Yellow foxtail	--------	--------	--------	--------	--------	215

*On land sowed to winter wheat.

FIELD 5.*

Weed	Mar. 29	Apr. 6	Apr. 13	Apr. 20	Apr. 27	May 4
Yellow foxtail	--------	--------	--------	--------	--------	599
Green foxtail	--------	--------	--------	--------	--------	718
Daisy fleabane	--------	1	--------	--------	--------	--------
Bracted vervain	--------	--------	3	--------	--------	--------
Peppergrass	--------	--------	3	--------	3	--------
Blue grass	--------	--------	--------	--------	4	--------
Pennsylvania smartweed	--------	--------	--------	--------	40	71
Spurge	--------	--------	--------	--------	--------	47

*On old corn land. Stalks harrowed down just previous to April 20.

FIELD 6.*

Weed	Date					
	Mar. 29	Apr. 6	Apr. 13	Apr. 20	Apr. 27	May 4
Small ragweed				1	33	
Yellow foxtail						475
Green foxtail						40
Lamb's quarters						3
Pennsylvania smartweed			11	54		
Blue grass					1	
Dooryard knotweed						3
Horseweed						3
Spurge						39
Hedge mustard						71

*On fall plowed oats stubble.

FIELD 7.*

Weed	Date					
	Mar. 29	Apr. 6	Apr. 13	Apr. 20	Apr. 27	May 4
Dandelion	5	11				
Veronica			1			
Lamb's quarters				1		
Small ragweed			9	6		
Yellow foxtail						16
Shepherd's purse	75	5	1			
or peppergrass	+5	+4	1			
Blue grass	2	7	7	2		
Hoary vervain	2					
Pennsylvania smartweed				1		
Lady's sorrel	+3					

*On unplowed oats stubble. Field plowed previous to April 27. +Marks winter annuals.

FIELD 8.*

Weed	Date					
	Mar. 29	Apr. 6	Apr. 13	Apr. 26	Apr. 27	May 4
Small ragweed	--------	33	169 46	8	--------	--------
Mexican dropseed	--------	--------	++37	++5	++16	++18
Lamb's quarters	--------	--------	10	7	--------	--------
Morning glory	--------	--------	--------	++4	++6	++7
Spurge	--------	--------	--------	49	--------	--------
Yellow foxtail	--------	--------	--------	--------	--------	--------
Green foxtail	--------	--------	--------	398	--------	1785
Pennsylvania smartweed	15	38	65	49	--------	--------
Mustard	23	--------	--------	--------	--------	--------
Horseweed	--------	--------	++26	9	10	11
Scribner's panic grass	--------	--------	+4	--------	--------	--------
Tansy mustard	--------	--------	2	--------	--------	--------
Nyctelea	--------	--------	--------	3	--------	--------
Yellow dock	--------	--------	--------	--------	--------	+158
Large spotted spurge	--------	--------	--------	--------	--------	129
Old witch grass	--------	--------	--------	--------	--------	2
Wild four-o'clock	--------	--------	--------	--------	--------	+2
Self-heal	--------	--------	--------	--------	--------	2

*In sheltered place on the south side of the railroad grade. Weeds were not all counted on April 27th, but there were hundreds of small ragweeds and smartweeds, and probably more than a thousand green foxtail plants.

++Winter annual.

+Perennial.

These tables reveal some interesting facts. The first weeds to appear in March were the winter annuals, like peppergrass and shepherd's purse, certain perennial weeds, and in one case horseweed (*Erigeron canadensis*) in a timothy meadow. Two weeks later smartweed (*Polygonum*) was abundant. Spurge (*Euphorbia*), an annual, was abundant in the latter part of April and early May. Foxtails in some cases surpassed all other weeds in abundance early in May. The smartweeds (*Polygonum*) and spurges increased enormously. These weeds were entirely removed from the plots. Fall plowing and clean cultivation certainly indicate a smaller number of weeds.

Long, who measured off a square yard of ground in* Great Britain, roughly grouping its plant life therein into species, found on this square yard 1,050 seedlings or 5,082,000 per acre. There were 654 buttercup seedlings, 107 of annual meadow grass, 60 of dock, 26 of goosefoot, 25 of groundsel, 15 of shepherd's purse, 14 of

*Trans. of Highland Agri. Soc. Scotland V. 23: 52.

FIG. 515. A weedy cornfield, mostly Foxtail and Smartweeds. (Photographed by Colburn.)

annual sow thistle, and 10 of chickweed, besides 139 of other species. He states that Korsmo's investigation revealed the presence of an even larger number of seeds having the power of germination, the seeds per square yard to a depth of 9.8 inches being as follows: Fallow field, 8,682 weed seeds (over 42,000,000 per acre); field for spring grain bearing the same crop for four successive years, 28,213 weed seeds (over 136,000,000 per acre); fallow field, 1,474 weed seeds (over 7,000,000 per acre).

Mr. Long gives the following species of weeds found in Great Britain within an area 100 feet square:

FIG. 516. Shepherd's Purse, a common winter annual. (After Vasey, U. S. Dept. Agr.)

FIG. 517. A cornfield from which Quack Grass was removed by hoeing and cultivation. In adjacent check it formed a sod. The check was given the ordinary methods of cultivation.
(Photographed by Colburn.)

Convolvulus arvensis (European bindweed)
Polygonum convolvulus (Black bindweed)
Polygonum aviculare (Knotgrass)
Rumex sp. (Dock)
Tussilago farfara (Coltsfoot)
Mentha arvensis (Peppermint)
Sinapis arvensis (Common mustard)
Sonchus arvensis (Field sow thistle)
Stellaria media (Chickweed)
Papaver sp. (Poppy)
Ranunculus arvensis (Corn crowfoot)
Viola sp. (Violet)
Potentilla anserina (Silver weed)
Aethusa cynapium (Fool's parsley)
Scandix pecten-veneris (Venus' comb)
Senecio vulgaris (Groundsel)
Galium aparine (Cleavers)
Vicia sativa (Vetch)

**Matricaria inodora* (Wild chamomile)
Plantago major (Common plantain)
Lychnis alba (White campion)
**Euphorbia exigua* (Spurge)
**Alopecurus agrestis* (Foxtail grass)
**Agrostis* sp. (Bent grass)
Agropyron repens (Quack grass)
Poa annua (Low spear grass)
**Veronica* sp. (Speedwell)
Myosotis sp. (Forget-me-not)
Alchemilla arvensis (Parsley-piert)

Most of these species are troublesome weeds, and it may be added that those marked with * were abundant.

For an Iowa cultivated field on June 2, 1903, the following weeds were found in one square rod.

Name of weed.	No. per sq. rod.
Smartweed (*Polygonum pennsylvanicum*)	40,324
Hedge mustard (*Sisymbrium officinale*)	3,060
Black beggar-ticks (*Bidens frondosa*)	476
Prickly lettuce (*Lactuca scariola var. integrata*)	204
Pigweed (*Chenopodium album*)	340
Horseweed (*Erigeron canadensis*)	7,412
Dandelion (*Taraxacum officinale*)	68
Foxtail (*Setaria*)	136,000

WEEDS AND CONTINUOUS CROPPING.

Everyone has observed that continuous cropping increases the number of weeds; not only is this true for many parts of Iowa but it is equally true for the older sections of the United States and of Europe. A. D. Hall who reported on the crops grown in grain land at Rothannstad* said:

After continuous cropping for forty-seven years said weeds of all descriptions occupy considerably more space after continuous cropping than before. The relative proportion they bear to the grasses and clover has increased from year to year. Such weeds as barnet, hawkbit and black knapweed became abundant.

Mr. Long gives the following list of worst weeds made by four expert Scotch agriculturists:

Arable Land.—Charlock, runch, chickweed, spurrey, docks, thistle, groundsel, coltsfoot, day nettle, red-shank, annual meadow grass, bulbous oat grass (pearl grass), couch grass, fine bent grass or black couch, and wild oats.

*Jour. Roy Agr. Soc. 64:-83.

Fig. 518. Green Foxtail (*Setaria viridis*). Common in gardens and fields. (Photographed by Colburn.)

Grass Land.—Buttercups, self-heal, docks, ragwort, daisy, thistles, ribwort, plantain, creeping soft grass, common bent grass, Yorkshire fog or woolly soft grass, moss.

There are, however, many other weeds which are given by him which are serious pests to the agriculturist of that country. Of the weeds of the arable land he lists buttercups, poppies, fumitory, charlock (*Brassica arvensis*), runch (*Raphanus raphanistrum*), shepherd's purse, corn cockle, spurrey, silver weed, cleavers, thistle (Canada thistle), sow thistle, coltsfoot, groundsel, bindweeds (*Polygonum convolvulus*), (*Convolvulus arvensis*), dodder, buckhorn, plantain, broom rape, corn or field mint, hemp and dead nettle, smartweed, or red-shank (*Plygonum persicaria*), knotweed, docks, goosefoot, quack grass, fine bent grass, pearl grass (*Arrenatherum avenaceum*), slender foxtail (*Alopecurus agrestis*), wild oats and

FIG. 519. Needle Grass (*Stipa spartea*). In pastures.
(Photographed by Charlotte M. King.)

FIG. 520. Purple Cone Flower (*Brauneria purpurea*). In a prairie pasture.
(Photographed by Pammel.)

horsetail. Of grass land weeds there are listed (*Colchicum autumnale*), buttercups, leguminous weeds, gorse (*Ulex*) broom, rest harrow (*Ononis spinosa*), dyer's green weed (*Genista tinctoria*), wild carrot, burdock, knapweed (*Centaurea nigra*), thistles (*Cirsium arvense, C. acaule, C. lanceolatum, C. palustris*), cotton thistle (*Onopordum acanthium*), daisy (*Bellis perennis*), ox-eye daisy, ragwort (*Senecio jacobaea*), plantains, yellow rattle, self-heal (*Prunella vulgaris*), docks, sorrel (*Rumex acetosa, R. acetosella*), stinging nettle (*Urtica dioica*); grasses: bent grass (*Agrostis alba*) tussock grass (*Aira caespitosa*), Yorkshire fog (*Holcus lanatus*), creeping soft grass (*H. mollis*), quaking grass (*Briza media*), barley grass (*Hordeum pratense*), and the bracken (*Pteris aquilina*), horsetail, and mosses.

FIG. 521. Common Porcupine or Needle Grass (*Stipa spartea*). A weed native to gravel soil, soon succumbs to cropping. a, single spikelet; b, fruit with sharp pointed callus.

(Lamson-Scribner, U. S. Dept. Agr.)

CHAPTER VIII.

INJURIOUSNESS OF WEEDS

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INJURIOUSNESS OF WEEDS.

Weeds are injurious to man in the following ways:

1. They crowd out the growing crop.
2. They consume the moisture necessary for a crop.
3. They consume the mineral or other food elements essential to a crop.
4. They pull down the crop.
5. They are injurious because the seeds are difficult to remove.
6. They are injurious because they harbor insects.
7. They are injurious because they harbor parasitic fungi.
8. They prevent the proper cultivation of the soil.
9. They may cause conditions which breed disease.
10. They may poison the soil.
11. They stop drains.
12. They poison animals and man.

1. WEEDS CROWD OUT GROWING CROPS.

When weeds are abundant they crowd out growing crops. Every plant requires a certain amount of space to bring forth a bountiful crop. Two plants cannot grow together in the same place; sooner or later, one plant will crowd out the other. If the weed is a more vigorous grower, like the greater ragweed, it will prevent the oat plant from maturing a crop. It prevents the proper amount of light coming to the plant, and so the food neecssary for a crop cannot be made.

2. WEEDS CONSUME THE MOISTURE.

To produce a crop all weeds need moisture, which should go to a more desirable crop. They transpire water just as cultivated plants do. Long, in ''Common Weeds of the Farm and Garden,'' says:

Weeds also absorb from the soil and ''transpire,'' or pass off into the atmosphere, large quantities of moisture which would be of great service to the growing crop. For example, a maize plant has been observed to transpire in the 16 weeks between May 22d and September 4th as much as 36 times its own weight. A large oak

FIG. 522. Ragweeds (*Ambrosia trifida*) consume an enormous amount of moisture.

tree is also stated to transpire 10 to 20 gallons of water in a day; while barley, beans, and clover were found to transpire, during five months of their growth, over 200 times their dry weight of water. Experiments conducted at the agricultural experiment station of Cornell university showed that during the growth of a 60-bushel crop of maize the plants pumped from the soil, and transpired into the air through the leaves, upwards of 900 tons of water. A 25-bushel crop of wheat similarly disposed of 500 tons of water. Weeds also transpire, and if the ground be covered with weeds it is certain that much of the moisture which would be of value to the crop will be lost in the manner indicated. Weeds are especially harmful in this way in a hot summer, and the loss is most felt by the cultivated crop on light sandy soils.

3. WEEDS CONSUME MINERAL AND FOOD ELEMENTS.

A weed needs not only the carbon dioxide of the air to make food, but the nitrogenous and mineral elements of the soil to make plant food, all of which should go to the crop. Long gives the following in his book, "Common Weeds of the Farm and Garden":

Some analyses made at Königsberg, and lately reported by Professor Stutzer and L. Seidler, show that the amounts of nitrogen, phosphoric acid, potash, and lime which are removed are deserving of serious consideration. A number of weeds without their roots were collected from oat fields, the soil of which was fairly heavy and poor in humus. In the case of the Wild Radish or White Charlock the plants had already formed many seed-pods, but the other weeds were in full bloom. The table following shows the percentage of ingredients in the dry matter. These figures indicate in a general way the amount of the chief plant foods required by weeds. The nitrogren in the Persicaria nearly equaled 20 per cent, and that in the Sow Thistle nearly 15 per cent of albuminoids in the dry matter. Phosphoric acid was chiefly taken up by Spurrey and Persicaria; potash by the Sow Thistle and Spurrey; and lime by Persicaria, Yarrow, and Cornflower.

PERCENTAGE CONTENTS OF DRY MATTER.

	Nitrogen	Phosphoric Acid	Potash	Lime	Sodium	Crude ash
Sow thistle (*Sonchus oleraceus*)	2.39	0.88	4.77	1.94	2.16	14.95
Cornflower (*Centaurca cyanus*)	2.30	0.78	1.94	3.13	1.07	8.12
Spurrey (*Spergula arvensis*)	2.36	1.08	4.21	1.52	1.91	10.12
Wild Radish (*Raphanus raphanistrum*)	1.85	0.78	1.30	1.81	0.71	5.22
Persicaria or red-shank (*Polygonum persicaria*).	3.12	1.16	3.12	4.93	2.53	10.58
Yarrow (*Achillea millefolium*)	2.30	0.93	3.15	3.84	1.17	9.61
Average of six weeds.....	2.38	0.93	3.08	2.86	1.59	9.76

4. WEEDS PULL DOWN THE CROPS.

Weeds like morning-glory, bindweed, wild buckwheat, and others, pull down a cultivated plant and then prevent the formation of a good crop.

5. WEEDS ARE INJURIOUS BECAUSE IT IS DIFFICULT TO REMOVE THE SEEDS.

It is difficult in many cases to remove weed seeds from seed of various kinds. Buckhorn can be removed with difficulty from clover seed; peppergrass with difficulty from timothy seed; greater ragweed from wheat; wild oats from oats; quack grass from brome grass; cockle from wheat. These impurities often greatly reduce the quality of the grain or seed.

6. WEEDS HARBOR INSECTS.

Long gives the following insects found on weeds:

FIG. 523. Morning-glory pulls down the corn and other crops. (After Vasey, U. S. Dept. of Agriculture.)

FIG. 524. Impurities found in Red Clover: 1, Bull Thistle; 2, Canada Thistle; 3, Green Foxtail (*Setaria viridis*); 4, common Plantain (*Plantago rugelii*); 5, Peppergrass (also found in Timothy); 6, Chicory; 7, Pigeon Grass (*Setaria glauca*); 8, Crabgrass (*Digitaria sanguinalis*); 9, Old Witch Grass; 10, Timothy; 11, Wild Carrot; 12, Pigweed (*Amaranthus retroflexus*); 13, Smartweed (*Polygonum persicaria*); 14, Lamb's quarters; 15, Dropseed Grass (*Muhlenbergia*).

(Drawings by Charlotte M. King.)

Weed "host."	Insect.
Charlock (*Sinapis arvensis*) and similar Crucifers	Turnip Flea Beetle or "Fly" (*Phyllotreta (Haltica) nemorum*) Cabbage and Turnip Gall Weevil (*Ceutorhynchus sulcicollis*)
Goosefoot (*Chenopodium album*) Thistles (*Cirsium* sp) Sow Thistle (*Sonchus*) Dandelion (*Taraxacum*) and apparently Docks (*Rumex*)	Mangold Fly (*Pegomyia betae*)

Charlock and other Crucifers Prickly saltwort (*Salsola kali*)	Diamond-Back Moth (*Plutella maculipennis*)
Thistles, and the Cotton Thistle (*Onopordon Acanthium*)	Celery Fly (*Acidia heraclei*)
Hops, Yorkshire Fog, *Poa annua*, Daisy, Shepherd's Purse, Spurrey, Buttercup, Cornflower, Sow Thistle, Black Bindweed (*Polygonum Convolvulus*) and Plantain	Stem Eelworm (*Tylenchus devastatrix*) (not an insect)
Nightshades, Henbane, Hedge, Mustard, Thistles, Goosefoot, and many other plants	Colorado Beetle (*Doryphora decemlineata*)
Shepherd's Purse, Winter Cress, Hedge Mustard	Cabbage Root Fly (*Phorbia brassicae*)
Various Grasses	Frit Fly (*Oscinis frit*)
Docks, Goosefoot, and some other weeds	Bean Aphis (*Aphis rumicis*)
Docks, Thistles, Burdock	Ghost or Otter Moth (*Hepialus lupuli*)

7. WEEDS ARE INJURIOUS BECAUSE THEY HARBOR PARASITIC FUNGI.

Long and Percival, in "Common Weeds of the Farm and Garden," have the following table of fungus diseases that affect various weeds:

Weed "host."	Disease.
Charlock and other Crucifers	Finger-and-toe of turnips (*Plasmodiophora brassicae* Wor.) *Peronospora parasitica* De Bary
Many species	White Root-rot (*Rosellinia necatrix* Prill.) Sclerotium Disease (*Sclerotinia sclerotiorum* Mass.)
Wild Barley (*Hordeum murinum*)	Blindness in Barley and Oats (*Helminthosporium gramineum* Erikss.)
Shepherd's Purse and other Crucifers	White Rust of Cabbages (*Cystopus candidus* Lev.)
Many species	Violet Root-rot (*Rhizoctonia violacea* Tul.)
Agrostis canina L., and other grasses	Reed-mace Fungus (*Epichloe typhina* Tul.)

Barberry	Rust of wheat (*Puccinia graminis* Pers.)
Sedges (*Carex*)	Gooseberry-leaf Cluster-cup (*Puccinia pringsheimiana* Kleb.)
Goosefoot	*Peronospora effusa* Rab., on spinach.
Docks, Sorrel, and many others	*Rosellinia radiciperda* Mass. A white Root-rot in New Zealand.
Hawkweed (*Hieracium*)	Chrysanthemum Rust (*Puccinia hieracii* Mart.)
Groundsel, Ragwort, and other species of Senecio	Pine Cluster-cups (*Peridermium pini* Wallr.)
Many wild grasses	Ergot of rye (*Claviceps purpurea* Tul.)

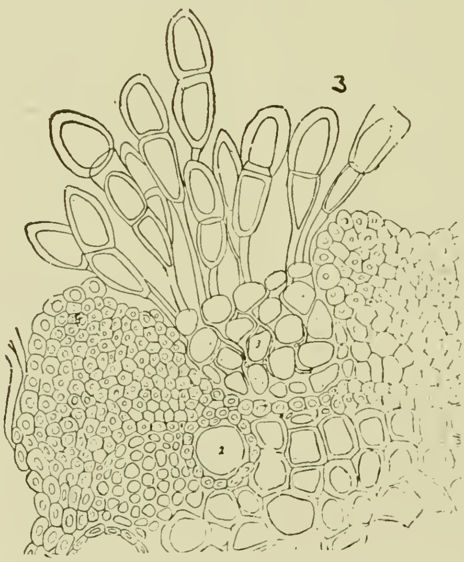

FIG. 525. Leaf rust of Wild Barley (*Puccinia rubigo-vera*) also occurs on wheat.
(Drawing by Charlotte M. King.)

These fungus diseases are particularly noticeable in a number of plants of the mustard family. The *Cystopus candidus* common upon cabbages in Europe is very common on a large number of cruciferous plants, like mustard, peppergrass, charlock, etc. At times it is very common upon the radish. A related fungus, downy mildew, of the mustard (*Peronospora parasitica*) is common and troublesome at times on some cultivated members of the mustard family. It is particularly common upon peppergrass and shep-

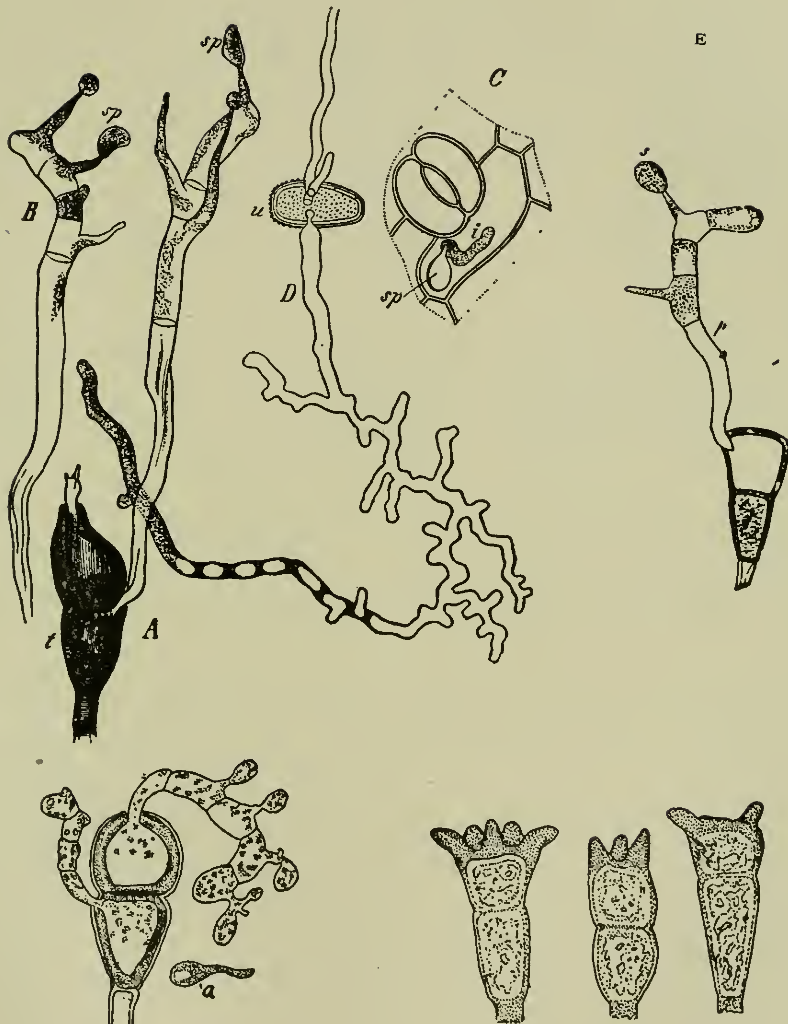

FIG. 526. Rusts of cereals also occur on weedy grasses, like Squirreltail Grass, Wild Oats, etc. *Puccinia graminis*: A, "winter" or teleutospore; t, germinating, B, germ-tube (*promycelium*) with lateral sporidia sp. C, epidermis of under surface of leaf of barberry showing crescent shaped cells of stoma and the germinating sporidium *sp* at *i* penetrating the epidermis. D, uredo spore germinating after being in water fourteen hours. E, *Puccinia rubigo-vera,* the upper cell has germinated. C. D. E, magnified 390 times, the other somewhat more. (After DeBary.) F, *Puccinia graminis,* Pers.; both cells have germinated; *a,* a sporidium germinating, magnified 600 times. (After Bolley.) G, *Puccinia coronata* Cda.; teleutospores of rust on leaves of oats, magnified about 600 times. (After Bolley.)

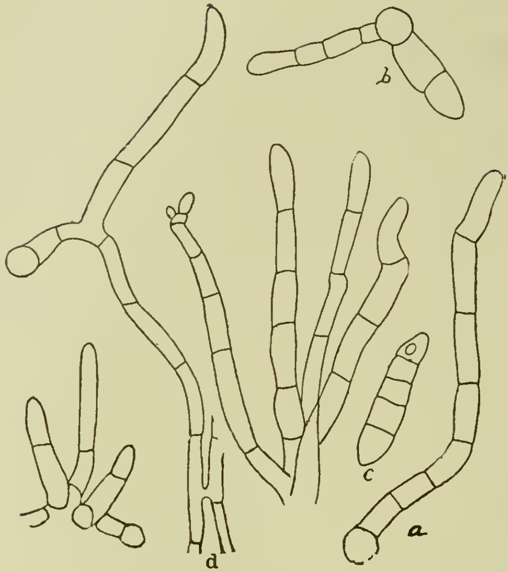

FIG. 527. Barley Blight (*Helminthosporium gramineum*) on Wild Barley. a and b, hypha; c, conidium.
(Drawing by Charlotte M. King.)

herd's purse. One of the very destructive diseases is the club-root of cabbage (*Plasmodiophora brassicae*) which is common upon cabbages in the eastern states, having now reached Illinois. This has been found on a large number of weeds of the mustard family, like mustard and charlock. A list of these was given by Dr. B. D. Halsted some years ago. Another most troublesome fungus disease is rust of wheat (*Puccinia graminis*) which is abundant upon quack grass, red top and other grasses. This rust frequently spreads upon these weeds and then to our cultivated cereals. Some of the related rusts like *Puccinia rubigo-vera* are common upon the leaves of squirrel-tail grass. A great many of the wild weedy grasses, like wild rye and quack grass, contain ergot (*Claviceps purpurea*). This is responsible in most cases for the conveying of this disease to cultivated cereals. We have a long list of root diseases found upon various weeds, like the scab of potato (*Oospora scabies, Ozonium omnivora*), etc. Certain species of *Sclerotinia,* one of which occurs upon sunflower, are transmitted from these weeds to cultivated plants.

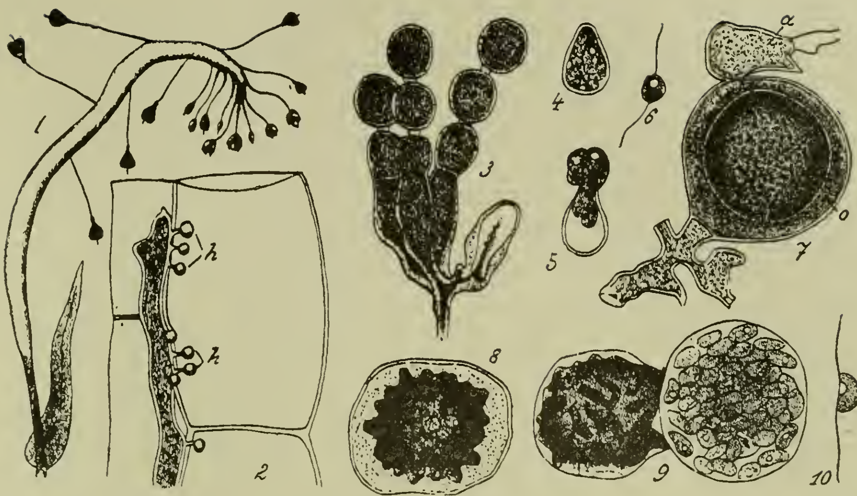

FIG. 528. White Rust (*Albugo candida*). 1. Inflorescence of Shepherd's Purse with fungus. 2. Mycelium with haustoria (h) x 390. 3. Conidiophores and conidia (spores) in chains x 400. 4 and 5. Formation of zoospores in conidia x 400. 6. Germinating zoospore. 7. Oogonium (o) and antheridium (a) attached, mycelium shown below. 8. Oospore with thick wall. 9. Germinating oospore forming a zoosporangium. 10. Zoospore 7-10 x 400. (After DeBary.)

8. WEEDS PREVENT THE PROPER CULTIVATION OF SOIL.

Weeds of certain types, particularly the perennial weeds, often make it extremely difficult to cultivate a soil. This is especially true of weeds like quack grass, which when present in the soil make it difficult not only to cultivate, but to plow and harrow, and also make the operation quite expensive.

9. WEEDS MAY CAUSE CONDITIONS WHICH BREED DISEASES.

Dr. Evans says that tall weeds contribute to the breeding places of mosquitos, and he thinks that in this way the mosquitos will lead to malaria. It is a well-known fact that the pollen from weeds like ragweed and goldenrod cause hay fever and for this reason these weeds should always be removed.

10. WEEDS MAY POISON THE SOIL.

There has long been a popular impression that weeds excrete poisonous substances which render the soil unfit for a succeeding crop. In regions where cocklebures are common, it is quite difficult to get a good stand of clover. Mr. E. B. Watson found that

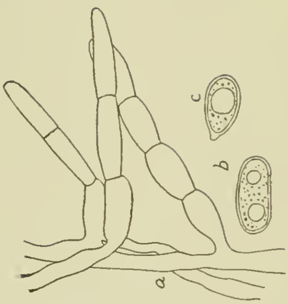

Fig. 529

Fig. 530

FIG. 529. Powdery Mildew of grasses (*Erysiphe graminis*). This is common on Wild Barley, occurs also on Wheat. a, mycelium and erect conidiophores; b, c, conidia.

FIG. 530. Cocklebur (*Xanthium canadense*). There is a widespread belief that Cocklebur and other weeds may excrete a substance which is injurious to other crops.

clover would not do as well in soil of this character, nor did the clover seed germinate as well, as in check soils. However, this subject has been investigated but little. Then there is the larger question of the actual antagonism between roots in occupied soils that should be occupied by the roots of agricultural plants.

11. WEEDS STOP DRAINS.

Drain tiles are frequently filled with a growth of the roots of weeds, causing stoppage and often much expense in removing the difficulty.

12. POISONOUS WEEDS.

There are many weeds which are injurious to man and to animals because they are poisonous. One of the best known illustrations is the cowbane, one of the most deadly poisonous plants in the state; then there are jimson weed, also poisonous; and poison ivy, which is poisonous to the touch.

A large number of weeds, while not strongly poisonous, are injurious; some taint cow's milk; some are injurious because of spines and prickles and thorns. This subject has been treated in full in a large book by the writer, "A Manual of Poisonous Plants." Too little attention has been paid by the school teachers of the state to the subject of poisonous plants.

FIG 531. Poison Ivy. Leaves poisonous to many people when they come in contact with the plant.

CHAPTER IX.

WEED MIGRATION

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WEED MIGRATION.

Geographical botany is that phase of botany which concerns itself with the distribution of plants over the earth's surface. The study involves questions of geology, climatology, plant physiology, geography, paleobotany, ethnology, history, agriculture, horticulture and commerce. J. Burtt Davy says: "The facies of the world's flora is rapidly changing, and tends to become more uniform, within certain limits, under the influence of agriculture and commerce." Before the advent of man the chief factors in weed immigration were the wind, water, snow, animals of various kinds, e. g., birds, mammals, reptiles, insects and gravity. Primitive man must have been an important factor in the distribution of plants. Many plants were no doubt widely scattered by the Indian. Some, like the persimmon, plum, pawpaw, maize, etc., were cultivated; but many weeds also were scattered by the Indian, finding a congenial environment near the wigwams. Commerce and the quest for new lands distributed many species far and wide. Lists of weedy plants of every civilized country, as indicated by Fernald, Davy, Gray and other botanists, show that a large percentage are foreigners. With the rapidity of modern transportation and with communication with every part of the world, weed seeds have naturally been carried with the commercial products. Without exception, wherever agriculture has advanced in Iowa, I believe weeds have followed cultivation, generally making their appearance along the water courses where our agriculture was fostered earlier than in the interior of the state. For instance, such weeds as Jimson weed, Indian mallow, burdock, mayweed or dog fennel, cheeses, mullein, dock, black nightshade, smartweed, bull thistle, pigweed, lamb's quarters, and purslane, have been known in Iowa for more than sixty years. Some of these were abundant species in cities and on farms along the Mississippi long before central and northwestern Iowa became settled. There are regions in northwestern Iowa where some of the above weeds are still unknown. The mayweed, velvet weed and mullein were only infrequent weeds in central Iowa twenty-five years ago, though becoming more frequent from year to year. Commerce indeed has taken an important part in the migration of weeds. Wild carrot, chicory, black medick, quack grass, Canada thistle, shoo-fly and dodder are becoming more and more abundant in the fields of Iowa. Many weeds, moreover, first make their appearance in the vicinity of cultivated fields. In nearly every case wild parsnip, tansy, shoo-fly, bouncing betty and butter and eggs show the influence of cultivation.

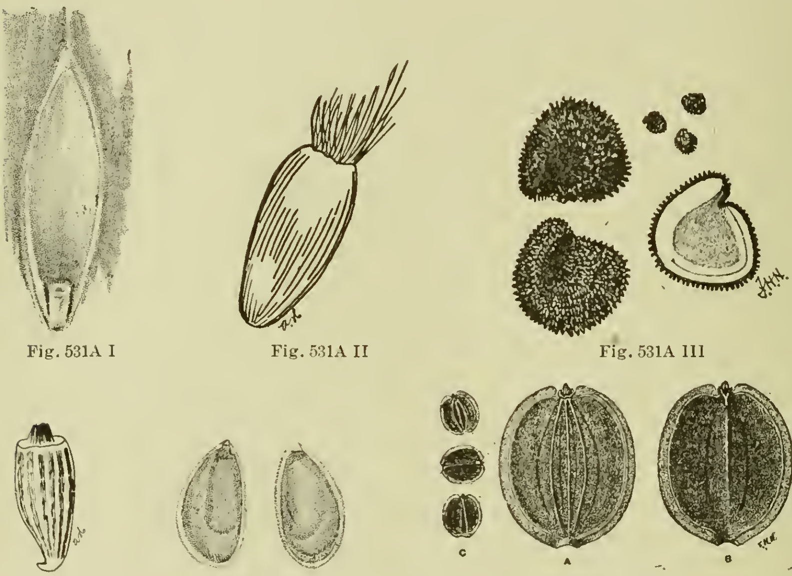

Fig. 531A I Fig. 531A II Fig. 531A III

Fig. 531 A IV Fig. 531A V Fig. 531A VI

FIG. 531-A. Seeds scattered with commercial seed. I. Quack Grass (*Agropyron repens*). II. Corn Flower (*Centaurea cyanus*); scattered with flower seed, a frequent escape from cultivation. III. Corn cockle (*Agrostemma githago*); scattered with wheat, frequent in wheat fields. IV. Chicory (*Cichorium intybus*); seed frequently found in alfalfa seed. It has been widely scattered in this way. V. Peppergrass (*Lepidium apetalum*); widely scattered with timothy seed. VI. Parsnip (*Pastinaca sativa*); a frequent escape from cultivation.
(I and V, drawings, Charlotte M. King; II and IV, drawings, Ada Hayden; III and VI, Hillman.)

Every phytogeographer is confronted with the problem of placing weeds of the given area in their relation to other floras. Let us take as an illustration a virgin Iowa prairie covered with a close mat of such plants as the blue stems (*Andropogon scoparius* and *A. furcatus*), vetch (*Vicia americana*), meadow rue (*Thalictrum*

FIG. 532. Blue Stem (*Andropogon scoparius*). A plant common to the prairies of Iowa. a, spikelet; b, c, first and second glumes; d, third glume; f, lodicules stamens and pistil.
(Lamson-Scribner, U. S. Dept. Agr.)

purpurascens), black-eyed Susan (*Rudbeckia hirta*), Scribner's panic (*Panicum scribnerianum*), Philadelphia lily (*Lilium philadelphicum*), lobelia (*Lobelia spicata*), sorrel (*Oxalis violacea*), closed gentian (*Gentiana andrewsii*), goldenrods (*Solidago missouriensis* and *S. rigida*), aster (*Aster laevis, A. azureus*) and a host of other associates. Compare with this an area in the Wisconsin drift where such plants as blue vervain (*Verbena stricta*), coreopsis (*Coreopsis palmata*), side oats (*Bouteloua curtipendula*), needle-grass (*Stipa spartea*), perennial ragweed (*Ambrosia psilostachya*), sunflower (*Helianthus occidentalis*), white aster (*Aster*

FIG. 532-A. Prostrate Pigweed (*Amaranthus blitoides.*)
(Photographed by Hart.)

multiflorus), fragrant goldenrod (*Solidago odora*), and many others occupy the ground. What becomes of the flora when the sod and its flora have borne their own peculiar vegetation? Comparatively few of the original inhabitants thereof remain as a part of the flora. The weeds most likely to appear here are such as have been partially adjusted to the open conditions. In such places it was not uncommon in the early days to find that such weeds as the common Iowa tumble weed (*Amaranthus graecizans*), tickle-grass (*Panicum capillare*), creeping verbena (*Verbena bracteosa*), milk spurge or milk purslane (*Euphorbia maculata* and *E. geyeri*), evening primrose (*Oenothera biennis*), horseweed (*Erigeron canadensis*), blue vervain (*Verbena stricta*), persisted for a few years, perhaps with a few other perennial weeds like flowering spurge (*Euphorbia corollata*), *Helianthus occidentalis* and *Desmodium canescens*, especially in a few places where tillage was not good; but in nearly every case these perennial weeds disappeared from the cultivated fields which thereupon became occupied by a large number of native annual weeds like the greater ragweed (*Ambrosia trifida*), Spanish needle (*Bidens frondosa, B. discoidea*) and smartweed (*Polygonum* sp.), a few hardy perennial weeds like milkweed (*Asclepias syriaca*), morning-glory (*Convolvulus sepium*), artichoke (*Helianthus tuberosus*) and meadow sunflower (*Helianthus grosseserratus*). Such annual or winter annual weeds as squirrel-tail grass (*Hordeum jubatum*), peppergrass (*Lepidium apetalum*) began to compete with a host of European and other exotic weeds like lamb's quarters (*Chenopodium album*), persicaria (*Polygonum persicaria*), purslane (*Portulaca oleracea*), foxtail (*Setaria glauca, S. viridis*) and, later, crab grass (*Digitaria sanguinalis* and *D. humifusa*). In grain

FIG. 533. Greater Ragweed (*Ambrosia trifida*). This weed rapidly occupies cultivated ground.
(Vasey, U. S. Dept. Agr.)

fields or flax fields appeared the usual crop of weeds that are carried with grain, like corn cockle, chess, cow-herb, mustard, pennycress and darnel. Then came the weeds which were introduced with clover seed as buckhorn, dodder, evening catchfly, chicory, wild carrot, etc.

FIG. 534. Small Peppergrass (*Lepidium apetalum*). Rapidly occupies the virgin soil.
(Drawing by Charlotte M. King.)

As our agriculture shifted from a wheat country to one dominating in corn, the weed flora changed slightly. Corn cockle, chess and vetch (*Vicia sativa*), so common everywhere in a small grain country, disappeared over a large section of Iowa. They are again appearing where wheat is grown. Charlock, a relic of flax culture, remained to be distributed largely with oats seed.

The fact, however, remains that a goodly number of our Iowa weeds are indigenous to this state. Many of these were plants capable of enduring sunshine and so did not have to readjust themselves to new conditions. So we have received not only from Iowa but from the country to the west, as Nebraska and the Dakotas, such plants as the squirrel-tail grass, buffalo bur, winged pigweed, common sunflower (*Helianthus annuus*), and stinkweed (*Cleome serrulata*).

The same thing has occurred in states to the west where many indigenous weeds are vying with the European weeds. To the north in Canada a pigweed (*Monolepis nuttalliana*) has become extremely common, while such weeds as foxtail are troublesome to a limited extent only. The holy grass, a curiosity in many parts of Iowa, is a troublesome perennial weed of Manitoba.

It would seem to me that it is not a question of self-fertilization or plasticity but one of tolerance of weeds for sunshine and ready means of dissemination either by natural agencies or by man.

Kabsch, in a discussion of this problem, notes that precisely the same things have occurred in various parts of the world where the forests have been cleared. In Bolivia, *Pteris, Anemia, Saururus, Lilicoya* were followed later by small shrubs of the *Eupatoriaceae* and *Malvaceae*. In Brazil, *Pteris caudata* and *Tristegis glutinosa* make their appearance after the forest fire. In Teneriffe, in 1815, *Pteris,* in 1820, *Erica arborea,* and in 1830 *Laurus canariensis* covered the ground. Kabsch notes how suddenly the vegetation of a forest changes in Europe when sunshine is admitted after a forest fire or after the clearing of the forest. Plants like vetchling (*Orobus*), four-leaved grass (*Paris quadrifolia*), *Arum*, lovers of the shade, soon succumb, and in their places fireweed (*Epilobium angustifolium*), bedstraw (*Galium*), thistle (*Cirsium*), wild marjoram (*Origanum*), foxglove (*Digitalis*), and others appear to be followed later by roses, brambles, hazel nut, birches, and grasses like reed bent grass (*Calamagrostis epigeios*), meadow grass (*Poa*), sweet vernal grass (*Anthoxanthum odoratum*), and bear moss (*Polytrichum commune*). Later shade-loving plants have a chance to grow.

In the Pacific northwest the fireweed (*Epilobium angustifolium*) and common brake (*Pteris aquilina*) occupy the ground after a forest fire. Velvet grass (*Holcus*) and groundsel (*Senecio*) are followed by *Spiraeas* and the California blackberries (*Rubus ursinus* and *R. nutkanus*) which in turn are succeeded by young

FIG. 535. Common Brake (*Pteris aquilina*). A troublesome weed following fires in the northwest, also under similar conditions in some parts of northeastern Iowa.
(Drawing by Charlotte M. King.)

forests of Douglas fir. In places, the red cherry (*Prunus emarginata*) may occupy the soil for a long time. Cusick states that the "elkweed" of eastern Oregon, more commonly called fireweed, the only herbaceous plant to follow the fires, is followed in a year or so by the lodge pole pine (*Pinus murrayana*) and Oregon fir (*Pseudotsuga taxifolia*). In western Oregon it takes more time; the ground is covered with a thick growth of blackberry plants. In the Rocky mountains the conditions are somewhat different. The first year after a fire very few plants will grow; but among the first, mention may be made of fireweed (*Epilobium angustifolium*), thistle (*Cirsium drummondii* and the variety *acaulescens*, *C. eriocephalum* and *foliosum*), groundsel (*Senecio canus*), (and in moist places *S. triangularis*), painted cup (*Castilleja integra*), wild heliotrope (*Phacelia sericea*), stone crop (*Sedum stenopetalum*), arnica (*Arnica cordifolia*). During the first year the vegetation is frequently widely scattered, much depending on the source of the seed. The lodge pole pine may not reappear on the burnt area for a long time. Here again much depends on the distance from which the seed has to come.

An Iowa forest, burned over, is covered by bull thistle (*Cirsium lanceolatum*), fireweed (*Erechtites hieracifolia*), horseweed (*Erigeron canadensis*), whiteweed (*Erigeron annuus*), followed later by small perennials, as blue grass, goldenrods, asters and sunflowers; then hazel, coral berry, hawthorns, elms, poplars, maples and oaks.

J. Burtt Davy* in an interesting account of alien plants spontaneous in the Transvaal enumerates 141 species alien to that part of Africa; of these 15 are now so cosmopolitan that their original home is not known. Two were unidentified. The origin of these

FIG. 536. Lamb's Quarters (*Chenopodium album*). A common foreign weed. Native to Europe.

*Rep. S. Afr. Ass. Adv. Sci. 1901: 252-299.

alien immigrants he gives as follows: Mediterranean region, 33 species; tropical America and warm temperate regions, 13; tropical Africa, 16; Australia, 1; temperate North America, 1; temperate South America, 1; uncertain origin, 16. It is interesting to note that the following Iowa species are abundant and troublesome in the Transvaal (the exceptions being capitalized): mayweed (*Anthemis cotula*), black mustard (BRASSICA NIGRA), hemp (*Cannabis sativa*), shepherd's purse (CAPSELLA BURSA-PASTORIS), goosefoot (*Chenopodium album*), wormseed (*Chenopodium ambrosioides*), nut grass (*Cyperus esculentus*), jimson weed (Datura *stramonium*), wire grass (*Eleusine indica*), fleabane (*Erigeron canadensis*), shoo-fly (*Hibiscus trionum*), common morning-glory (IPOMOEA PURPUREA), toad flax (LINARIA VULGARIS), darnel (*Lolium temulentum*), lady's sorrel (*Oxalis corniculata*), ribgrass (*Plantago lanceolata*), common plantain (*Plantago major*), black bindweed (POLYGONUM CONVOLVULUS), larger knotweed (*Polygonum erectum*), purslane (*Portulaca oleracea*), jointed charlock (*Raphanus raphanistrum*), sheep sorrel (*Rumex acetosella*), yellow dock (RUMEX CRISPUS), smooth tobacco (*Nicotiana glauca*), cow-herb (SAPONARIA VACCARIA), bristly foxtail (*Setaria verticillata*), black nightshade (*Solanum nigrum*), dandelion (*Taraxacum officinale*), chickweed (*Stellaria media*), sow thistle (SONCHUS OLERACEUS), goat's beard (TRAGOPOGON PORRIFOLIUS), vetch (VICIA SATIVA). In addition to the above plants, Davy lists quite a number which are common in the states to the south of Iowa and in California. Such plants as castor-oil bean (*Ricinus communis*), zinnia (*Zinnia pauciflorus*), marigold (*Tagetes erecta*), cosmos (*Cosmos bipinnatus*), cockscomb (*Celosia cristata*), four-o'clock (*Mirabilis jalapa*), evening primrose (*Oenothera grandiflora*), *Xylopleurum tetrapterum,* Mexican poppy (*Argemone mexicana*) are commonly cultivated in Iowa. Some, like *Argemone, Oenothera* and *Cosmos,* occasionally escape in Iowa. In a classification of these weeds, Davy places the alien plants under the following heads: I. Colonists (species not yet showing signs of spreading); shepherd's purse (*Capsella bursa-pastoris*), cat's-ear (*Hypochaeris radicata*), (one of the most common weeds on the Pacific coast and spreading in New England, not reported from Iowa), black bindweed (*Polygonum convolvulus*) (common everywhere in Iowa), toad-flax (*Linaria vulgaris*) (common in the north). II. Adventive (occasional, but spreading); mayweed (*Anthemis cotula*), Mexican poppy (*Argemone mexicana*), *Cosmos bipinnatus,* morning-glory (*Ipomoea purpurea*), darnel (*Lolium*

FIG. 537. Caster Oil plant. Cultivated as an ornamental plant in Iowa, but a troublesome weed in South Africa.
(After Faguet.)

temulentum), plantain (*Plantago major*), ribgrass (*Plantago lanceolata*), sheep sorrel (*Rumex acetosella*), curled dock (*Rumex crispus*), black nightshade (*Solanum nigrum*), dandelion (*Taraxacum officinale*), cow-herb (*Saponaria vaccaria*), vetch (*Vicia sativa*). III. Common; spiny amaranth (*Amaranthus spinosus*), goosefoot (*Chenopodium album*), hemp (*Cannabis indica*), nut grass (*Cyperus esculentus*), shoo-fly (*Hibiscus trionum*), lady's sorrel (*Oxalis corniculata*), purslane (*Portulaca oleracea*), castor-oil bean (*Ricinus communis*), and caltrop (*Tribulus terrestris*). IV. Abundant; (the most common species) purple amaranth (*Amaranthus paniculatus*), sticktight (*Bidens pilosa*), jimson weed (*Datura stramonium*), purple thorn apple (*Datura tatula*), wire grass (*Eleusine indica*), *Sida rhombifolia,* spiny clotbur (*Xanthium spinosum*), zinnia (*Zinnia pauciflora*).

FIG. 538. Spiny Clotbur. An abundant and troublesome weed in South Africa, occasionally a weed in southeastern Iowa. (After Thurber.)

As an example of the spread of American weeds in Europe several weeds may be cited. The small ragweed (*Ambrosia artemisiaefolia*), which is common throughout the United States, has according to Laubert, been widely spread with American grown clover seed*, though known in isolated places in Germany for forty years. It is now on the increase, perhaps because of the recent clover importation, yet its spread is somewhat limited because it blooms late. The plants are often only pistillate. In Steglitz, Germany, it was associated with black bindweed (*Polygonum convolvulus*), fleabane (*Erigeron canadense*), wall barley (*Hordeum murinum*), ribgrass (*Plantago lanceolata*), common plantain (*Plantago major*), wild carrot (*Daucus carota*), yarrow (*Achillea millefolium*) and tumble weed (*Corispermum hyssopifolium*).

*Landw. Jahrbucher. 35: 735-737.

FIG. 538A. Caltrop (*Tribulus terristris*).
(Photographed by Colburn.)

Scherer and others record the occurrence of *Solanum rostratum* in Germany (1883) and in France.

In Pflanzenleben, Kabsch says, "There are many illustrations of plant immigrations and spreading of plants in Europe, but so far as I know they have never occupied the soil to the same degree in Europe as in America. Most of our weeds of fields, like the cereals among which they grow, are of foreign origin, as star thistle (*Centaurea cyanus*), corn cockle (*Agrostemma githago*), charlock (*Raphanus raphanistrum*), *Myagrum*, etc." There are many other weeds of grain fields that are of similar origin that are not mentioned by Kabsch. Among them are the common mustard (*Brassica arvensis*), common vetch (*Vicia sativa*), darnel (*Lolium temulentum*), Russian thistle (*Salsola kali* var. *tenuifolia*), pennycress

FIG. 539. Corn Cockle (*Agrostemma githago*). An immigrant from western Asia.
(After U. S. Dept. of Agr.)

(*Thlaspi arvense*), false flax (*Camelina sativa*), Berteroa (*Berteroa incana* and *B. mutabilis*). These weeds were undoubtedly spread with the cultivation of grain. Many, though by no means all, were brought to Europe with wheat during the early cultivation of grain in Europe. The crusaders undoubtedly were responsible for the spread of these small grain weeds in Europe. Other plants, of which the horseradish is an illustration, were no doubt brought into west Europe as cultivated plants.

It may not be out of place to give the expression of some of the phytogeographical writers on the subject.

FIG. 540. A. Charlock (*Brassica arvensis*). B. Black Mustard (*B. nigra*). Immigrants from western Asia brought to the United States by way of Europe; early colonists.
(Dewey, U. S. Dept. of Agr.)

Warming and Vahl, in Oecology of Plants, speaking of the pampas in South America and the European plants found there, say:

The pampas occupy the vast, rockless, alluvial, South American plains that stretch from the Atlantic coast to the Andes, and from Patagonia to the forests of Paraguay and Brazil. The boundless, level or somewhat undulating, uniform, treeless surface is clothed with perennial grasses and herbs, like "a shoreless sea of grasses on whose horizon the eye finds no resting point, save where the sun rises and sinks". The genera represented are *Melica, Stipa, Aristida, Andropogon, Pappophorum, Panicum,* and *Paspalum.* Between the grasses grow numbers of herbs belonging to various families; these include *Verbena, Portulaca, Apocynaceae, Compositae, Eryngium,* and others. Curiously enough, there are very numerous European species, which have succeeded in exterminating the inland vegetation for miles and include not only such thistle-like Compositae as *Cynara cardunculus, Silybum marianum* and *Lappa,* but also *Lolium perenne, Hordeum murinum, H. secalinum,* *Medicago denticulata,* and *Foeniculum capillaceum.* In the flora of Buenos Ayres, according to Otto Kunze, at least three-quarters of the species are introduced, and largely Mediterranean in source.

Roland M. Harper says:

Every botanist who attempts to classify the vegetation of a populous region, such as the northeastern United States, is confronted at the outset with the problem of distinguishing the natural or undisturbed habitats from those which have been modified by civilization. Of course all our vegetation has felt the influence of civilization more or less, but it seems possible to draw a fairly sharp line between those habitats whose flora is essentially the same now as it was in prehistoric times and those where it has been so much altered that it is impossible to reconstruct the primeval conditions.

In general it seems to be true—and the task of the phytogeographer would be almost hopeless if it were otherwise—that external influences of slight amount or of short duration produce no permanent changes in vegetation. As an example of the first kind, when the pine trees are removed from an area of southern pine-barrens the amount of sunlight reaching the ground is increased probably not more than ten per cent, and this seems to make no perceptible difference to the herbaceous vegetation. But if the ground is then plowed up and cultivated, the original vegetation disappears, most of it never to return.

In the second place if a deciduous forest is destroyed by lumbermen or swept by fire it presents a very different appearance for a time, but if left undisturbed it will regain its former appearance and flora, or very nearly so, as soon as the trees have time to grow up again. But if the cutting or burning is repeated every few years the ground will gradually become covered with herbs and short-lived shrubs, among which it is difficult for trees to regain a foothold.

M. L. Fernald has said along the same line:

The clearing of the forest lands and the letting in of the direct sunlight is the inevitable forerunner of the farm and the village, but it is as inevitably the death warrant of hundreds of native plants. As is now well understood, a majority of our woodland species have a root structure which allows them to grow only in the moist, spongy humus of the forest or the swamp, conditions as many of us know from practical experience, almost impossible of artificial attainment. Try as we will, most if not all of us have failed to imitate with sufficient skill permanently to satisfy the plant the exact conditions which please the stemless lady's slipper (*Cypripedium acaule*), the trailing arbutus (*Epigaea*), the various species of *Pyrola,* the yellow wild foxgloves (*Gerardia*), the painted-cups (*Castilleja*), or the fringed gentian; though in their undisturbed haunts these plants bloom regularly and reproduce freely.

In their own wild homes, likewise, these and scores of other species are almost as sensitive to change as when forced by man into an unappreciated state of culture. The simple cutting of the forest is to most of these plants disastrous, though such of them as are very hardy will often linger until fire has swept the cleared land and burned out the tinder-like humus. After the fire comes a complete change of vegetation, and, during the interval before the stumps are finally removed and the land turned by the plow, the clearing too often becomes a tangle of fire cherry (*Prunus pennsylvanica*), aspens (*Populus tremuloides* and *P. grandidentata*) and other quick-growing trees and shrubs with a liberal mixture of blackberry and raspberry bushes, fireweeds (*Epilobium* and *Erechtites*), rattlesnake-weeds (*Prenanthes*), and other coarse plants which love the open and the direct sunshine. When the final planting of the farm crop comes, however, these sturdy plants of the burned land are quickly disposed of and rarely if ever do they make themselves troublesome in the cultivated field.

E. W. Claypole, in speaking of the migration of weeds to America, says:

Underneath the great wave of human emigration from the so-called Old to the so-called New World, underneath the noisy, busy surface tide that has swept westward from the shores of Europe to those of America during the last two hundred years, there has existed another and a less conspicuous wave, another and a less prominent tide of emigration. Westward in its direction, like the former, it has silently accomplished results that seldom strike the superficial eye, but yet are scarcely less in magnitude than those which have followed the advent of the white man to the shores of America.

I allude to that slow and noiseless immigration of European plants which has been going on for many years, and which probably commenced when the first European vessel touched our shores. Side by side with the displacement of the red man by the white man has gone on the displacement of the red man's vegetable companions by plants which accompanied the white man from his trans-Atlantic home. Not more completely have the children of the pilgrim fathers made themselves at home on the banks of the Charles and the Neponset, not more completely have the successors of Champlain and Jacques Cartier established themselves along the St. Lawrence, not more completely have the descendants of the aristocratic colonists of Maryland and Virginia appropriated the shores of the Chesapeake, than have the homely weeds of England and France made themselves at home in the New World; established themselves on its soil, appropriated its fields, its gardens and its waysides. Nor have the older states alone been seized by those European invaders. The stream has flowed beyond them, and as no village or hamlet in the west is without its population of European descent, so too it is never without its plant population of European weeds.

Dr. Asa Gray, who discussed the subject of weeds from a philosophical standpoint, said:

In the United States, and perhaps in most parts of the world, a large majority of the weeds are introduced plants, brought into the country directly or indirectly by man. Some, such as dandelion, yarrow, and probably the common plantain and the common purslane, are importations as weeds, although the species naturally occupy some part of the country.

Why weeds are so pertinacious and aggressive is too large and loose a question; for any herb whatever when successfully aggressive becomes a weed; and the reasons of predominance may be almost as diverse as the weeds themselves. But we may inquire whether weeds have any common characteristic which may give them advantage, and why the greater part of the weeds of the United States, and probably of similar temperate countries, should be foreigners.

As to the second question, this is strikingly the case throughout the Atlantic side of temperate North America, in which the weeds have mainly come from Europe; but it is not so, or hardly so, west of the Mississippi in the region of prairies and plains. So that the answer we are accustomed to give must be to a great extent the true one, namely, that, as the district here in which weeds from the Old World prevail was naturally forest-clad there were few of its native herbs which, if they could bear the exposure at all, were capable of competition on cleared land with emigrants from the Old World. It may be said that these same European weeds here prepotent had survived and adapted themselves to the change from forest to cleared land in Europe, and therefore our forest-bred herbs might have done the same thing here. But in the first place the change must have been far more sudden here than in Europe; and in the next place we suppose that most of the herbs in question never were indigenous to the originally forest-covered regions of the Old World; but rather, as western and northern Europe became agricultural and pastoral, these plants came with the husbandmen and the flocks, or followed them, from the woodless or sparsely wooded regions farther east where they originated. This, however, will not hold for some of them, such as dandelion, yarrow, and ox-eye daisy. It may be said that our weeds might have come to a considerable extent from the bordering, more open districts on the west and south. But there was little opportunity until recently, as the settlement of the country began on the eastern border; yet a certain number of our weeds appear to have been thus derived; for instance, *Mollugo verticillata, Erigeron canadense, Xanthium, Ambrosia artemisiaefolia, Verbena hastata, V. urticifolia,* etc., *Veronica peregrina, Solanum*

Fig. 541A

Fig. 541B

FIG. 541. A and B. Small Ragweed (*Ambrosia artemisiaefolia*). An immigrant from the southern part of the United States.
(Vasey, U. S. Dept. of Agr.)

carolinense, various species of *Amarantus* and *Euphorbia, Panicum capillare,* etc. Of late, and in consequence of increased communication with the Mississippi region and beyond—especially by railroads—other plants are coming into the eastern states as weeds, step by step, by somewhat rapid strides; such as *Dysodia chrysanthemoides, Matricaria discoidea,* and *Artemisia biennis.* Fifty years ago *Rudbeckia hirta,* which flourished from the Alleghanies westward, was unknown farther east. Now, in twenty years, it has become an abundant and conspicuous weed in grass fields throughout the eastern states, having been accidentally disseminated with red clover seed from the western states.

There are also native American weeds, doubtless indigenous to the region, such as *Asclepias cornuti, Antennaria margaritacea* and *A. plantaginifolia,* and in enriched soils *Phytolacca decandra,* which

FIG. 542. Tickle Grass (*Panicum capillare*). A common grass, probably originally found in clearings, has rapidly spread to cultivated ground. (Lamson-Scribner, U. S. Dept. of Agr.)

have apparently become strongly aggressive under changed conditions. These are some of the instances which may show that predominance is not in consequence of change of country and introduction to new soil.

In the interesting paper of Claypole the author argues that the abundance of European weeds in North America is because European plants are more plastic than American plants. He says: But a weed possessing a plastic nature—one capable of being moulded by and to its new surroundings—ere long adapts itself, if the change is not too great or sudden, to its new situation, takes a new lease of life, and continues in the strictest sense a weed.

Is it not possible that some such cause as this may lie underneath the facts we detailed in the earlier part of this paper? The true and full explanation of the transfer of European species to America should at the same time explain the absence of American species from Europe. But the partial causes already alluded to fail to do this. There is a residual effect for which they do not account. May it not be true that the plants of the European flora possess more of this plasticity, are less unyielding in their constitution, can adapt themselves more readily to new surroundings, and thus secure their continuance in the New World? And may it not be the lack of this plasticity in the American flora which incapacitates it for securing a foothold and obtaining a living in the different conditions of the New World? Under the care of the gardener they grow and embellish the gardens and conservatories of Europe, but without this care they speedily fail and die.

Dr. Gray in a very friendly criticism of this paper remarked that, "So far as we know, the greater plasticity of European as compared with American plants is purely hypothetical. More plastic, would mean of greater variability, which, if true, might be determined by observation. Because Europe once had more species or types in common with North America than it now has, it does not seem to follow that the former has 'a younger plant-life,' or that its existing plants are more recent than those of the American flora. And as already intimated, so refined an hypothesis is hardly necessary for the probable explanation of the predominance of Old World weeds in the Atlantic United States."

It is interesting to note the large number of plants which are continually being added to the flora of Europe. Bitter in his paper on the adventive flora of Bremen notes that out of the 2,492 plants listed by Garcke in his flora of Germany, 230 are adventive; Hock, who published a paper on the plants of North Germany, lists 54 as weedy and ruderal.

The region embraced in North Germany probably contains as many exotic weeds as Iowa. For our purpose let us compare foreign weeds of Iowa with the native plants. Hitchcock, in his catalogue of the plants of Ames and vicinity, lists 740 plants, of which 86 are introduced and of these about one-third have not become permanently established.

Dr. Charles Mohr in his paper on Plant Life in Alabama, states that "fully one-sixth of the plants enumerated in the catalogue of the Alabama flora as growing without cultivation are immigrants from other regions, and but few of them are native in the more distant parts of the continent north of Mexico. They are mostly from the warmer temperate, subtropical, and tropical regions of the Old World. Those of widest distribution and which have gained the firmest foothold are wanderers following civilized man in his conquest of the wilderness. Originally children of the open plain, exposed to the extremes of heat, cold, drought, and excessive rain, these plants necessarily acquire the widest elasticity in adapting themselves to new surroundings and possess the greatest power of resisting adverse conditions.''

THE DIRECTION OF WEED MIGRATION.

Mr. L. H. Dewey, who made a study of 200 North American weeds and their migration, says: ''A study of the origin of weeds now in this country will impress one with the largeness of the number that have been introduced from Europe in comparison with the number of native species or of species received from other directions.'' In the list of 200 weeds of the United States published in the Year Book for 1895, 108 species are of foreign origin, while 92 are native. Of the 108 introduced species, 64 are native in Europe and 30 are ascribed to the Old World in general, only 2 Asiatic species in the list having established themselves as weeds in this country without being first distributed in Europe. Africa and Australia are not represented among our weeds, while Central and South America have contributed only 12 or 15 important species, most of which are confined to the Gulf states. A list of the plants of Michigan published in 1892 contains 1,604 indigenous species, of which 22 are recognized as injurious weeds, and 142 species introduced from Europe, of which 57 have become troublesome weeds.

A list of Kansas weeds enumerating 209 species contains 129 native species, 42 introduced from Europe, and 38 from all other sources. Eighteen species native in the states east of the Mississippi river have been introduced into Kansas in opposition to the prevailing winds and the direction of the drainage, while only 3 species are mentioned which have come from the Rocky Mountain region with both of these natural forces in their favor.

In an article on the weeds of California 110 species are mentioned as troublesome in that state. Of these, 53 are native, 43 are introduced from Europe, 5 are from the eastern United States, 3 from Central and South America, and only 2 from Asia. Even in the states bordering the Gulf of Mexico the number of weeds introduced from Europe in cultivated land equals or exceeds those from Mexico and South America. Canada thistle, bur clover, and skunkweed have been taken from California to Australia, where they quickly become naturalized and are now rapidly spreading.

The weeds which have followed civilization in America are, shepherd's purse, dandelion, sow thistle, stinging nettle, mallow, plantain, chickweed, St. John's-wort, yarrow, toadflax and purslane. Manasseh Cutler, in 1783, reported 66 species, among them buttercup, chicory and daisy. Dr. Bigelow, in Florula Bostoniensis,

FIG. 543. Jimson Weed (*Datura stramonium*). An immigrant from India, reached United States by way of Europe.
(After Chesnut, U. S. Dept. of Agr.)

1814, records 83 introduced species and in the edition of 1840, lists 140 species. Dr. Fernald says: "Gradually this list has increased until we are forced to number among the wild plants of New England more than 600 species which have been introduced through human agency since the first cutting of the forests." The causes for the appearance of these weeds into New England, the west, Pacific coast and elsewhere must be ascribed to the sowing of seed that contained the weed seeds. Wheat always contained the seed of cockle, mustard, vetch, etc., consequently we find that these weeds are found wherever cereals are cultivated. Many plants were, however, planted for medicinal purposes, among which were peppermint, black henbane, tansy, chamomile, caraway, poison hemlock, and a long list of other plants utilized by the Mormons which have become weedy wherever these people have settled. Even in Iowa we find that such plants as tansy, elecampane, jimson weed, European morning-glory, shoo-fly, and others have been spread from cultivation and have become weeds. In regard to the introduction of plants, Dr. Fernald has stated the case very well in the following paragraph:

A review of the history and spread of this vagrant class of plants presents many aspects which are well worth consideration. John Josselyn, in 1672, stated that several species of European weeds had "sprung up since the English planted and kept cattle in New England", thus implying that these plants had come unbidden or at least were not purposely brought to this country. He records no less than 40 European weeds introduced in this manner. According to a time-honored tradition, based perhaps on fact, the first weed to spring up in the track of the pioneer is plantain, and on this account it has been called by some primitive races "White-man's Foot", a name of more than fanciful application; for without question the plantain and many other roadside species are spread directly by the foot of man. For some years strange and outlandish weeds have been appearing along the river below Waterbury, Connecticut. These plants, upon careful study, prove to be vagrant species from geographically remote portions of the world, and their presence along the Naugatuck river has

FIG. 544. Poison Hemlock (*Conium maculatum*). Common in Salt Lake Basin. (After Chesnut, U. S. Dept. Agr.)

been a mystery. Eventually, however, the whole matter was cleared when the source of these plants was traced to a factory which utilized old rubber shoes. These shoes were collected from every available source, and, before being melted for their rubber were stripped of the cloth linings which were thrown upon a rubbish heap. These linings naturally contained seeds of innumerable plants from the roadsides of every land, and the rains and spring freshets of the Naugatuck valley gave them every opportunity to scatter and to start life anew in Connecticut soil. In this or similar ways many of the plants mentioned by John Josselyn, Manasseh Cutler, and Jacob Bigelow undoubtedly reached our shores; and these emigrants are being reinforced by almost every person who comes to us from foreign lands.

Many weeds start in the proximity of woolen mills. Among these are, teasel, buffalo bur, various borages, erodium, etc. Others are introduced with agricultural seeds. In recent years there

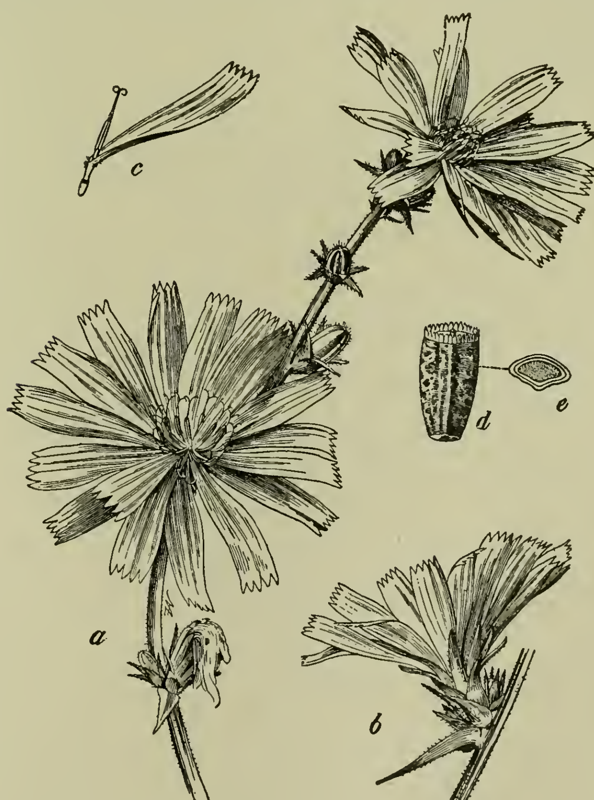

FIG. 545. Chicory (*Cichorium intybus*). An immigrant from Europe. a, flowering branch; b, single head; c, single flower; d and e achene; e, cross section.

(U. S. Dept. of Agr.)

have been introduced into Iowa such weeds as wild carrot (*Daucus carota*), *Silene noctiflora, S. dichotoma, Cichorium intybus, Conium maculatum, Centaurea solstitialis, Cirsium arvense, C. pratense, Cuscuta arvensis, C. epithymum, Eruca sativa,* and others, largely with clover and alfalfa seed. Still another and frequent source of the introduction of weeds is through the cultivation of ornamental plants which become weedy as: shoo-fly (*Hibiscus trionum*) during recent years, the bouncing bet (*Saponaria officinalis* L.), toad flax (*Linaria vulgaris*), *Euphorbia cyparissias,* live forever (*Sedum telephium*), snow-on-the-mountain (*Euphorbia marginata*) in many localities, pickerel weed (*Eichornia crassipes*) in Florida, water chestnut (*Trapa natans*) in central New England. The orange hawkweed (*Hieracium aurantiacum*), and others of this class are excellent illustrations of how ornamental plants become weedy. In some cases plants cultivated for food have become weedy, as in Iowa, the horse radish; in California, the beet (San Francisco Bay region); and in Utah and California, the spinach.

FIG. 546. Snow-on-the-Mountain (*Euphorbia marginata*). A western weed now common in some places in the east. (After Chesnut, U. S. Dept. Agr.)

New introductions have come not only into western Europe from the United States, but from eastern Europe, Asia, and from the tropical world. The *Berteroa incana,* a recent introduction into Iowa, has been reported in Germany by Scherer. The spiny knapweed (*Centaurea solstitialis*), a recent Iowa introduction, has been reported from Germany by Lehmann, Bitter and Alpers. The *Galinsoga parviflora,* an introduction from South America into the United States, has been reported from northern France and southern Germany by Kieffer. The storksbill (*Erodium moschatum*), the butterprint (*Abutilon theophrasti*), the spiny clotbur (*Xanthium spinosum*) and the shoo-fly (*Hibiscus trionum*), are common plants of the tropical regions everywhere; these have extended far northward. In recent years they have been reported in north Germany by Bitter. He has likewise reported as recent introductions the yellow sweet clover (*Melilotus officinalis*), *Matri-*

Fig. 547. Velvet Weed or Butterprint (*Abutilon theophrasti*). A tropical weed now common in the north and spreading to Europe. (U. S. Dept. of Agr.)

caria discoidea of Asia, Mexican fireweed (*Kochia scoparia*), brome grass (*Bromus tectorum*) in the vicinity of Bremen; all being indigenous to eastern Europe and western Asia.

Dr. Fernald states that of the species of plants growing in the British Isles, at an altitude of 3,000 feet in the mountain country, where the primitive vegetation is but little disturbed, 68% are also native to the mountainous regions of New England, but of the species that occur everywhere at low altitudes and in thickly settled and closely farmed districts only 23% are native to New England while more than 50% have become established in New England as weeds; and that barely 1% of the plants of temperate Europe have been imported from America, but every year adds to the new weeds introduced into Europe.

Dr. Gray, in that interesting paper on the Pertinacity of Weeds, refers to the book by Mr. Henslow on the Self-Fertilization of Plants, in which the latter comes to the conclusion that weeds are intrusive and dominating plants of great emigrating capabilities, and have a longer ancestral life history than their more or less aggressive relatives. Furthermore, this dominance may be attributed to self-fertilization. In the list of weeds that Dr. Gray mentions in this paper as the most abundant in eastern North America and the southern United States, the rule evidently does not hold that this dominance is due to self-fertilization; in fact some of the most dominant of these plants are pollinated by insects. For the sake of convenience I shall here use a list prepared by Dr. Gray in 1879, adding to it weeds that are more or less predominant in the state of Iowa at the present time; the Iowa weeds are printed in small capitals. There is a slight rearrangement, according to present interpretation of taxonomists.

Gramineae.

DIGITARIA HUMIFUSA, Smooth crab grass.
D. SANGUINALIS, Crab grass.
PANICUM CAPILLARE, Old-witch grass.
P. DICHOTOMIFLORUM, Sprouting crab grass.
ECHINOCHLOA CRUSGALLI, Barnyard grass.
SETARIA GLAUCA, Pigeon grass.
S. VIRIDIS, Green foxtail.
S. VERTICILLATA, Bristly foxtail.
CENCHRUS TRIBULOIDES, Sandbur.
Anthoxanthum odoratum, Sweet vernal grass.

Muhlenbergia mexicana, Mexican drop-seed.
M. racemosa, Marsh muhlenberg.
M. Schreberi, Nimble Will.
Sporobolus vaginiflorus. Sheathed rush grass.
S. neglectus, Small rush grass.
Alopecurus pratensis, Meadow foxtail.
A. geniculatus, Marsh foxtail.
Phleum pratense, Timothy.
Agrostis alba, Red top.
Avena fatua, Wild oats.
Eleusine indica, Wire grass.
Eragrostis pilosa, Southern spear grass.
E. megastachya, Candy grass.
Dactylis glomerata, Orchard grass.
Poa annua, Low spear grass.
P. pratensis, Kentucky blue grass.
P. trivialis, Rough-stalked meadow grass.
P. compressa, Wire grass.
Bromus secalinus, Chess.
B. hordeaceus, Soft chess.
B. arvensis, Field brome grass.
B. tectorum, Downy brome grass.
Festuca pratensis, Meadow fescue.
F. ovina, Sheep's fescue.
Lolium perenne, Common darnel.
L. temulentum, Poison darnel.
Agropyron repens, Quack grass.
A. caninum, Awned wheat grass.
A. Smithii, Western wheat grass.
Hordeum jubatum, Squirel-tail grass.
H. pusillum, Little barley.

Cyperaceae.

Cyperus esculentus, Nut grass.

Juncaceae.

Juncus tenuis, Slender rush.

Liliaceae.

Allium vineale, Wild garlic.

Urticaceae.

Cannabis sativa, Hemp.
Urtica gracilis, Nettle.

Polygonaceae.

RUMEX CRISPUS, Curled dock.
R. ALTISSIMUS, Pale dock.
R. SANGUINEUS, Bloody dock.
R. ACETOSELLA, Sheep sorrel.
POLYGONUM AVICULARE, Knotweed.
P. ERECTUM, Larger knotweed.
P. LAPATHIFOLIUM, Slender smartweed.
P. MUHLENBERGII, Marsh smartweed.
P. PENNSYLVANICUM, Pennsylvania smartweed.
P. ACRE, Water smartweed.
P. PERSICARIA, Lady's thumb.
P. CONVOLVULUS, Black bindweed.

Chenopodiaceae.

CHENOPODIUM BOTRYS, Jerusalem oak.
C. ALBUM, Goosefoot.
C. HYBRIDUM, Maple-leaved goosefoot.
ATRIPLEX PATULA, Orach.
CYCLOMA ATRIPLICIFOLIUM, Winged pigweed.
KOCHIA SCOPARIA, Mexican fireweed.
SALSOLA KALI VAR. TENUIFOLIA, Russian thistle.

Amaranthaceae.

AMARANTHUS RETROFLEXUS, Green pigweed.
A. GRAECIZANS, Tumble weed.
A. BLITOIDES, Prostrate pigweed.
ACNIDA TUBERCULATA V. PROSTRATA, Water hemp

Nyctaginaceae.

OXYBAPHUS NYCTAGINEUS, Wild four-o'clock.

Caryophyllaceae.

STELLARIA MEDIA, Chickweed.
Cerastium nutans, Mouse-ear chickweed.
AGROSTEMMA GITHAGO, corn cockle (wheat sections).
LYCHNIS ALBA, White campion.
L. dioica, Red campion.
Silene latifolia, Bladder campion.
S. NOCTIFLORA, Night-flowering catchfly.
S. ANTIRRHINA, Sleepy catchfly.

Saponaria officinalis, Bouncing Bet.
S. vaccaria, soapwort (wheat sections).

Portulacaceae.

Portulaca oleracea, Purslane.

Ranunculaceae.

Ranunculus abortivus, Small-flowered crowfoot.
R. bulbosus, Bulbous buttercup.
R. acris, Tall buttercup.
R. septentrionalis, Swamp buttercup.

Cruciferae.

Berteroa incana, Alyssum.
Thlaspi arvense, Frenchweed.
Lepidium virginicum, Large peppergrass.
L. apetalum, Small peppergrass.
Capsella bursa-pastoris, Shepherd's purse.
Camelina sativa, False flax.
Neslia paniculata, Ball mustard.
Raphanus raphanistrum, Jointed charlock (northeastern Iowa).
Brassica arvensis, English charlock.
B. nigra, Black mustard.
Sisymbrium officinale, Hedge mustard.
S. altissimum, Tumbling mustard.
Radicula nasturtium-aquaticum, Water cress.
R. armoracia, Horseradish.
Barbarea vulgaris, Winter cress.

Capparidaceae.

Polanisia graveolens, Clammy weed.
Cleome serrulata, Stinkweed.

Resedaceae.

Reseda lutea, Dyer's rocket.

Rosaceae.

Geum canadense, White avens.
Rosa pratincola, Prairie rose.

Leguminosae.

CASSIA CHAMAECRISTA, Partridge pea.
Genista tinctoria, Dyer's greenweed.
CROTALARIA SAGITTALIS, Rattle-box.
Trifolium arvense, Stone clover.
T. PROCUMBENS, Low hop clover.
T. procumbens, Low hop clover.
T. repens, White clover.
MELILOTUS OFFICINALIS, Yellow sweet clover.
M. ALBA, White sweet clover.
MEDICAGO LUPULINA, Black medick.
DALEA ALOPECUROIDES, Pink dalea.
ROBINIA PSEUDO-ACACIA, False acacia.
GLYCYRRHIZA LEPIDOTA, Liquorice.
VICIA SATIVA, Vetch.
V. villosa, Hairy vetch.
STROPHOSTYLES PAUCIFLORA, Wild bean.

Oxalidaceae.

OXALIS CORNICULATA, Lady's sorrel.

Geraniaceae.

GERANIUM MACULATUM, Wild cranesbill.

Euphorbiaceae.

ACALYPHA VIRGINICA, Three-seeded mercury.
EUPHORBIA PRESLII, Large spotted spurge.
E. MACULATA, Spotted spurge.
E. COROLLATA, Flowering spurge.
E. CYPARISSIAS, Cypress spurge.

Malvaceae.

ABUTILON THEOPHRASTI, Butterprint.
SIDA SPINOSA, Prickly sida.
MALVA ROTUNDIFOLIA, Cheeses.
HIBISCUS TRIONUM, Shoo-fly.

Onagraceae.

OENOTHERA BIENNIS, Evening primrose.
GAURA BIENNIS, Biennial gaura.

Umbelliferae.

Conium maculatum, Poison hemlock.
Carum carvi, Caraway.
Pastinaca sativa, Wild parsnip.
Daucus carota, Wild carrot.

Primulaceae.

Anagallis arvensis, Pimpernel.

Apocynaceae.

Apocynum androsaemifolium, Spreading dogbane.
A. cannabinum, Indian hemp.

Asclepiadaceae.

Asclepias speciosa, Showy milkweed.
A. syriaca, Milkweed.

Convolvulaceae.

Convolvulus sepium, Wild morning-glory.
C. arvensis, European bindweed.
Cuscuta epithymum, Clover dodder.
C. arvensis, Field dodder.

Hydrophyllaceae.

Ellisia nyctelea, Waterleaf.

Boraginaceae.

Cynoglossum officinale, Hound's tongue.
Lappula echinata, Stickseed.
Symphytum officinale, Comfrey.
Echium vulgare, Blue weed.

Verbenaceae.

Verbena bracteosa, Bracted vervain.
V. hastata, Blue vervain.
V. stricta, Hoary vervain.

Labiatae.

Nepeta cataria, Catnip.
N. hederacea, Ground ivy.
Lamium amplexicaule, Dead nettle.

Leonurus cardiaca, Motherwort.
Mentha piperita, Peppermint.
M. spicata, Spearmint.
Satureja nepeta, Thyme.
S. VULGARIS, Basil.
Marrubium vulgare, Hoarhound.
Galeopsis tetrahit, Hemp nettle.
SOLANUM NIGRUM, Black nightshade.
S. CAROLINENSE, Horse nettle.
S. ROSTRATUM, Buffalo bur.
DATURA STRAMONIUM, Jimson weed.
D. TATULA, Purple thorn apple.
VERBASCUM THAPSUS, Mullein.
V. blattaria, Moth mullein.
LINARIA VULGARIS, Butter and eggs.
VERONICA PEREGRINA, Speedwell.
PLANTAGO MAJOR, Common plantain.
P. RUGELII, Rugel's plantain.
P. LANCEOLATA, Ribgrass.
P. ARISTATA, Bracted plantain.

Compositae.

ERIGERON ANNUUS, Daisy fleabane.
E. CANADENSIS, Fleabane.
E. RAMOSUS, Whiteweed.
IVA XANTHIFOLIA, Marsh elder.
AMBROSIA ARTEMISIAEFOLIA, Smaller ragweed.
A. TRIFIDA, Greater ragweed.
XANTHIUM CANADENSE, Cocklebur.
Gnaphalium uliginosum, Cudweed.
Inula helenium, Elecampane.
HELIOPSIS SCABRA, Ox-eye.
RUDBECKIA HIRTA, Cone-flower.
HELIANTHUS ANNUUS, Common sunflower.
BIDENS FRONDOSA, Beggar-ticks.
B. DISCOIDEA, Small beggar-ticks.
DYSSODIA PAPPOSA, Fetid marigold.
ACHILLEA MILLEFOLIUM, Yarrow.
ANTHEMIS COTULA, Mayweed.
CHRYSANTHEMUM LEUCANTHEMUM, Ox-eye daisy.
TANACETUM VULGARE, Tansy.

ARTEMISIA BIENNIS, Wormwood.
ERECHTITES HIERACIFOLIA, Fireweed.
ARCTIUM LAPPA, Burdock.
CIRSIUM LANCEOLATUM, Bull thistle.
C. ARVENSE, Canada thistle.
C. CANESCENS, Woolly thistle.
CICHORIUM INTYBUS, Chicory.
Leontodon autumnalis, Hawkbit.
TARAXACUM OFFICINALE, Dandelion.
T. ERYTHROSPERMUM, Red-seeded dandelion.
SONCHUS ASPER, Spiny-leaved sow thistle.
LACTUCA SCARIOLA, Prickly lettuce.
L. SCARIOLA VAR. INTEGRATA.
LYDGODESMIA JUNCEA, Lygodesmia.
SOLIDAGO CANADENSIS, Goldenrod.

FIG. 548. Narrow Sneezeweed (*Helenium tenuifolium*). General aspect of plant and a single head enlarged.
(After Chesnut, U. S. Dept. Agr.)

Dr. Gray, in the above list mentioned 86 weeds which are more or less aggressive in the Atlantic United States. It would seem, however, that comparatively few of the aggressive weeds of the Gulf states are enumerated in the list. The more important gulf coast weeds are sneezeweed (*Helenium tenuifolium*), Louisiana carpet grass (*Paspalum platycaule*), Johnson grass (*Sorghum halepense*), beard grass (*Andropogon virginicum*), buffalo bur (*Solanum rostratum*), prickly sida (*Sida spinosa*), southern nut grass (*Cyperus rotundus*), wild pansy (*Viola arvensis*). Dr. Mohr gives the following list of weeds as the most conspicuous by their abundance all over the state of Alabama.

FIG. 549. Johnson Grass (*Sorghum halepense*). An African weed. Common in the Gulf states, and reported from southwestern Iowa. (Lamson-Scribner, U. S. Dept. Agr.)

Leptochloa mucronata, Yard grass.
Manisurus granularis, Manisurus.
Cyperus rotundus, Southern nut grass.
Amaranthus retroflexus, Green pigweed.
Amaranthus hybridus, Pigweed.
Amaranthus spinosus, Spiny amaranth.
Spergula arvensis, Corn spurrey.
Portulaca oleracea, Purslane.
Cassia occidentalis, Senna.
Cassia tora, Low senna.
Sida rhombifolia, Rhombleaf sida.
Sida spinosa, Prickly sida.
Senebiera pinnatifida, Peppergrass.
Veronica peregrina, Neckweed.
Veronica arvensis, Corn speedwell.
Lamium amplexicaule, Dead nettle.
Richardia scabra, Mexican clover.

Dr. W. A. and Mrs. Kellerman in a paper on the non-indigenous Flora of Ohio, state that out of 2,060 plants of the state 430 are not indigenous. Of the latter number 326 have come from Europe, 30 from Asia, 2 from Africa, 46 from Southern and Western United States and 21 from tropical or South America. When expressed in percentages the numbers are as follows: from Europe, 75.81%; from Asia, 6.99%; from Africa, 0.47%; from the United States, 10.70%; and from tropical and South America, 4.81%.

Comparing the Old World species with those from parts of the American continent we find the numbers to be 358 and 67 respectively. Therefore 83.25% of the introduced species have come from the eastern hemisphere and 15.58% from America.

Expressed in percentages of the total number of introduced species they are as follows: waifs, 11.86%; occasionally escaped, 38.84%; and thoroughly naturalized, 49.30%.

The following list shows the families represented and the number of species in each.

1. *Amaranthaceae,* Amaranth Family 5
2. *Aizoaceae,* Carpet Weed Family 1
3. *Apocynaceae,* Dogbane Family 2
4. *Berberidaceae,* Barberry Family 1
5. *Bignoniaceae,* Bignonia Family 2
6. *Boraginaceae,* Borage Family 11

7. *Cactaceae,* Cactus Family 1
8. *Campanulaceae,* Bluebell Family 1
9. *Capparidaceae,* Caper Family 1
10. *Caprifoliaceae,* Honeysuckle Family 4
11. *Caryophyllaceae,* Pink Family 23
12. *Chenopodiaceae,* Goosefoot Family 11
13. *Compositae,* Thistle Family 88
14. *Convolvulaceae,* Morning-glory Family 8
15. *Crassulaceae,* Orpine Family 2
16. *Cruciferae,* Mustard Family 27
17. *Cucurbitaceae,* Gourd Family 6
18. *Cyperaceae,* Sedge Family 1
19. *Dipsacaceae,* Teasel Family 1
20. *Elatinaceae,* Waterwort Family 1
21. *Euphorbiaceae,* Spurge Family 7
22. *Fumariaceae,* Fumitory Family 1
23. *Geraniaceae,* Geranium Family 5
24. *Gramineae,* Grass Family 46
25. *Hypericaceae,* St. John's-wort Family 1
26. *Labiatae,* Mint Family 24
27. *Leguminosae,* Pulse Family 19
28. *Liliaceae,* Lily Family 7
29. *Linaceae,* Flax Family 1
30. *Malvaceae,* Mallow Family 9
31. *Martyniaceae,* Martynia Family 1
32. *Nyctaginaceae,* Four-o'clock Family 2
33. *Oleaceae,* Olive Family 2
34. *Oxalidaceae,* Oxalis Family 1
35. *Onagraceae,* Evening primrose Family 3
36. *Papaveraceae,* Poppy Family 5
37. *Plantaginaceae,* Plantain Family 4
38. *Polygonaceae,* Smartweed Family 14
39. *Portulacaceae,* Purslane Family 1
40. *Primulaceae,* Primrose Family 2
41. *Ranunculaceae,* Crowfoot Family 9
42. *Resedaceae,* Mignonette Family 3
43. *Rhamnaceae,* Buckthorn Family 1
44. *Rosaceae,* Rose Family 15
45. *Rubiaceae,* Madder Family 3
46. *Salicaceae,* Willow Family 8
47. *Saxifragaceae,* Saxifrage Family 4

48. *Scrophulariaceae,* Figwort Family........................14
49. *Simarubaceae,* Quassia Family.......................... 1
50. *Solanaceae,* Nightshade Family.......................... 9
51. *Umbelliferae,* Parsley Family.........................12
52. *Urticaceae,* Nettle Family............................. 5
53. *Valerianaceae,* Valerian Family......................... 1
54. *Verbenaceae,* Verbena Family........................... 1
55. *Violaceae,* Viola Family............................... 1

The weeds of the Pacific coast are somewhat different from those of the Atlantic coast. Eugene Hilgard, in a series of interesting articles in Garden and Forest, some years ago, S. B. Parish, J. Burtt Davy and other California botanists, have contributed notes on the introduction of these weeds of the coast. They enumerated the more important weeds, among which mention may be made of black mustard (*Brassica nigra*), catchfly (*Silene gallica*), storksbill (*Erodium cicutarium*), musk erodium (*Erodium moschatum*), small-flowered mallow (*Malva borealis*), black medick (*Medicago lupulina*), bur clover (*M. denticulata*), white sweet clover (*Melilotus alba*), and yellow sweet clover (*M. officinalis*), star thistle (*Centaurea cyanus*), knapweed (*C. solstitialis*), brown knapweed (*C. jacea*), black knapweed (*C. nigra*), wild carrot (*Daucus carota*), beet (*Beta vulgaris*), spinach (*Spinacia oleracea*), lady's thistle (*Silybum marianum*), cotton thistle (*Onopordon acanthium*), dodder (*Cuscuta epithymum*).

The writer recently noted the following weeds in the San Francisco Bay region, Oakland, and Sacramento, many of our eastern weeds being common among them: Hedge mustard (*Sisymbrium officinale*), *Raphanus sativus, Marrubium vulgare,* dock (*Rumex crispus*), cheeses (*Malva rotundifolia*), mallow (*M. crispa*), bull thistle (*Cirsium lanceolatum*), sow thistle (*Sonchus oleraceus*), cat's-ear (*Hypochaeris radicata*), knotweed (*Polygonum erectum*), black medick (*Medicago lupulina*), *Brassica campestris,* lamb's quarters (*Chenopodium album*), chickweed (*Stellaria media*), *Poa annua,* Alfilaria (*Erodium cicutaria*), pineapple weed (*Matricaria suaveolens*), common groundsel (*Senecio vulgaris*), burdock (*Arctium lappa*), *Silybum marianum, Centaurea melitensis,* prickly lettuce (*Lactuca scariola*), mustard (*Brassica campestris*), also such native weeds as *Amsinckia* and *Escholtzia.*

Fig. 549A I

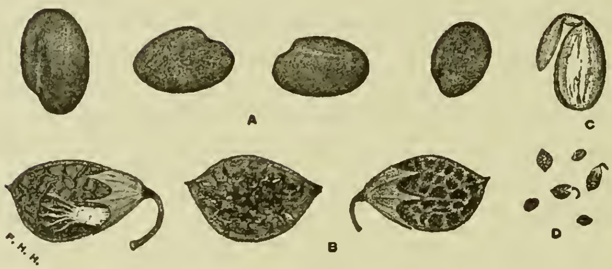

Fig. 549A II

Fig. 549A III

Fig. 549-A. Seeds of weeds scattered with agricultural seeds. I. Dodder in clover and alfalfa seed. II. White Sweet Clover in alfalfa seed. III. Bitter Dock (*Rumex obtusifolius*) in red clover seed.

Many of these weeds have made their way into California by way of South America. Others are indigenous and widely scattered on the Pacfiic coast. The Pacific northwest has in common with the rest of the Pacific coast many European weeds,, but also many that are indigenous to the country. Many years ago Cusick called attention to the predominance of the Northern fireweed (*Epilobium angustifolium*), which, after the removal of the forest and the burning of the slashings, comes up in great abundance. The writer in another connection* discussed the weeds commonly

*The Problem of Weeds in the West; Proc. Ia. Acad. Sc. 15: 34.

FIG. 550. Curled Dock (*Rumex crispus*). A common European weed now occurring across the continent.
(After Chesnut, U. S. Dept. Agr.)

found in the northwest. A few of the abundant species may be mentioned. Russian thistle (*Salsola kali* var. *tenuifolia*) is abundant in the drier regions, especially east of the Cascades. In the Puget Sound country are found such common European weeds as Canada thistle (*Cirsium arvense*), bull thistle (*C. lanceolatum*), batchelor's button (*Centaurea cyanus*), chicory (*Cichorium intybus*), common mustard (*Brassica arvensis*), mullein (*Verbascum thapsus*) and also *V. blattaria,* and toadflax (*Linaria vulgaris*). It is not uncommon to find in clearings of the forest the small Kenilworth ivy (*Linaria cymbalaria*), the common pansy (*Viola tricolor*), the petunia (*Petunia grandiflora*), the dead nettles (*Lamium amplexicaule* and *L. album*), ox-eye daisy (*Chrysanthemum leucanthemum*), hemp nettle (*Galeopsis tetrahit*), foxglove (*Digitalis purpurea*), European bindweed (*Convolvulus arvensis*). The cats'-ear (*Hypochaeris radicata*) is one of the most common weeds in lawns. There is a common belief that it was introduced from Chile.

In the Great Basin country, especially in Utah, a large number of the weeds are of European origin. Of the most common of these mention may be made of the brome grasses (*Bromus brizaeformis* and *B. tectorum*), bouncing Betty (*Saponaria vaccaria*), black medick (*Medicago lupulina*), dodders (*Cuscuta arvensis* and *C. epithymum*), poison hemlock (*Conium maculatum*), moth mullein (*Verbascum blattaria*), mint (*Mentha viridis*), Russian thistle (*Salsola kali* var. *tenuifolia*), horehound (*Marrubium vulgare*),

FIG. 551. Awned Brome Grass (*Bromus tectorum*). Common in the Great Basin country and California, occasionally in Iowa.

prickly lettuce (*Lactuca scariola*) and storksbill (*Erodium cicutarium*). There are also such native weeds as bee-plant (*Cleome serrulata*), wild liquorice (*Glycyrrhiza lepidota*), the squirrel-tail grasses (*Hordeum jubatum* and *H. caespitosum*), prickly lettuce (*Lactuca pulchella*), pine-apple weed (*Matricaria suaveolens*) and prickly poppy (*Argemone platyceras*). In the Rocky mountain region, especially Colorado, many of the more recent introductions are from Europe. Among these are the sweet clovers (*Melilotus alba* and *M. officinalis*), black medick (*Medicago denticulata*), purslane (*Portulaca oleracea*), dodder (*Cuscuta arvensis* and *C.*

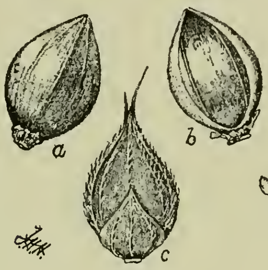

Fig. 551A I

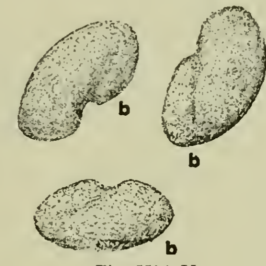

Fig. 551A II

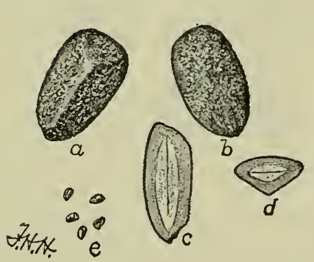

Fig. 551A III

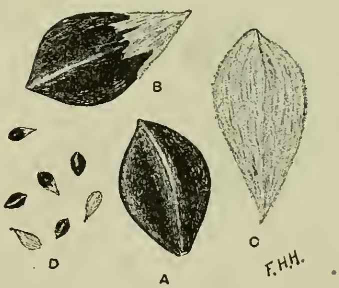

Fig. 551A IV

FIG. 551-A. Seeds scattered with agricultural seeds. I. Barnyard Grass (*Echinochloa crusgalli*). II. *Medicago denticulata*, common in alfalfa seed. II. Horehound (*Marrubium vulgare*), a weed commonly scattered with alfalfa seed. Common in the Great Basin country. IV. Wild Buckwheat or Bindweed (*Polygonum convolvulus*), commonly scattered with grain seed.

(All after Hillman.)

epithymum), foxtail (*Setaria viridis*), storksbill (*Erodium cicutarium*), Russian thistle (*Salsola kali* var. *tenuifolia*), vegetable oyster (*Tragopogon porrifolius*), goat's beard (*T. pratensis*) and lamb's quarters (*Chenopodium album*). A large number of native plants have become weedy, such as marsh elder (*Iva xanthifolia*), (*Franseria discolor*), the two annual sunflowers (*Helianthus annuus, H. petiolaris*), small ragweed (*Ambrosia artemisiaefolia*), buffalo bur (*Solanum rostratum*), Rocky Mountain bee plant (*Cleome serrulata*), gumweed (*Grindelia squarrosa*) and squirreltail grass (*Hordeum jubatum*).

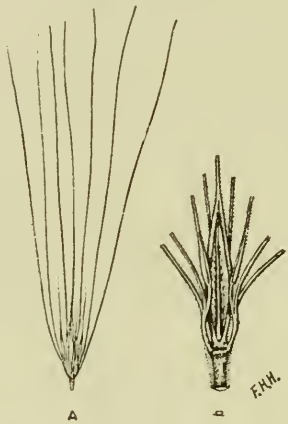

Fig. 551B I

Fig. 551B II

Fig. 551B III

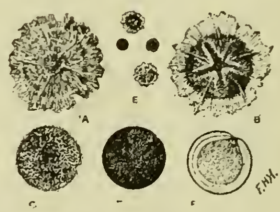

Fig. 551B IV

Fig. 551-B. Seeds of immigrant weeds. I. Squirreltail (*Hordeum jubatum*); widely scattered with hay and stock trains from the western plains. II. Spinage (*Spinacia oleracea*); a common weed of the Great Basin country. Scattered from cultivated plants. III. Russian Thistle (*Salsola kali* var. *tenuifolia*); brought to Dakota with flax seed and grain seed; now scattered in Iowa with alfalfa seed. IV. Winged Pigweed (*Cycloma atriplicifolium*).

(II, drawing, L. R. Collins; the others after Hillman.)

Cosmopolitan Weeds.—A great many weeds, originally, had a very wide distribution, although many of these so-called weeds were probably introduced by man. In many cases it is almost impossible to tell how and whence they came to the places in which they occur.

Who can trace the immigration of such weeds as common purslane, or charlock, or barnyard grass? In the first place, these plants immigrated when little was known about the species of plants. What was said about them by the early botanical writers was often very indefinite. In the second place, many of the early writers did not take pains to leave statistics concerning the introduction of the plants. The future records, however, will be more accurate as the adventive plants are being recorded by a host of botanical writers the world over. The notes in such floras as Britton's Manual, Robinson and Fernald-Gray's Manual, Bentham and Hooker's Handbook of the British Flora, Garcke's Flora of Germany, Acloque's Flora of France, Moore's Handbook of the Flora of New South Wales, Arcangeli's Flora of Italy, Baron Ferdinand von Mueller's Systematic Census of Australian Plants, Grisebach's Flora of the British West Indies, Millspaugh's Flora of Yucatan, Hemsley's Botany of Central America, Urban's papers on the Flora of the West Indies give more or less detailed information on introduced weeds.

FIG. 552. Crabgrass (*Digitaria sanguinalis*). A cosmopolitan weed.

The following weeds are more or less cosmopolitan: crab grass (*Digitaria sanguinalis*), found in North and South America, Europe, Asia, Africa, Australia and New Zealand; barnyard grass (*Echinochloa crusgalli*), in Europe, Asia, Africa, North and South America and Australia; green foxtail (*Setaria viridis*), in Europe,

FIG. 553. Foxtail Grass (*Alopecurus geniculatus*). Widely distributed. Cosmopolitan grass.
(U. S. Dept. of Agr.)

Asia, Africa, Australia, North and South America; pigeon grass (*Setaria glauca*), in Europe, Asia, Africa, North and South America; whorled millet (*Setaria verticillata*), in Europe, Asia, Africa, North and South America; Johnson grass (*Sorghum halepense*), in Europe, Asia, Australia and North America; foxtail grass (*Alopecurus geniculatus*), in Asia, New Zealand, Australia, North America; hair grass (*Agrostis hyemalis*), in Australia, New Zealand, North America; Bermuda grass (*Cynodon dactylon*), a valuable forage plant, but, in cultivated fields, a weed, Europe, Asia, Africa, Australia, New Zealand, North and South America; southern spear grass (*Eragrostis pilosa*), Europe, Asia, Africa, Australia, New Zealand, North and South America; crowfoot grass

(*Eleusine indica*), Europe, Asia, Africa, Australia, New Zealand, North and South America; cheat (*Bromus secalinus*), Europe, Asia, North America, a weed; brome grass (*Bromus tectorum*), Europe, Asia, Africa, North America; soft chess (*Bromus arvensis*), Europe, Asia, Africa, North America. It is singular that only one species of *Bromus* is given by Moore and Ferdinand von Mueller, the *Bromus arenarius*. Reed (*Phragmites communis*), though not regarded as a weed in the United States, is a cosmopolitan plant found in Europe, Asia, Africa, Australia, New Zealand, Papua, North America (Canada, United States and Mexico).

FIG. 554. Tumbling Mustard (*Sisymbrium altissimum*). Introduced with grain in the Dakotas.
(Dewey, U. S. Dept. Agr.)

Cress (*Barbarea vulgaris*) occurs in Europe, Asia, Australia, New Zealand and North America. None of the most common North American weeds among the remaining members of the mustard family occur in Australia or New Zealand, although shepherd's purse (*Capsella bursa-pastoris*), common mustard (*Brassica arvensis*), the hedge mustards (*Sisymbrium officinale* and *S. altissimum*) and peppergrass (*Lepidium apetalum*) are common in Europe and Asia.

Of the pulse family the bird's-foot trefoil (*Lotus corniculatus*) occurs in Europe, Asia, Africa and Australia; the indigo plant (*Indigofera hirsuta*) in Africa, Australia, Papua and Asia. The absence of black medick (*Medicago lupulina*) and hop clover (*Trifolium agrarium*) from Australia is striking.

Of the geranium family the common European, African and Asiatic species of storksbill (*Erodium cicutarium*) are absent in Australia and New Zealand and the little yellow flowered sorrel (*Oxalis corniculata*) is the only representative in New Zealand, Australia and Papua. This species also occurs in Europe, Asia, Africa and America. The only malvaceous weeds in Australia common also to the United States are sida (*Sida spinosa*) and butter-print (*Abutilon theophrasti*), both of tropical origin. The former occurs in Europe, Asia, Africa, North and South America, Australia and Papua. The pigweed (*Amaranthus retroflexus*) of southern North America is common in Europe but has not reached Australia. None of our troublesome weedy species of dock, which are cosmopolitan, occurs in Australia. Of the smartweeds there are two species, the water pepper (*Polygonum hydropiper*) (Europe, Asia, North and South America) and slender smartweed (*P. lapathifolium*) of Europe, Asia, North and South America. Silky cinquefoil (*Potentilla anserina*), of the rose family, is common in the west and here and there in northern Iowa; it is found in Europe, Asia, Africa, Australia, New Zealand and North America. Feverfew (*Agrimonia striata*) is found in Europe, Africa and North America. None of our *Oenotheras* is cosmopolitan; however the primrose willow (*Jussiaea suffruticosa*), a sub-tropical plant, is widely distributed in Asia, Africa, America and Papua. Very few of the Umbelliferae are cosmopolitan. Moore and Mueller record water parsnip (*Sium latifolium*) for New Zealand and Australia.

The Mexican *Ageratum conyzoides* of the sunflower family, found in Africa, Asia, Europe, North and South America, is often weedy. The Spanish needle (*Bidens bipinnata*) is found in Asia, Europe, North and South America. The small number of plants of this family found in Australia and New Zealand is remarkable. None of our plantains is of common occurrence. There is no morning-glory.

It may be of interest to compare the noxious weeds of Germany with those of the United States. Dr. A. Thaer of the University of Giessen in 1881 published a small book on the agricultural weeds of that country listing the following: (Those printed in small capitals are also weedy in Iowa.) Corn poppy (*Papaver rhoeas*), mustard (BRASSICA ARVENSIS), charlock (RAPHANUS RAPHANISTRUM), Canada thistle (CIRSIUM ARVENSE), corn cockle (AGROSTEMMA GITHAGO), chickweed (STELLARIA MEDIA), sheep sorrel (*Rumex acetosella*), vetch (*Vicia hirsuta*), colt's-foot (*Tussilago farfara*), corn chamomile (*Anthemis arvensis*), corn marigold

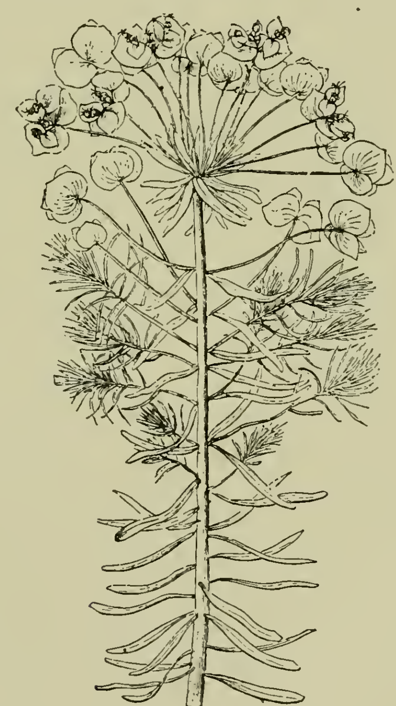

FIG. 555. Cypress Spurge (*Euphorbia cyparissias*). Common in Europe and waste places in Iowa. In many cases started in the vicinity of cemeteries. (After Strasburger, Noll, Schenck and Karsten.)

(*Chrysanthemum segetum*), groundsel (*Senecio vernalis*), cornflower (*Centaurea cyanus*), sow thistle (SONCHUS OLERACEUS), small bindweed (CONVOLVULUS ARVENSIS), clover dodder (CUSCUTA EPITHYMUM), broom rape (*Orobanche ramosa*), garden orach

(*Atriplex hortense*), cock's comb (*Rhinanthus crista-galli major* and *minor*), smartweed (POLYGONUM PERSICARIA), cypress spurge (EUPHORBIA CYPARISSIAS), meadow saffron (*Colchicum autumnale*), silky bent-grass (*Agrostis spica-venti*), wild oats (AVENA FATUA), chess (BROMUS SECALINUS), quack grass (AGROPYRON REPENS), horse-tail (EQUISETUM ARVENSE).

L. Danger in his work on weeds and parasites of Germany, published in 1887, divides the weeds of Germany into two classes: *A.* Root weeds, *B.* Seed weeds.

A. Root weeds.—Quack grass (*Agropyron repens*), reed grass (*Phragmites communis*), bindweed (*Convolvulus arvensis*), deadly nightshade (*Atropa belladonna*), goatweed (*Aegopodium rodagraria*), sheep sorrel (*Rumex acetosella*), sour dock (*R. crispus*), meadow saffron *Colchicum autumnale*), marsh marigold (*Caltha palustris*), mint (*Mentha arvensis*), thistle (*Cirsium arvense, C. alteraceum, C. acaule, C. heterophyllum, C. palustre, C. lanceolatum*), (*Carduus crispus, C. lanceolatus, C. natans*), (*Onopordon acanthium*), sow thistle (*Sonchus arvensis, S. palustre, S. asper, S. oleraceus*), colt's-foot (*Tussilago farfara, T. hybrida, T. petasites*), yarrow (*Achillea millefolium*), (*Leontodon autumnalis*) dandelion (*Taraxacum officinale*), plantain (*Plantago coronopus, P. arenaria, P. major, P. media, P. maritima, P. lanceolata*), horsetails (*Equisetum arvense, E. palustre*).

B. Seed weeds.—Chess (*Bromus secalinus*), (*Alopecurus agrestis*), wild oats (*Avena fatua*), (*Agrostis spica-venti*), darnel (*Lolium temulentum*), black nightshade (*Solanum nigrum*), black henbane (*Hyoscyamus niger*), Jimson weed (*Datura stramonium*), fool's parsley (*Aethusa cynapium*), hemlock (*Conium maculatum*), cowbane (*Cicuta virosa*), Venus' comb (*Scandix pecten-veneris*), buckwheat (*Fagopyrum esculentum*), smartweed (*Polygonum persicaria*), dooryard knotweed (*Polygonum aviculare*), corn cockle (*Agrostemma githago*), buttercups (*Ranunculus septentrionalis, R. flammula, R. arvensis*), nettle (*Lamium*), charlock (*Raphanus raphanistrum*), foxglove (*Digitalis purpurea*), mustard (*Brassica arvensis*), mayweed (*Anthemis arvensis* and *A. cotula*), groundsel (*Senecio vulgaris*), horseweed (*Erigeron canadensis*), field marigold (*Chrysanthemum segetum*), Frenchweed (*Galinsoga parviflora*), spurge (*Euphorbia cyparissias*), orach (*Atriplex hortense*), nettles (*Urtica urens, U. dioica*).

AMERICAN WEEDS INTRODUCED INTO EUROPE.

Every year more weeds are introduced into Europe from America; however, it is very noticeable that the more abundant of these are from the warmer regions of America, rather than from the colder regions. A good many of these are weeds of the open country of North America. I have looked rather hastily through a few of the floras of Great Britain, Italy, Austria and Germany, in addition to a number of recent references on the adventive flora of Europe, from which these data have been compiled.

Apple of Peru (*Nicandra physaloides*) Germany (Garcke).

Aster (*Aster novi-belgii*) Italy (Arcangeli), Germany (Garcke), France (Acloque).

Aster (*Aster parviflorus*) Germany (Garcke).

Aster (*Aster salicifolius*) Germany (Garcke).

Bug seed (*Corispermum hyssopifolium*) Germany (Garcke), Italy (Arcangeli).

Bur cucumber (*Sicyos angulatus*) Germany (Garcke), Italy (Arcangeli).

Clotbur (*Xanthium spinosum*) Italy (Arcangeli), Germany (Garcke, Bitter, Kiefer), Austria (Neilreich), France (Acloque).

Collomia (*Collomia grandiflora*) Germany (Garcke).

Cone flower (*Rudbeckia hirta*) Germany (Garcke).

Cone flower (*Rudbeckia laciniata*) Germany (Garcke, Bitter, Lehmann).

Cone flower (*Lepachys pinnata*) Germany (Bitter).

Evening primrose (*Oenothera sinuata*) Germany (Bitter).

Fleabane (*Erigeron annuus*) France (Acloque), Italy (Arcangeli).

Fleabane horseweed (*Erigeron canadensis*) France (Acloque), Austria (Neilreich), Germany (Garcke, Lehmann), England (Hooker), Italy (Arcangeli).

Galinsoga (*Galinsoga parviflora*) Italy (Arcangeli), Germany (Garcke).

Pigweed (*Amaranthus retroflexus*) Italy (Arcangeli), Germany (Garcke, Alpers), France (Acloque), Austria (Neilreich).

Goldenrod (*Solidago canadensis*) Germany (Garcke, Wegelin), Austria (Neilreich).

Goldenrod (*Solidago lanceolata*) Germany (Garcke), England (Hooker).

FIG. 556. Goldenrod (*Solidago rigida*). Common in Iowa. (Photographed by Gardner.)

Goldenrod (*Solidago serotina*) Italy (Arcangeli), Germany (Garcke).

Mexican tea (*Chenopodium ambrosioides*) Germany (Garcke, Alpers), Italy (Arcangeli).

Nightshade, buffalo bur (*Solanum rostratum*) Germany (Garcke, Alpers).

Nightshade, buffalo bur (*Solanum heterodoxum*) Germany (Garcke).

Nightshade, Three-flowered (*Solanum triflorum*) Germany (Garcke, Alpers).

Pellitory (*Parietaria pennsylvanica*) Germany (Garcke).

Peppergrass (*Lepidium virginicum*) Germany (Garcke), France (Tourlet).

Phacelia (*Phacelia tanacetifolia*) Germany (Garcke).

Pigweed, Tumbleweed (*Amaranthus graecizans*) Italy (Arcangeli), Germany (Bitter).

Pigweed (*Amaranthus retroflexus*) Italy (Arcangeli), Germany (Garcke, Alpers), France (Acloque), Austria (Neilreich).

FIG. 557. Rice Cut Grass (*Leersia oryzoides*). Common in low grounds, Iowa; not, however, regarded as a weed. Common in Italy. (Lamson-Scribner, U. S. Dept. of Agr.)

Pigweed, winged (*Cycloloma platyphyllum*) Italy (Arcangeli).

Plantain (*Plantago aristata*) Germany (Bitter).

Ragweed, small (*Ambrosia artemisiifolia*) Germany (Garcke, Laubert).

Rice cut-grass (*Leersia oryzoides*) Italy (Arcangeli), Germany (Garcke, Buchenau), France (Acloque), Austria (Neilreich), England (Hooker).

Sida (*Sida spinosa*) Germany (Alpers).

Spanish needle (*Bidens bipinnata*) Italy (Arcangeli), Germany (Garcke, Boute), France (Acloque).

Spanish needle (*Bidens frondosa*) Italy (Arcangeli).

Spanish needle (*Bidens leucanthus*) Germany (Garcke).

Speargrass (*Eragrostis pilosa*) Italy (Arcangeli), Germany (Garcke), France (Acloque).

Speedwell (*Veronica peregrina*) Italy (Arcangeli), Austria (Neilreich).

Sunflower, artichoke (*Helianthus tuberosus*) Italy (Arcangeli), Germany (Garcke).

Sunflower, common (*Helianthus annuus*) Germany (Garcke), Austria (Neilreich).

Tickle grass (*Panicum capillare*) Germany (Alpers, Garcke), France, Italy (Arcangeli), Austria (Neilreich).

Tickseed (*Coreopsis tinctoria*) Germany (Bitter).

Waterweed (*Elodea canadensis*) Germany (Garcke, Scherer, Weshoff, Bitter), England (Hooker), France (Acloque).

INDIGENOUS WEEDS COMMON TO THE NORTHERN HEMISPHERE.

In all probability a few of the weeds here listed have been introduced, at any rate their origin is in doubt; some occur in Europe and North America only; those found in Asia are marked (As.).

Achillea millefolium (yarrow) (As.).

Alopecurus geniculatus (marsh foxtail).

Anagallis arvensis (pimpernel) (As.).

Anaphalis margaritacea (everlasting).

Atriplex patula var. *hastata* (orach).

Barbarea vulgaris (yellow rocket).

Bidens cernua (sticktight).

Capsella bursa-pastoris (shepherd's purse).

Cerastium arvense (mouse-ear chickweed).

Convolvulus sepium (morning-glory) (As.).

FIG. 558. Yarrow (*Achillea millefolium*). Common in the northern hemisphere.
(Drawing by Charlotte M. King.)

Cyperus esculentus (northern nut grass) (As.).
Epilobium angustifolium (fireweed) (As.).
Erigeron acris (fleabane).
Erysimum cheiranthoides (treacle mustard).
Galium trifidum (bedstraw) (As.).
Galium aparine (cleavers) (As.).
Gnaphalium uliginosum (cudweed).
Hierochloe borealis (holy grass).
Juncus tenuis (wire-grass).
Lepidium apetalum (peppergrass).
Mentha arvensis (mint) (As.).
Myosurus minimus (mouse-tail).
Oxalis corniculata (field sorrel).

Plantago major (common plantain) (As.).
Polygonum aviculare (dooryard knotweed) (As.).
Polygonum hydropiper (smartweed).
Polygonum lapathifolium (smartweed).
Potentilla anserina (silvery cinquefoil).
Potentilla monspeliensis (five-finger) (As.).

FIG. 559. Holy or Vanilla Grass (*Hierochloe borealis*). Common in the northern hemisphere, mountain regions. In northern Iowa. (Lamson-Scribner, U. S. Dept. Agr.)

Prunella vulgaris (self-heal).
Radicula palustris (marsh cress) (As.).
Ranunculus cymbalaria (crowfoot).
Ranunculus pennsylvanicus (crowfoot) (As.).
Ranunculus repens (crowfoot).
Rhinanthus crista-galli (yellow rattle).

Senecio palustris (ragwort).

Stachys palustris (woundwort) (As.).

Taraxacum officinale (dandelion). This species occurs everywhere in the United States and Europe, even on the highest mountains.

Fig. 560. Dandelion (*Taraxacum officinale*). Common in the northern hemisphere, across the continent.

INTRODUCTION OF SOME WEEDS INTO THE UNITED STATES AND INTO IOWA.

CHENOPODIACEAE, GOOSEFOOT FAMILY.

Russian Thistle (*Salsola kali* var. *tenuifolia*).

This plant has long been known as a troublesome weed. Henfrey, in his work, "The Vegetation of Europe, its Condition and Causes," published in 1852, notes its abundance in Russia, east of the Volga.

Linnaeus, the Swedish botanist, seems to have known the plant as it occurred in eastern Europe. Prof. L. H. Dewey has given us a good account of the introduction of this weed in the United States.* It seems to have been first observed in Scotland, Bonhomme county, South Dakota, in 1873 or 1874, the seed having been brought in with flax seed. In 1877, it was reported from Yankton county; five years later in the counties to the north and west of Bonhomme. By 1888 it had infested many of the counties east of Missouri river and two years later practically all of the counties of South Dakota and southern North Dakota. About the same time it invaded

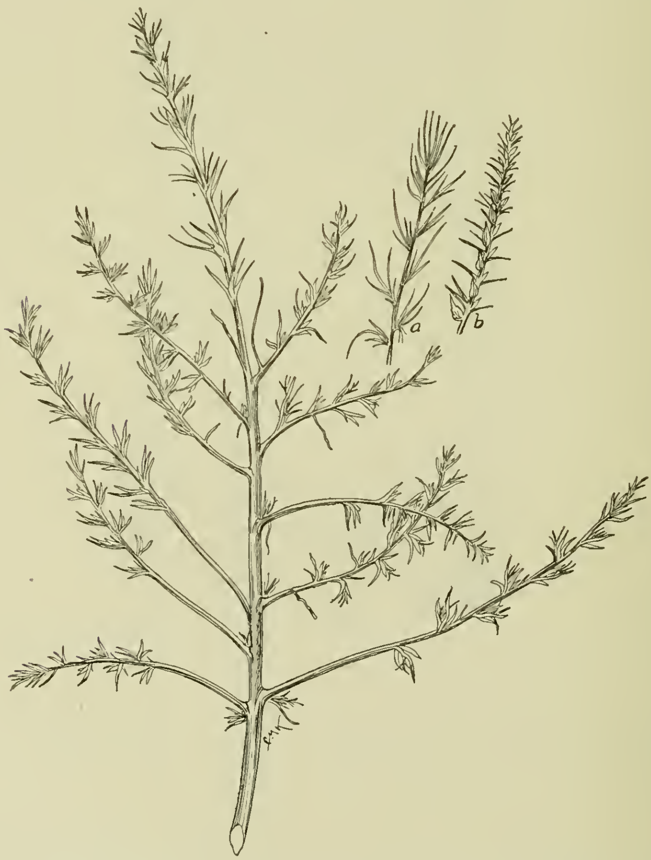

FIG. 561. Russian Thistle (*Salsola kali* var. *tenuifolia*). Common in eastern Europe. Introduced into the Dakotas, 1873 or 1874. Now common in northern United States, particularly in the west.
(Drawing by Charlotte M. King.)

*Bull. Div. of Bot., U. S. Dept. of Agr. 15:12. 1894.

northwestern Iowa, northeastern Nebraska and western Minnesota. In 1898 it was reported from Colorado, Wisconsin, Illinois and other western states. In 1894 Pammel gave the following account of its distribution:

Prof. Dewey's map indicates that the badly infested area extends from the east bank of the Missouri river at Bismarck to Jamestown and Moorehead in North Dakota; south to Sioux City, in Iowa; it also occurs in many isolated places in Minnesota, Wisconsin, Iowa, and at Denver, Colorado. The localities at which he found it in Iowa are Rock Rapids, Emmetsburg, Spencer and west to the Missouri river, Council Bluffs, and on the Missouri river opposite Nebraska City. To these we must add Edna, Ames, Little Rock (Ball), Calumet (Louthan), Missouri Valley, Mason City, Eagle Grove, and in all probability it occurs along our great trunk lines across the state. Last season Mr. G. W. Carver found a small specimen of what undoubtedly was Russian thistle along the Chicago & Northwestern railroad; the place was revisited this year, and an abundance of the weed was found. A few days later Messrs. Robt. Combs and C. B. Weaver found several localities between Ames and Ontario, and Mr. Sheldon reported it in the Ames stock yards. As to its probable early appearance in Iowa we have reliable data. Prof. A. S. Hitchcock, an excellent observer and collector, reported it from Woodbury county in 1888, and Mr. R. I. Cratty, of Emmetsburg, reported it from Emmet county in 1890 or 1891. It has also been sent to me from Ellsworth, in Nobles county, Minnesota, close to the Iowa line. Mr. G. W. Carver found great quantities of it near Chicago, at Turner Junction, and J. J. McMahon from Peatone, Illinois.

It occurred as early as 1890 in Wisconsin. The writer, in recently looking over a collection of specimens made in the vicinity of Prairie Du Chien, in 1890, found a specimen of Russian thistle. The species was growing in considerable quantity along the sandy embankment of the river and railroad, not far from the railway station. It is not unlikely that it spread eastward along the Chicago, Milwaukee and St. Paul railroad for considerable distance.

It now occurs in many Iowa counties, especially along railroads. It is one of the most abundant weeds in western Nebraska, Colorado, Utah, Montana and Idaho. It is more or less sporadic in its appearance; some years more abundant than others. It was especially common at many points in Iowa in 1910 and 1911. Its distribution in Iowa as reported from time to time is as follows: Postville, 1894 (Orr); Mason City and Eagle Grove, 1894 (Pammel); Muscatine, 1894 (Reppert); Boone, 1895 (Carver); Ames, 1895 (Rolfs); Hawarden, 1895 (Pammel); Missouri Valley, 1897 (Pammel); Ledges, 1898 (Pammel); Armstrong, 1901 (Cratty); Ogden, 1901 (Pammel); Slater, 1902 (Fawcett, Tener and Reinbott); Marshalltown, 1902 (Pammel); Aurelia, 1912 (Summers); Sidney, 1912 (Graham).

Winged Pigweed (*Cycloloma platyphyllum* Moquin.).

Not indigenous in Iowa. Des Moines, 1887 (A. S. Hitchcock); Hamburg (A. S. Hitchcock); Muscatine, 1890; Ontario, 1892 (Burgess); Des Moines, 1894 (Carver); Cedar Rapids, 1895 (Palmer).

City Goosefoot (*Chenopodium urbicum* L.).

Nevada, 1880 (A. S. Hitchcock); Iowa City, 1887 (A. S. Hitchcock); Keokuk, 1887 (A. S. Hitchcock); Muscatine, 1890 (F. Reppert); Ames, 1891 (A. S. Hitchcock); Keokuk, 1891 (P. H. Rolfs).

Oak-leaved Goosefoot (*Chenopodium glaucum* L.).

Iowa City, 1889 (Hitchcock); Muscatine (F. Reppert).

Jerusalem Oak (*Chenopodium botrys* L.).

Ames, 1883; Iowa City, 1887 (A. S. Hitchcock).

Mexican Tea (*Chenopodium ambrosioides* L.).

Keokuk (J. C. Arthur); Muscatine, 1890 (F. Reppert).

Coast Blite (*Chenopodium rubrum*).

Keokuk, 1891 (P. H. Rolfs).

Orach (*Atriplex patula* L. var. *hastatum* Gray).

Iowa City, 1887 (A. S. Hitchcock); Keokuk, 1891 (P. H. Rolfs); Ames, 1896, where it has now become well established; Boone, Ft. Dodge, 1912 (L. H. Pammel); Storm Lake, 1912 (L. H. Pammel). Var. *littorale*, Iowa City, 1887. (A. S. Hitchcock).

Silvery Orach (*Atriplex argenteum* Nutt.).

Ames, 1895 (G. W. Carver).

Mexican Fireweed (*Kochia scoparia* (L.) Schrad.).

Mexican fireweed is recorded as an adventive from Europe in the sixth edition of Gray's Manual of Botany, 1889, by Watson and

Coulter, with the statement "sparingly introduced in Vermont, Ontario, and Illinois." It is not recorded in the fifth edition of the same work by Dr. Gray in 1867. In the Britton Manual, 1901, the distribution is given as Ontario, Vermont, and northern New York, adventive from Europe, native also of Asia. According to the Robinson and Fernald Edition of Gray's Manual (7th. Ed.), 1908, it had become so common because of its cultivation and "locally established as a weed" that the distribution was not given. The writer saw it in abundance as a weed in Denver and Ft. Collins, Colorado, and Salt Lake, in 1902, and in Chicago the same year. It has been spontaneous as a weed in Ames since the year 1900. It has been observed in Ames, Council Bluffs (1901), Sioux City (1902), Cedar Rapids (1905), LaCrosse, Wis. (1904). The following catalogue of plants lists the species: Rydberg, Colorado, at Fort Collins.

COMPOSITAE, SUNFLOWER FAMILY.

Prickly Lettuce (*Lactuca scariola*).

This species was abundant in Utah in 1898 and was observed in many parts of California the same year, but was, however, far less common in the east. It was first observed in central Iowa, Ames, in 1909 and now occurs in Ft. Dodge, Boone and Des Moines, and is rapidly spreading. It is common in dry places in the Rocky mountains and on the Pacific coast. Robinson and Fernald state, "Roadsides, railway ballast, etc., New England to Oregon, N. W., and Kentucky, chiefly westward, but even then less common than the following variety (var. *integrata*)." It is common in northern and central Ohio, Indiana and Illinois (DeKalb, Fox, Aurora, Geneva, Chicago and Wheaton).

Prickly Lettuce (*Lactuca scariola* var. *integrata*).

Waste grounds, roadsides and fields from the Atlantic to the Pacific, especially northward. This is the form commonly referred to by botanists when speaking of the weed in the east. This variety was first reported by Dr. Gray. Specimens were collected by Mr. D. Murray in 1863 and 1864; some specimens were collected by M. S. Bebb at Rockford, Illinois, in 1879, and about the same time by Mr. Henry Eggert in St. Louis. In 1883 it was common in the vicinity of Madison but had not reached La Crosse, Wisconsin. In 1886 a few specimens were reported in the vicinity of Onalaska near La Crosse. It was abundant in Iowa in 1886, was reported from Eagle Grove in 1894 by Cratty, and by the same observer at lake Okoboji in 1901. The writer observed it abundantly in various places in Nebraska and eastern Colorado in 1894 and gave a more definite account of its distribution and spread in a paper in Proceedings Iowa Academy Sciences. In 1912 it was very abundant everywhere in Iowa. The seeds are easily scattered by the wind, which probably accounts for its wide distribution in a comparatively short time.

Thistle (*Cirsium palustre*).

This European thistle is recorded as naturalized in woods, East Andover, New Hampshire, (Holt) by Robinson and Fernald in the 7th edition of Gray's Manual, 1908, and was reported from Iowa in 1911 and again in 1912.

Canada Thistle (*Cirsium arvense*).

This well known weed is common everywhere in Europe and is perhaps a weed of the open. Linnaeus in his Flora Lapponica (1837) notes that it is the greatest pest of our fields. It is distributed from the Atlantic to the Pacific across the northern states and in Canada. In Iowa it is found more particularly in the north half of the state. The earliest floras of the state (Arthur, Bessey, and Parry) note its occurrence in Iowa. It has occurred in Ames for forty years. In 1889 it was noticed in many counties. Cratty reports the species from Emmet county in 1892. At this time it had been reported also from Howard, Adair, Chickasaw, Johnson and Poweshiek counties. In 1899 it was thoroughly established in a forest near Steamboat Rock in Hardin county. Plants from the early introduction seldom produced seed, but seed from the later introductions is not uncommon; thus it has been matured in O'Brien county and in Cresco, 1892 (C. V. Johnson). It is spreading rapidly in northern Iowa, having become much more widely distributed in 1903 and 1906 with clover seed.

It has been reported from Johnson county, 1874 (O. G. Babcock); Lawler, 1890 (P. H. Rolfs); Greenfield, 1891 (F. C. Stewart); Corning, 1895 (A. B. Shaw); Taylor, 1895 (J. B. Matthews); Maple River Junction, 1895 (L. Bernholtz); Farragut, 1895 (C. Collman); Marcus, 1896 (Willey); Winterset, 1896; Barnes City, 1896 (J. W. Jones); Nevada, 1898 (G. C. White); Steamboat Rock, 1899; Rockwell, 1901 (J. H. Boom); Badger, 1902 (Myrhe); Audubon, 1905 (M. C. Griffith); Graettinger, 1906 (E. L. George); Clarion, 1909 (Melhus); also in Lorimer (Lochrie); Blairsburg (J. M. Hall); Oelwein (J. Thompson); Muscatine (F. Reppert); Reading (Dr. McClanahan); Griswold (R. E. Pierce); Randall (C. & G. R. Christianson); Hartley (H. R. Foblenkamp); Garrison (J. Grayson); Roland (E. N. Waugh); Kossuth (S. A. Merrill); Cedar Falls (C. E. Daily); and Woolstock (A. P. Reynold).

Woolly Thistle (*Cirsium canescens*).

This plant has been reported from several states north and west of the Mississippi. In Iowa it occurs chiefly in the northern half of the state, having been reported by A. S. Hitchcock in 1889, as growing near Sioux City. Later it was reported from Sioux City by Pammel, 1895; Armstrong (Cratty), 1897; Webster City (McCoy), 1901; Onawa (Fletcher), 1902; Le Mars, 1902 (Wm. Long); Charter Oak, 1903 (C. N. Weed); Pisgah (L. H. Raymond), 1903; Rolfe (J. B. Jolliffe), 1908; Lu Verne (W. F. Blumer),

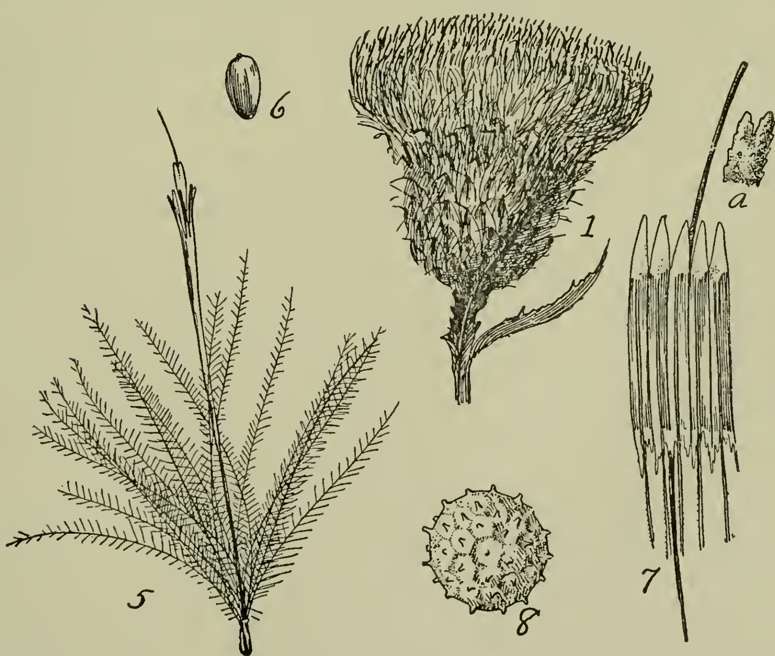

FIG. 562. Woolly Thistle (*Cirsium canescens*). Originally along the Missouri and adjacent territory. Now spreading eastward. 1, head; 5, single flower; 6, achenium; 7, stamens and style; a, stigma enlarged; 8, pollen grain. (Drawings by Charlotte M. King.)

1911; Harlan, Shelby county, Buena Vista county, and Clay county, 1912 (Pammel); Sac county, 1912 (Lee); Storm Lake, 1912 (Rehnstron); Dickens, 1912 (Evans); Smithland, 1912 (Barber); Cartersville, 1912 (Connor).

Hawkweed (*Hieracium floribundum*).

This weed, reported from Cutler, Maine, in 1902, now occurs in fields from New Brunswick to eastern Maine.

Paint Brush (*Hieracium aurantiacum*).

Paint brush was cultivated as an ornamental plant in Maine in 1875 and became frequent in the New England states and New York in the early eighties. It is now distributed from eastern Quebec to Pennsylvania and occasionally in Iowa.

Cat's-ear (*Hypochaeris radicata*).

According to Fernald this appeared in Penzance and Wareham, Massachusetts, in 1899; since then it has spread to other New England localities, as New Bedford and Dartsmouth. It had been, however, a very troublesome weed of lawns of the Pacific northwest for some time previously. It was abundant in Portland, Oregon, in 1906.

Stinking Willie (*Senecio jacobaea*).

Fernald (1905) states that in the late 70's a coarse yellow flowered plant (*Senecio jacobaea*) appeared as a waif on ballast at some points along Northumberland Strait in eastern New Brunswick. In 1884, it had begun to spread along the local railroads and now has reached Portland, Maine. The seventh edition of Gray's manual (1908) gives its distribution from Newfoundland to New Jersey.

Barnaby's Thistle or Knapweed (*Centaurea solstitialis*).

This weed was not reported in the sixth edition of Gray's manual (1889) nor in Britton's manual (1901). In the seventh edition of Gray's manual, Robinson and Fernald state, "Waste ground, eastern Massachusetts to Ontario and Iowa." It was reported from Iowa as early as 1903, and since, a few times each year, in alfalfa fields as follows: Paton, 1903 (Lundell); Mapleton, 1904 (Perrin); Moville, 1905 (Morton); Des Moines, 1907

(Wallace). J. Burtt Davy reported it from central California in the nineties.

Marsh Elder (*Iva xanthifolia*).

Dr. Gray in the fifth and sixth editions of the manual gave its distribution, "Northwest Wisconsin to Minnesota, Kansas and westward." Originally this must have been a local weed in Wisconsin and eastern Minnesota. Upham in 1890 mentions it as one of the most aggressive weeds of Red river, especially in waste places. Parry includes it in his list of plants collected in the upper Mississippi valley in 1848. It is not improbable that this plant was brought to eastern Minnesota and Wisconsin by the early voyagers, the Indians or the white settlers. It is a weed of the open and cultivated soil, especially near habitations. The early settlers in the Red river valley gave to it the name of "half breed weed" because so commonly found near the habitations of the half breeds who lived in that section of Minnesota, Manitoba and Dakota. There are early records of the weed, however. Hall mentions its occurrence near Athens, Illinois, in 1863. This was after Hall had returned from his trip to the Rocky mountains. He may have thrown away some of the seed, which germinated and produced plants. It was a common plant in the Rocky mountains, as reports of such botanists as Parry, Vasey, Hall, Fendler, M. E. Jones, Suksdorf, Cusick, Kelsey, Brandegee, Havard, Bigelow, (Camanche Plains, 1853) and others indicate its abundance. Though reported from Charles City by Arthur in 1871 it has not made much progress east of the Missouri river basin. Its distribution and date of appearance may be seen from the following: Boone, 1890 (Pammel); Keokuk, 1890 (Rolfs); Woodbine, Vale, Eagle Grove, Mason City, and Carroll, 1894 (Pammel); Armstrong, 1897 (Cratty); Ogden and Slater, 1896; Hanlontown and Ames, 1902 (Pammel); Decatur county, 1911 (Anderson). It was a frequent and abundant weed from Sioux City to Council Bluffs and probably south to Hamburg; reported at Independence, and, in 1876, at Humboldt, by Harvey. It had been reported from Emmet county as early as 1875, having been introduced with cattle. It has not spread very rapidly at any of these interior points. It was reported in St. Paul in 1861 (T. J. Hale) and it was abundant along the highway on a bank near La Crescent, Minnesota, in 1884. It now occurs in Hokah, Brownsville, and other points along the river (1910). In the early nineties it appeared in Onalaska, Wis-

FIG. 563. Marsh Elder (*Iva xanthiifolia*). Common in the Red River Valley, spreading eastward.

consin (Pammel); Menominee Valley, 1888 (Runge); Kewaunee county, 1889 (Wheeler, Farwell) and in Seneca, New York. It is abundant throughout the country and common in the northwest to Washington. It is abundant in western Iowa and is rapidly spreading eastward, also becoming an aggressive weed from Ames north to the Minnesota line and westward. It was reported from Europe (Denmark, Ostenfeld) 1895.

Perennial Sow Thistle (*Sonchus arvensis*).

This thistle was reported by John Torrey in 1826 in the northern and middle states. Dr. Gray in 1848 in the first edition of the manual reported it from Massachusetts, Staten Island, and in New Jersey; it did not occur in Pennsylvania, or at least was not mentioned by Darlington. The 5th edition of Gray's manual, 1867, gives its distribution "roadsides, etc., New England, New York, becoming more abundant;" the 7th edition (1908) says "from Newfoundland to the Rocky mountains northward." Britton (1901) places it in the same general region and west to Salt Lake, Utah. The weed is not common in Iowa nor in the surrounding states except northward in Minnesota and Dakota. It was reported from Grand Junction, Iowa, in 1898 by Tomson and from Ogden, Iowa, about 1900; the writer found it in Englewood, Illinois, in 1886, and in northern Ohio in 1912. It has spread rapidly in recent years in Canada, North Dakota and Minnesota, as recorded in the agricultural press of the last two or three years.

Galinsoga or Frenchweed (*Galinsoga parviflora*).

Danger has given several accounts of the introduction of this weed into Europe. The term Frenchweed seems to have been commonly applied to this weed in Germany shortly after the French soldiers occupied Hanover. One authority states that it was brought from France with horse feed; it is said to have been introduced into Germany about 1812. One authority states that the weed was distributed from the Berlin Botanical Garden in the year 1812, at any rate it was very common in Hanover in the year 1839; and has continued to spread. It may have spread from its first introduction near Paris to other places of France about the year 1800, although there is no definite date as to when it made its appearance in the vicinity of Paris. This plant is native to Peru where it was discovered by Ruiz and Pavon about 1794, so it must have been introduced into Europe following their description. In the United States the weed has become quite widely disseminated in recent years. The writer found it abundant in the vicinity of green-houses in the Missouri Botanical Garden in 1886, subsequently in 1896 he found it in similar situations in Ames and about 1898 or 1899 in La Crosse, Wisconsin. The writer has observed it at other points but always first in the vicinity of green-houses. This would lead to the assumption that it probably has been disseminated with flower seed.

Horseweed (*Erigeron canadensis*).

This widely distributed weed is common everywhere in North America and is said to have been introduced in the vicinity of Paris in 1635, although Leunis' Botany states "introduced in Europe in 1500." It is mentioned as one of the most common weeds of Germany and Switzerland by Ratzeburg (1859). Treatises by Garcke, Koch, Ratzeburg and Acloque mention it as a common weed.

Spiny Clotbur (*Xanthium spinosum*).

According to Kabsch, this weed is said to have been introduced into Germany with wool brought from Hungary. Though it originated in tropical America it has become established as far north as Maine (Robinson and Fernald). Thurber in 1859 gave its distribution from Massachusetts to Georgia. In 1889, it reached Leavenworth, Kansas, and in the course of time will be found in Iowa.

Hawkweed (*Senecio vernalis*).

This weed was first mentioned by Rosenberg as occurring in Switzerland in 1882. It spread to Silesia; disappeared; was reported in West Prussia in 1824, in Breslau, 1835, Brandenburg, 1850, Stettin in 1860, first as a mere waif, then spread to cultivated fields generally.

Chicory (*Cichorium intybus*).

Chicory was introduced into Dorchester, Massachusetts, in 1775. Torrey records it for the northern and middle states in 1826. Gray in 1848 stated "naturalized in the Atlantic States;" the 6th edition of Gray's Manual stated that it occurs from New England to Iowa and Minnesota; the 7th edition adds Newfoundland and southward. It was common in Wisconsin in 1884 and was spreading; it occurred in Colorado in 1896. Gray reports it for Santa Barbara, California, in 1880, and since then it has become fairly common in that state. It was reported from several localities by Crandall and Rydberg in Colorado in 1906; reported by Webber in Nebraska. Mr. F. W. Paige states that this weed has been known in Ft. Dodge since 1887. In 1906 it was spreading in Pottawattamie, Story, Sac, Clay, and Kossuth counties, and has been reported from Westgate (Bruce Fink), 1893; Boone (Geo. W. Carver and Pammel), 1895; Des Moines, 1895; Corning, 1895 (Ellen Bettomer); well established in Midway, 1896; Jordan, 1906 (Harriette Kellogg).

Vegetable Oyster (*Tragopogon pratensis* L.).

This was reported from Ames, in meadow, 1894; Iowa City, 1889; Newton, 1889 (A. S. Hitchcock).

Fetid Marigold (*Dyssodia papposa* (Vent.) Hitchc.).

Ackley, 1878 (B. E. Canavan); Boone, 1890; Keokuk, 1891 (P. H. Rolfs); Muscatine, 1891 (F. Reppert). This striking weed has been known for some time at Ames, and was said by Hitchcock to be frequent (Anth. Pteridophyta of Ames, p. 503). It is more or less sporadic in its appearance, being frequent in some years, in others not so common. It is, however, always abundant in western Iowa, which leads me to believe that the plant is not indigenous to central Iowa, but introduced, although now occurring in timber and along river banks.

Ox-eye Daisy (*Chrysanthemum leucanthemum* L.).

For a long period of years occasional specimens of this weed have been found in the vicinity of the college, and it is an occasional introduction in meadows, but except in one place some four miles from Ames it shows no evidence of being naturalized. It has also been reported from Muscatine (Reppert); Atlantic (S. O. Hamill); Ames, 1871 (C. E. Bessey); Ackley, 1878 (B. E. Canavan); Sheldahl, 1885 (L. V. Harpel); Ames, 1891 (P. H. Rolfs); still occurs between Ames and Gilbert, 1911, but is not spreading.

Mr. J. H. Lees reports this plant as having been introduced into the vicinity of Cedar Falls as early as 1890 and as occurring near LeMars in 1912.

Gumweed (*Grindelia squarrosa* Dunal).

Indigenous to western Iowa, rapidly spreading in contiguous territory, and reported from Boone and Moingona, as abundant in borders of woods along Chicago & North Western Railway in 1890 and still spreading in 1912; reported from Keokuk, 1891 (P. H. Rolfs); Battle Creek, 1895 (E. G. Preston); Osgood, 1895 (C. A. Wells); Carbonado, 1895 (John H. Smith); Smithland, 1896 (J. M. Wrapp).

Eclipta (*Eclipta alba* Hassk.).

Keokuk, 1877 (Geo. E. Ehinger), 1891 (P. H. Rolfs).

Sunflower (*Helianthus annuus* L.).

Occasional in Ames and other parts of central Iowa, but in western Iowa indigenous and very abundant, becoming frequent as far as Carroll (Kelley) 1900; Denison and Boone. It was reported in Boone in 1871 (C. E. Bessey); Ames, 1882; Grinnell, 1891 (M. E. Jones); Keokuk, 1894 (P. H. Rolfs); Muscatine, 1891 (Reppert); and Marshalltown, 1891 (F. C. Stewart). It is not abundant except in a few localities in central Iowa. It is an introduced plant with us.

CONVOLVULACEAE, MORNING-GLORY FAMILY.

Bindweed (*Convolvulus arvensis*).

This weed is of long standing in the United States. It is mentioned by Torrey in his Compendium of "The Flora of the Northern and Middle States" in 1826, and Dr. Gray in his first edition of his manual in 1848 gives the distribution from Massachusetts to Pennsylvania. Darlington, in 1853, states: "This foreigner has gradually extended itself among us—and will probably give our farmers much trouble if they do not carefully guard against it." This certainly has been realized in many of the central and eastern states. The statement in the seventh edition of Gray's manual would indicate quite general distribution in the region embraced in this work. The fifth edition (1867) states, "fields near the coast; likely to become a troublesome weed." Britton gives its distribution from Nova Scotia to Kansas (1901); South Dakota, Parker (1903). It was abundant in St. Louis in 1886 and was reported at various times in Iowa as a troublesome weed before 1889. Since 1887 it has been well established in Ames; it was reported from Ladora, 1895 (John Hiltbrummer); Des Moines, 1896 (C. N. Page); Westgate, 1902 (P. H. Hinager); Fort Dodge, 1912 (F. W. Paige); and very likely occurs in other places. It was first introduced as a cultivated plant. This may become one of the most pestiferous of our perennial weeds.

EUPHORBIACEAE, SPURGE FAMILY.

Snow-on-the-Mountain (*Euphorbia marginata* Pursh.).

Indigenous to western Iowa. Little Rock, Sioux City, Onawa, Council Bluffs and Hawarden. Naturalized east. Iowa City, 1887 (A. S. Hitchcock); Hamburg, 1888 (A. S. Hitchcock). Abundant at Denison, 1894; Woodbine, 1894; Vale, abundant, 1894; Missouri Valley, Carroll, 1895, abundant (W. Newell).

GRAMINEAE, GRASS FAMILY.

Squirrel-tail Grass or Wild Barley (*Hordeum jubatum* L.).

This plant was made known to science by Linnaeus, from specimens found in Canada. Dr. Asa Gray, in his Manual of Botany of Northern United States in 1856, gives its distribution as "marshes and moist sands of the sea shore and the northern lakes." In 1868, its distribution was not extended, but Watson and Coulter, who revised the manual (1890), add to the above "and westward." In the seventh edition of Gray's manual the distribution is given as "coast Labrador to New Jersey prairie and waste ground, Ontario to Illinois, Kansas, and westward." It evidently is very generally distributed throughout the United States. At Ames, specimens have been received from Wyoming, Colorado, Nevada, New Mexico, Idaho, Utah, Montana, Yellowstone Park, Illinois, Nebraska, the Dakotas, Minnesota, Kansas and from Argentine. It has also been reported from California, Wisconsin, Arkansas, Missouri, Michigan, Indiana, Ohio, New York, New Jersey, Massachusetts, Maine, Canada (in many parts), Europe (Russia), and Siberia in Asia. A truly cosmopolitan weed.

We are without exact data in regard to its early appearance in Iowa, though it was probably native in portions of western and northwestern Iowa, especially where the soil was somewhat broken up. From answers received it would seem that this grass has been known in parts of Iowa for over fifty years, but it is only during the last twenty-five years that it has made much headway. Though

FIG. 564. Wild Barley (*Hordeum jubatum*). Originally common along the shores of the Great Lakes, and alkali regions of the west.

possibly native, it is more than probable that this weedy grass has come into our state from the west as well as the east. It has become so thoroughly at home in many parts of Iowa that no one would be able to say, except for the records we have, that it has not always been indigenous.

Forty years ago this weed was mentioned by Dr. Bessey as occurring in Iowa, "found along railroads, perhaps introduced," being noticed at Ames especially. It undoubtedly occurred in other parts of the state, but could not have been abundant or its presence would have been noted. Early in 1876 Dr. J. C. Arthur listed the plant from Iowa without locality. Prof. Halsted refers to the weed as common, but not excluding valuable plants. He considered it an introduced plant. One other botanist, Prof. A. S. Hitchcock, listed the plant from Ames, and remarks: "Waste places; common." The plant was certainly abundant about Ames in 1889, when I came here, but it has not spread quite so alarmingly as prickly lettuce (*Lactuca scariola* L.). In July, 1895, a circular was sent out to some correspondents in every county in the state inclosing a specimen and requesting information in regard to its introduction, weedy nature, diseases, etc. Replies were received from most of the correspondents. From this information it appears that the plant has been in parts of the state many years, and several correspondents reported it as indigenous. It has been in Cedar Rapids for 57 years; in Carroll county, 33 years; Mason City, 45 years; Hawkeye, 40 years; Hampton, 37 years; Jefferson, 40 years; Mount Pleasant, 36 years; Cresco, 35 years; Newton, 35 years; Unity, 35 years; Iowa City, 30 years; Shenandoah, 35 years; Neola, over 45 years; Fort Dodge, 50 years; Dedham, 35 years; Rossville, 45 years. It was not, however, generally distributed in the state. But it has shown wonderful aggressive powers and now occurs without doubt in every county in the state.

It is more than likely that in Iowa, at least, the weed has spread from three sources: (1) Indigenous plants scattered in western and northwestern counties. (2) From the Great Lakes, where it is indigenous. (3) From the western plains, where it no doubt was indigenous.

LABIATAE, MINT FAMILY.

Lance-leaved Sage (*Salvia lanceaefolia* Poir.).

Indigenous to western Iowa. Council Bluffs, Fremont county, Missouri Valley, Ames, 1890 (F. A. Sirrine); Muscatine, 1890 (F. Reppert); Des Moines, 1895, well established; Harlan, 1912 (Pammel).

LEGUMINOSAE, PULSE FAMILY.

Sweet Clover (*Melilotus officinalis*).

Torrey, in 1826, gave the habitat of sweet clover as "wet meadows." Gray, in 1848, reports it for the east; it apparently had not reached Pennsylvania, since it is not recorded by Darlington. This plant was observed in the vicinity of St. Louis, Missouri, in 1887, and in Humboldt, Iowa, in 1892. In 1894 it was abundant in eastern Colorado, Fort Collins, Denver, and other localities, indicating naturalization for a considerable length of time. As yet it is not common in central Iowa, though it was abundant in Sioux City and Council Bluffs as early as 1895. It had already been reported from Iowa City by Hitchcock in 1889, and from Muscatine by Reppert in 1891. L. H. Pammel found it in Dakota City in 1896, and R. I. Cratty reported it from Emmet county in 1903; it is rather abundant at present in Scott county.

White Sweet Clover (*Melilotus alba* Lam.).

This plant is not named by Torrey in 1826, but in 1840 its distribution was given by Torrey and Gray as "Rich soils, along rivers, New York and New England. Introduced." In Flora Cestrica, Darlington says that it appears in gardens and lots, having been naturalized from Europe. In 1853 he says that "this coarse hard stemmed plant has been partially cultivated by some amateur farmers; but it is not likely to supersede the herbs now in general use as food for cattle." In the first edition of Gray's Manual its distribution is given as "adventitious from Europe." The same distribution is given in the sixth edition. In the seventh edition we read, "Roadsides, etc., common. (Nat. from Europe)." In Iowa, while it is found along the roadsides everywhere, the dates given with the following localities may indicate to some extent how it has spread: Vicinity of Ames, 1886; Iowa City, 1887 (A. S. Hitchcock); Emmet county, 1888 (Cratty); Ames, found frequently, 1890 (J. F. Rolfs and F. C. Stewart); Muscatine, 1891 (Reppert); Turin and Onawa, 1894 (L. H. Pammel); Webster City and Postville, 1894; Alden, 1895 (Stevens); abundant in Moingona, Boone. Slater, Council Bluffs and Sioux City, 1895 (Pammel); Dakota City, 1896 (Pammel); Kossuth county, 1897 (R. I. Cratty); Ogden, 1898; Carroll, 1898; Marshalltown and Des Moines, 1902 (Pammel). It was introduced into the vicinity of La Crosse, Wisconsin, as a forage plant in 1878 or 1879.

Wild Liquorice (*Glycyrrhiza lepidota* Nutt.).

This weed was reported from Grand Junction, 1872 (C. E. Bessey), and Harrison county, 1875 (Rev. Burgess); Ontario, 1886 (Hitchcock); Ames, 1889 (Hitchcock); Greenfield, 1891 (F. C. Stewart). Spreading near Greenfield, undoubtedly introduced, indigenous to western and northwestern Iowa. It was spreading at Little Rock, 1893 (C. R. Ball); Hull, 1895 (W. Newell); Logan, 1895; Council Bluffs, LeMars, 1896 (W. J. Newell); Lenox, 1896 (J. L. H.).

Stone Clover (*Trifolium arvense* L.).

Collected by Professor Bessey in 1871, has not been found since.

Hop Clover (*Trifolium agrarium* L.).

Reported by Hitchock from Ames in 1886, has not been found since.

Low Hop Clover (*Trifolium procumbens* L.).

Ames, 1882 (Hitchcock); Iowa City, 1884 (Hitchcock). It is now frequent in Ames; also in northeastern Iowa, in Waukon, Decorah and Dubuque, also in Clayton county.

Dakota Vetch (*Hosackia purshiana* Benth.).

Indigenous to the loess of Iowa along Missouri river. Sioux City, naturalized. Boone, 1895 (G. W. Carver).

Black medick (*Medicago lupulina*).

Reported by Dr. John Torrey in 1826 as occurring in fields, also by Dr. Gray in 1848 and Dr. Darlington in 1853. In the fifth edition of Gray's manual it was said to be "adventitious from Europe in waste places." Britton, in 1901, states, "In fields and waste places, common only throughout our area." It was found in Kossuth county, Iowa, in 1898; at Ames, 1871 (C. E. Bessey); 1898 (A. F. Sample and E. R. Hodson). Mr. F. W. Paige records having seen it in Fort Dodge about 1900.

MALVACEAE, MALLOW FAMILY.

Shoo-fly (*Hibiscus trionum*).

Reported in the first edition of Gray's manual in 1848. It is also mentioned by Darlington in 1853 as occurring in gardens and lots. The fifth edition of Gray's manual states, "advanced from Europe." The seventh edition gives "a wide distribution, culti-

Fig. 565. Shoo-fly (*Hibiscus trionum*). This weed was widely distributed as an ornamental plant.
(Drawing by Charlotte M. King.)

vated and waste ground, rather local." This weed was common in Texas in 1888 and local in a good many counties in Iowa in 1909. In Iowa it has been reported as follows: Fayette, 1894 (Bruce Fink); Winterset, 1895 (G. W. Carver); Waterloo, 1904 (B. D. Roberts).

Indian Mallow or Butterprint (*Abutilon theophrasti*).

This weed is not mentioned by Torrey, 1826, nor in the first edition of Gray's manual, 1848, but is recorded by Darlington in 1853. This foreign weed is becoming rather troublesome in cultivated grounds in Iowa. It was more or less common in the vicinity of LaCrosse in 1883; was abundant in Iowa in 1886.

ONAGRACEAE, EVENING PRIMROSE FAMILY.

Evening Primrose (*Oenothera biennis*).

This American weed became a settler of Padua, Italy, in 1612. Since then it has spread to every country of Europe and is recognized as one of the most common weeds of the continent, although it does not have as good a means of dissemination as many other weeds, like the dandelion, thistle, bull thistle, etc. The small seeds of this plant may and perhaps frequently do cling to hoofs of animals and with mud may be carried by the feet of birds.

PLANTAGINACEAE, PLANTAIN FAMILY.

Buckhorn (*Plantago lanceolata*).

This weed seems to have been pretty well established in the eastern states, when the first edition of Gray's manual was published in 1848, as it was reported as common. John Torrey, in a compendium of the Flora of the Northern and Middle States, published in 1826, describes the weed, indicating that it was evidently pretty well established. Darlington, in his Flora Cestrica, 1853, states, "this weed is extensively naturalized and more abundant than welcome in upland pastures." In the fifth edition of Gray's manual the distribution is given as "dry fields, common eastward," 1867. The seventh edition indicates a wider distribution, and Britton in 1901 indicates a distribution from New Brunswick to northwest territory, Florida and Canada. It was observed in the vicinity of LaCrosse, Wisconsin, in 1892, and as early as 1874 in Ames (C. E. Peterson). F. W. Paige records it from Fort Dodge in 1899. It is reported as quite common now in many counties of the state, being generally distributed with clover seed. It has also been reported in Ames, 1890 (F. A. Sirrine and L. H. Pammel); 1894 (G. W. Carver); Hartley, 1905 (W. B. Elliott); Audubon, 1906 (A. H. Edwards); Ames, 1909 (M. Clapper); Fayette (Bruce Fink); Maynard (A. F. Crawford).

PHYTOLACCACEAE, POKEWEED FAMILY.

Pokeweed (*Phytolacca decandra* L.).

Grinnell, 1889 (A. S. Hitchcock); Muscatine, 1891 (F. Reppert); Ames, 1894 (L. H. Pammel). A waif; not established.

POLYGONACEAE, BUCKWHEAT FAMILY.

Patience Dock (*Rumex patientia* L.).

Boone (G. W. Carver). Established. Escaped from cultivation.

Prince's Feather (*Polygonum orientale* L.).

Muscatine, 1890 (F. Reppert); Onawa, 1894; Clinton, 1897 (Pammel).

PORTULACACEAE, PURSLANE FAMILY.

Purslane (*Portulaca oleracea*).

Cultivated in Massachusetts in 1672 and since has spread to every part of the United States, appearing like an indigenous plant. It is likewise common in Germany, Holland, England, France and other European countries and in Australia. A cosmopolitan weed.

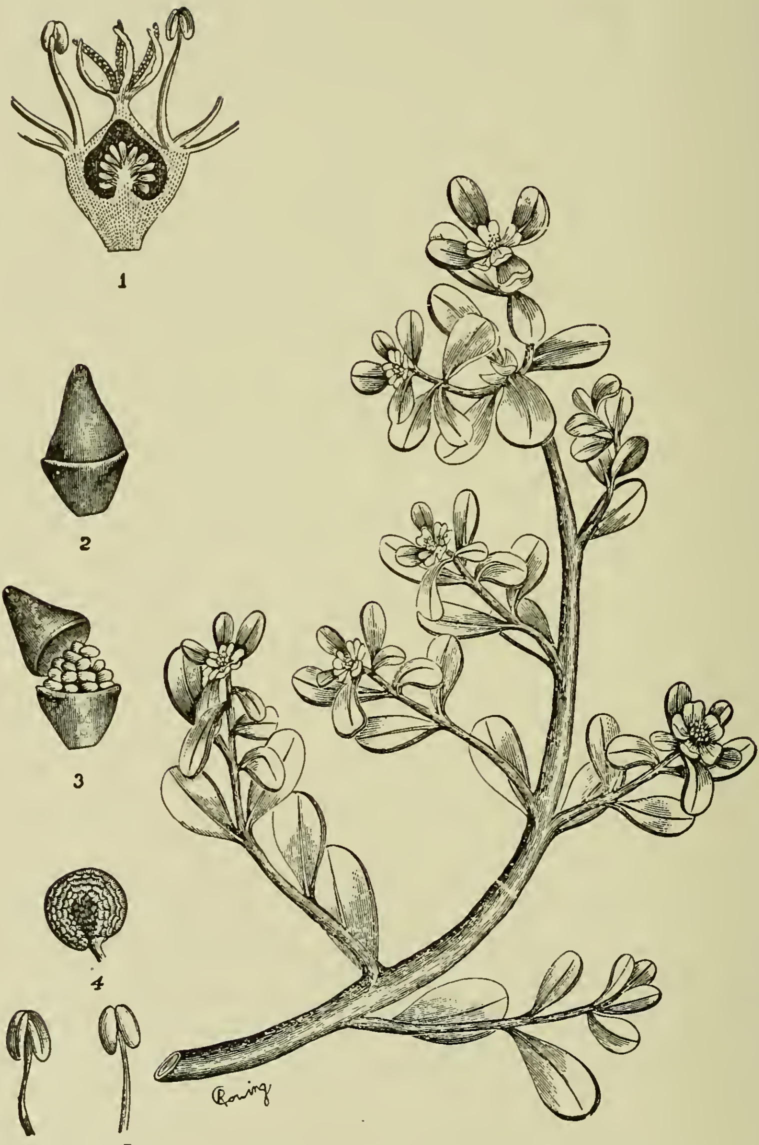

FIG. 566. Purslane (*Portulaca oleracea*). At first cultivated in the United States for greens; now appearing like an indigenous plant. (Vasey, U. S. Dept. Agr.)

SOLANACEAE, POTATO FAMILY.

Horse Nettle (*Solanum carolinense*).

This weed is a most troublesome species in southern Iowa. It was reported in the southeastern part of the state as early as 1876 and has gradually moved northward until at present it is well scattered over the state. In Nebraska, Aughey had found it in 1875, and it was reported in Weeping Water by T. A. Williams in 1889; in Illinois it had been known for half a century near Peoria (Brendel); Port Byron, 1894 (Pammel); South Chicago (Higbee and Raddin); Delaware, Newcastle county, 1860 (Tatnall); Pennsylvania, 1823 (Humphrey Marshall and Beck); Westchester, 1853 (Darlington); New Jersey, 1887 (Halsted and Britton); New York, 1888; Buffalo, 1864 (Clinton); Cincinnati,

FIG. 567. Horse Nettle (*Solanum carolinense*). Originally a weed of the southern states; rapidly spreading northward. a, general aspect of plant; b, flower; d, seeds; c, seed enlarged.
(After Dewey, U. S. Dept. Agr.)

Ohio, 1889 (James); central and southern Ohio, 1860 (Newberry); Grand Rapids, Michigan, 1886 (Crozier); Topeka, Kansas, 1883 (Popenoe); Connecticut, Iowa, Illinois and Michigan. Within fifty years this perennial weed has extended its range northward in Iowa over 150 miles. This has been possible because of its deep roots. Darlington, in his Flora Cestrica, states that it was introduced by the late Humphrey Marshall into his botanical garden at Marshalltown.

It was reported from Nashville, Tennessee, in 1877 by Gattinger; St. Louis, 1879, by Eggert, and abundant in western Missouri in 1886 (S. M. Tracy); Rhode Island, 1887 (J. L. Bennett); Wisconsin, Watertown, 1887 (L. H. Pammel); Indiana, Dune Park, 1890 (Higbee and Raddin, Bolley, Arthur); Illinois, 1891 (Brendel). In Iowa it was reported from Emmet county, 1875 (Cratty); southeastern Iowa, 1876; Fremont county and Council Bluffs, 1883 (Arthur); Ames, 1886 (Halsted); Agency, 1888 (Mrs. Richman); Carroll county, 1890 (T. T. Rutledge); Grand Junction, 1890 (Pammel); Polk City and Mt. Pleasant, 1891 (L. H. Pammel and J. H. Mills); Fontanelle, 1892; Denison, 1893 (J. Rollins); Corning, 1893 (W. L. Abbey); Iowa City, 1893 (Fitzpatrick); Springdale, 1894; Plattesville, 1894 (Studley); Postville, 1894 (Orr); Mt. Ayr, Guthrie Center and Story county, 1894 (Sale, Ashton and Pammel); Des Moines, 1895 (Carver); Decatur county and Des Moines county, 1896 (Fitzpatrick); Webster City, 1897 (Garber); Sheldahl, 1898 (Pammel); Yorkshire, 1899 (Stokes); Dallas Center, 1902 (C. B. Royer); Mondamin, 1903 (A. Spooner); Cooper, 1903 (Squires); Afton, 1904 (Geo. Williams); Audubon, 1905 (J. N. Eskech); Keota, 1905 (Klein); Lidderdale, 1907 (Mrs. Sanderson); Reinbeck, 1907 (Fred Wilcox); La Porte, 1908 (R. S. Meath); Algona, 1912 (A. Hutchinson); Collins, 1912 (J. Leonard); Brandon, 1912 (Roster); Whitten, 1912 (Parrish); Ontario, 1884 (Fletcher); Germany, Mulhausen, 1893 (Scherer Schorler); Denmark, 1895 (Ostenfeld).

Buffalo Bur (*Solanum rostratum*).

Has been reported frequently to me during the last few years. The number of specimens sent from Iowa correspondents during the season 1911 and 1912 was numerous, indicating a rapid spread in many different parts of the state. It has always been a native to the plains, finding a congenial home in the buffalo wallows. It was reported by Hartweg in 1837 as being seen north of the city of Mexico; by Bexar in Texas in 1828, in Rock Creek by Fendler in 1847, and in El Paso in 1849; and by Geyer from Pierre, South Dakota, in 1839. Nearly all of the early collectors, as Rothrock, Parry, Fendler, Geyer, Hayden, Brandegee, Palmer, mention this weed. It is generally believed to have become rapidly diffused in Texas after 1865.

Jimson Weed (*Datura stramonium*).

Found everywhere in Iowa and in many parts of the United States from the Atlantic to the Pacific. Common in eastern North America for more than seventy-five years. It is mentioned by Darlington, 1847, and Gray, 1848, states that it is a well known weed. The date of its appearance in Europe is not given by Ratzeburg, Kabsch notes that the thorn apple was introduced from India by gypsies. The plant is native to India where its poisonous properties were long known. The 5th and 6th editions of Gray's Manual indicate a wide distribution in eastern North America. It was common in western Wisconsin in 1881. Cratty states that it was rare in Emmet county, Iowa, in 1881.

UMBELLIFERAE, CARROT FAMILY.

Wild Carrot (*Daucus carota* L.).

This was reported by Dr. Torrey as occurring in fields in the northern and middle states in 1826. Dr. Gray records it as common in 1848; Darlington, in 1857, states that "this foreigner is extensively naturalized and becoming more troublesome from the culpable negligence of our farmers." In his 5th edition, Dr. Gray, in 1867, states "advanced from Europe." In the 7th edition, 1908, Robinson and Fernald state "fields and waste places, a pernicious weed" indicating a general distribution. Britton, 1901, states "common throughout our area" and the writer knew this weed in western Wisconsin, in 1880. In some places it was pretty well naturalized. Occasional specimens were found by the writer in 1889, in Iowa. It had previously been reported by Halsted and Arthur. It began to spread quite rapidly in 1904. F. W. Paige reports it from Ft. Dodge in 1909. It is now reported quite frequently from different places in the state. The following are a few of the localities: Greenfield, 1891 (F. C. Stewart); Earlham, 1903 (J. Long); Carrolton, 1904 (E. C. Schreiber); Zearing, 1904 (E. E. Sparrow); Hawarden, 1905 (C. S. McCarty); Hartley, 1905 (W. B. Elliott); Panora, 1906 (L. J. Hooper); Marshall

FIG. 568. Carrot (*Daucus carota*). Common in the east. Probably first spread from the cultivated carrot.

county, 1906 (W. R. Moninger); Whiting, 1907 (W. S. Whiting); Allerton, 1907 (J. H. Duncan); Lamoni, 1907 (T. L. Naftsger); Blackhawk county, 1907 (Pammel); Ames, 1909 (J. R. Campbell); Polk county, 1910 (Pammel); Rippey, 1910 (Osborn); Dumont, 1910 (Titus); Libertyville, 1911 (Armstrong); Bedford, 1911 (Spacht); Glidden, 1912 (Walters); Kelley and Ledges, 1912 (Pammel).

Poison Hemlock (*Conium maculatum*).

This weed was reported by Dr. John Torrey in 1826 as occurring on roadsides. It is mentioned by Dr. Gray in 1848 as occurring in waste places. Britton in 1901 records it from Quebec to Michigan and Indiana, California, and Mexico. Robinson and Fernald in the 7th edition of Gray's Manual indicate "to Pennsylvania," the same distribution that Britton gives. It is not, however, common in the Mississippi valley. It was reported from Pottawattamie county, Iowa, in 1909 and it was abundant in Salt Lake City, Utah, in 1908 where it evidently had been naturalized for some time. It was abundant in places in the Sacramento Valley in 1912 indicating naturalization for some time. Brewer and Watson in Botany of California (1876) state ''Sparingly naturalized.''

CHAPTER X.

MEDICINAL WEEDS OF IOWA

HARRIETTE S. KELLOGG

CHAPTER X.

MEDICINAL WEEDS OF IOWA.

In the United States, the raising of drug plants has never received the commercial attention that has been devoted to this branch of agriculture abroad. As a result, we are importing regularly for the drug trade thousands of pounds of dried plants that might be raised in this country. Among them are many weeds, as, quack grass and mustard that, to us, are pests to be eradicated as quickly as possible. Not that it would be wise to devote good agricultural land to raising medicinal weeds but as by-products these are of value. The word "weed" is used advisedly; for, while many of our vegetable drugs come from plants which in this country are not weeds, it is undoubtedly true that many drug plants are noxious weeds in the country in which they were first applied medicinally. This is illustrated by such weeds as quack grass, the mustards, the docks, tansy, and dandelion, all of which are official in the U. S. P.

As early as the days of Dioscorides the physician was the herbalist, and his knowledge of the active principles of plants was his stock in trade. Among semi-civilized and barbarous peoples the same thing is true today.

While very many of the plants formerly considered medicinal are at present discredited, a sufficient number remains to make raising drug plants a profitable industry.

The literature of medical botany, if we include the "Herballs" is quite voluminous. In Germany, in 1787, Schoepf published the "Materia medica americana, potissimum regni vegetabilis" in which he listed three hundred and sixty medicinal plants which he had collected among the American Indians; but he stated that there were actually over seven hundred in use. Between 1817 and 1821 Jacob Bigelow published three volumes of the "American Medical Botany; being a collection of the native medical plants of the U. S." in which he listed fifty plants, each illustrated by colored plates. William Barton, about the same time, published "Vegetable materia medica of the U. S.; or medical botany containing a botanical, general, and medical history of medicinal plants indigenous to the United States,'' in which fifty plants were described and illustrated. The high price of these books, however, necessarily limited their distribution.

In Rafinesque's ''Medical Flora,'' published in 1828 and 1830, one hundred and five plants are named as being native North American plants. Among those listed are such weeds as mayweed, butterfly weed, wormseed, wild hemlock, cowbane, thorn-apple, fleabane, boneset, Joe-Pye weed and mullein.

The most complete work of recent years is Millspaugh's American Medicinal Plants in which he describes and illustrates with colored plates 180 medicinal plants native in the United States and recognized by homeopathic physicians as of therapeutic value. He also adds to each description, the active principles of the plant in question, the method of preparation and the physiological action of the drugs derived therefrom. In addition to the one hundred and eighty plants fully described, he mentions hundreds of others that are known to the profession but are not native to the United States, making in all so satisfactory a treatise that for many years it must remain our most reliable source of information in this line. In Dr. Pammel's Manual of Poisonous Plants, many medicinal weeds not of a poisonous nature are listed among the economic plants.

The United States Department of Agriculture has issued a number of bulletins containing references to medicinal weeds, which are listed in the bibliography at the end of the volume.

Many plants not listed as official in the United States Pharmacopœia have, nevertheless, value as commercial products. Such, for instance, is true of the wormseed plant which, although not recognized in our Pharmacopœia, brings from 6 to 8 cents per pound in the drug market.

Quack grass (*Agropyron repens*) is the only weed of the grass family that is official in the U. S. P. A fluid extract from the rhizome of this plant sold under the name of dog grass or triticum is a remedy in kidney and bladder troubles.

The roots of various docks of the Iowa species are official. Bitter dock (*Rumex obtusifolius*) and yellow dock (*R. crispus*) are rated at 2 to 8 cents per pound and form the basis of various blood purifiers. The leaves of sheep sorrel (*R. acetosella*) while not official, are of market value.

FIG. 569. Quack Grass (*Agropyron repens*). The root-stock used for bladder trouble.
(Drawing by Charlotte M. King.)

The entire herb of water pepper (*Polygonum hydropiper*) when decanted with alcohol forms a valuable diuretic, but is not recognized in the Pharmacopœia.

The entire leafy part of the American wormseed (*Chenopodium ambrosioides*) is valued for its anthelmintic properties. Oil from the fruit is official and sells for $1.50 per pound.

Of the *Phytolaccaceae*, pokeweed (*Phytolacca decandra*) has long been considered of medicinal value. The berries, collected when mature, are rated at 5 cents per pound; the roots at 2 to 5 cents; although not official they are the basis of remedies for various diseases of the skin and blood, especially in allaying rheumatism.

In the order *Caryophyllaceae* is the corn-cockle (*Agrostemma githago*), the powdered seeds of which are the basis of a remedy used to cleanse the blood in certain skin diseases.

Chickweed (*Stellaria media*) formerly had some reputation as an alterative but is now used very seldom.

Among the *Cruciferae* are several weeds that are recognized as medicinal. The most important are the mustards, the seeds of which are official and sell at 3 to 6 cents per pound. Both the black mustard (*Brassica nigra*) and the white mustard (*B. alba*) are collected for this purpose and are used principally in making plasters and poultices but occasionally are administered in cases of dyspepsia. They are emetic when given in large doses.

The shepherd's purse (*Capsella bursa-pastoris*) is not official. At one time it was considered of value as a tonic, astringent, and antiscorbutic but has fallen into disuse except when occasionally applied as an astringent in hemorrhages.

Among the *Malvaceae* is a dooryard weed, common mallow (*Malva rotundifolia*), the whole plant of which is sometimes applied locally as a poultice or internally as a demulcent.

A decoction of the dried plant of the evening primrose (*Oenothera biennis*), a member of the *Onagraceae*, is a remedy in cases of infantile eruptions, spasmodic asthma and bladder trouble.

An introduced weed of the *Leguminosae* is noted; the yellow sweet clover (*Melilotus officinalis*), the seeds of which boiled with lard are sometimes made into a salve which is applied to ulcers and open indolent sores, the remedy proving efficacious.

Among the *Umbelliferae* are the caraway (*Carum carvi*), the root of which is sometimes ground into a poultice and the fruit and leaves of which are diuretic and stimulant; the poison hemlock (*Conium maculatum*), the root of which is deadly poisonous, although the unripe fruit, dried and preserved, is official, selling at 8 cents per pound, and the leaves, though not official, are sometimes applied in cases of rheumatism, neuralgia or asthma to sooth the nerves; and the water hemlock (*Cicuta maculata*), sometimes substituted for cowbane.

Two of the Milkweeds (*Asclepias incarnata* and *A. syriaca*) are listed as medicinal, an extract from the root alone being used. This is a diaphoretic and was formerly applied in acute pulmonary and bronchial affections and in rheumatism. Although at present it has fallen somewhat into disrepute, it is sometimes given in cases of dropsy.

A tincture from the whole plant of bindweed (*Convolvulus arvensis*), of the family *Convolvulaceae,* is sometimes used as a diuretic or gentle laxative.

The leaves and root of one of the *Boraginaceae,* hound's tongue (*Cynoglossum officinale*), are both medicinal, the latter being somewhat narcotic. The leaves were at one time used as a styptic.

Of the *Verbenaceae* we find records of the use of the root and green parts of vervain (*Verbena hastata*) which were substituted occasionally for boneset in fevers and agues. They are emetic and expectorant.

The Labiate, self-heal (*Prunella vulgaris*), is an astringent but by no means is the universal curative agent that its name would suggest.

Catnip (*Nepeta cataria*) no longer official, nevertheless is rated at 2 to 8 cents per pound for leaves and flowering tops, the coarse stems being rejected. A decoction from these parts is a mild stimulant and tonic, being rather quieting in effect.

Motherwort (*Leonurus cardiaca*) has similar properties.

The family *Solanaceae* is very important medicinally, as it furnishes at least twenty drugs to the trade, of which the most important is belladonna. Of the Iowa weeds Jimson (*Datura stramonium*) is the best known. The leaves and seeds are official, the former being rated at 2½ to 8 cents and the latter at 3 to 7 cents per pound. The leaves are applied in cases of asthma and the seeds in spasmodic diseases affecting the respiratory tract. *Datura tatula* is sometimes used in the same manner.

The black nightshade (*Solanum nigrum*) is especially valuable as a resolvent but its use is no longer prevalent. In some parts of Iowa the bruised leaves are considered an unfailing remedy in cases of ivy poisoning.

The root leaves and berries of horse nettle (*S. carolinense*) are mentioned by Alice Henkel as being medicinal though not official.

Of the *Scrophulariaceae,* the cosmopolitan mullein weed (*Verbascum thapsus*) possesses considerable market value although it is not recognized by the U. S. P. as official. The dried leaves retail at $2\frac{1}{2}$ to 5 cents and the flowers at 25 to 75 cents per pound. A tincture from these is a recognized remedy in coughs and catarrh. It quiets nervous irritation and relieves inflammation.

The uses of the plantains (*Plantago*) are various. The fresh leaves are sometimes applied to wounds or chronic sores. The seeds steeped in milk form a remedy used in checking hemorrhages from mucous surfaces and in dysentery. Almost every part of the plant at some time has been recorded as medicinal. The fibers from the leaves were thought to be an unfailing remedy for toothache, the fiber, however, being placed in the ear on the side of the tooth affected rather than about the tooth itself.. Plantain is also an antidote to snake bites. A decoction of the root was sometimes administered in cases of intermittent fever.

In short it would seem possible for one to have quite a complete medical dispensary in his own dooryard without care or expense.

The family *Compositae* undoubtedly contains a larger number of medicinal genera than any other plant family.

A decoction made from the whole herb of yarrow (*Achillea millefolium*) is a bladder medicine and is administered sometimes in cases of hemorrhage or catarrh. The ragweed (*Ambrosia artemisiaefolia*) is used in similar cases. The mayweed (*Anthemis cotula*) furnishes a bitter stimulant and tonic in aid of digestion. From the leaves may be made a fermentation which relieves pain and inflammation, sprains and bruises; none of the last three named is official.

The burdock (*Arctium lappa*), however, is recognized in the U. S. P. Its fresh root gathered in autumn retails at 3 to 8 cents and seeds at 5 to 10 cents per pound. These are both useful in preparations against blood and skin diseases. The leaves are sometimes applied externally as cooling poultices.

An infusion of the root of chicory (*Cichorium intybus*) is sometimes offered to increase the appetite and to aid digestion. A decoction from fireweed (*Erechtites hieracifolia*) is an alterative and is applied in cases of dysentery. The oil of horseweed (*Erigeron canadense*) is official, the herb being rated at 6 to 8 cents per pound. The plant has been known locally as ''blood stanch'' and, as the name implies, was used in arresting hemorrhages and bleeding from wounds.

According to Millspaugh this use of the plants is practiced today among the North American Indians. The oil only is official. The various local names of *Eupatorium perfoliatum,* boneset, feverwort,

FIG. 570. Burdock (*Arctium lappa*). Formerly used as blood purifier. (Vasey, U. S. Dept. Agr.)

or agueweed, indicate the uses of the plant. It is tonic, diaphoretic, emetic, or cathartic according to the size of the dose administered; the root of the white snakeroot (*E. urticaefolium*) is also of commercial importance, being rated at 2 to 8 cents per pound. The Joe-Pye weed (*E. purpureum*) has uses somewhat similar to the preceding but is also a diuretic and is valuable in cases of jaundice, dropsy, rheumatism or gout.

The leaves and flowering tops of the scaly grindelia (*Grindelia squarrosa*) are the basis of a remedy against asthma and are also sometimes made into a poultice to apply in cases of ivy poisoning. The sneezeweed (*Helenium autumnale*) is a tonic and diaphoretic; the powdered flowers are sometimes snuffed to relieve affections of the nasal passages. The wild lettuce (*Lactuca canadensis*), once considered a substitute for opium, is an anodyne, a diaphoretic, and a diuretic, and is applied principally in nervous complaints. Tansy (*Tanacetum vulgare*) is official in the U. S. P., the leaves and flowering tops being rated at 3 to 6 cents per pound. It is a well known but poisonous vermifuge.

The root of the dandelion (*Taraxacum officinale*), collected in autumn, is official, selling at 4 to 6 cents per pound. A decoction from this is a tonic in cases of dyspepsia and diseases of the liver. A hair tonic is also made from it.

Undoubtedly this list could be greatly extended were it possible to obtain information in regard to all cases of home use of native drug plants. Unfortunately few written records are obtainable and one is obliged to depend largely on tradition handed down by word of mouth.

There is undeniably an opening in Iowa for raising and marketing medicinal plants and a few words in this line may not be out of place at this point.

For the profitable marketing of drug plants it is necessary that the plants be suitably prepared, that is, that they be thoroughly cleaned and well cured. To be cleaned they must be freed from all foreign substances, whether dirt, sand, insects, or fragments of other plants; when cured properly, they have been picked at the right season, and have been dried so as to retain so far as possible their characteristic color. If the leafy part is sought for the trade, the plant should be cut when in flower or before seeds have formed, then dried in gentle heat (not higher than 125° F.) so as to lose as little as possible of the volatile principle. In some plants, as cowbane, the unripe fruit, well dried and preserved, has value officially, but of mustard on the other hand, ripe seeds, only, are official. The dried leaves of the catnip have market value but no longer are recognized as official. The roots of the dandelion collected in the autumn are listed in the U. S. P.; the rhizome of quack grass is marketable. In short, if one is to realize any financial profit from his fields of weeds, he must be able to recognize absolutely the weed in question, for poisonous herbs sometimes closely resemble innocuous weeds and a mistake in identification may result seriously; he must also know what part of each plant is salable, when it must be collected, whether in the ripe or immature state, and in what form it is preferred by the trade. It is not an occupation to be followed by the careless or ignorant worker. Ignorance is no excuse for offering to the trade a deadly herb in mistake for its harmless relative. When the life of the patient is sacrificed as a result of such a mistake the old saying, that "if it kills it is poisonous, if it cures it is the right herb," will hardly suffice as an excuse.

For the careful gardener, however, who is willing to wait for his herbs to mature one year, two years, or, as with ginseng, seven years, the occupation of growing drug plants offers many inducements.

CHAPTER XI.

PHENOLOGY OF WEEDS

CHARLOTTE M. KING

CHAPTER XI.

PHENOLOGY OF WEEDS.

Several species of weedy plants bloom very early in the spring, responding promptly to a comparatively limited amount of light and warmth; others come to bloom after the growing season is more advanced; while a number blossom throughout the season, or from spring until fall.

The time of bloom is, in each species, related to its definite physiological constant of warmth, sunshine and moisture. Warm, sunshiny weather in the early part of the season will hasten the time of bloom, as cold, cloudy weather will retard it. There is a difference of about two weeks between the blooming date of plants of northern and southern parts of Iowa.

The season of a plant's activity is related in part to the hardiness it has developed, and to the climatic conditions of the geographical region selected by it, as most favorable to its existence.

It is vigor and tenacity as well as wide seed distribution which contribute to the troublesome character of the plants which we call weeds.

It is indicated by the accompanying table, as known also by common experience, that the rain, warmth and sunshine received at the arrival of midsummer produce greatest bloom of weedy plants for the season in both number and kinds; and since weeds quickly mature, it is apparent that the harvest of weed seeds steadily increases from that time until fall.

The crucifers are among our earlier blooming weeds, as the winter annuals, shepherd's purse and peppergrass; the legumes and umbellifers are at their full growth about midsummer; the plantains begin in May, the polygonums in June; whilst composites are usually blooming throughout the latter part of the season.

Grasses distribute their blossoming-time throughout the summer from May until October; vanilla grass and blue grass appear in May, orchard grass, quack grass, needle grass and timothy in June, crab grass, fescue grass, and rye grasses about July, Bouteloua in August, blue-stem and drop-seed grasses in September.

Many plants, either annual or perennial, which have a recognized weedy character, have a prolonged period of bloom and seeding, thus maintaining a vigorous hold.

Common cosmopolitan weeds, belonging to various orders, have often remarkable perennation, as in case of the dandelion, shepherd's purse and chickweed; these weeds begin bloom in earliest spring and are also more resistant to frost than are other weeds.

The period of time required for maturing fruit after blooming varies in different species; a comparatively short time is needed in case of most weeds, especially the late blooming ones.

The dormant period required for a seed before germination will take place differs with varieties, and with individual seeds of the same variety. In seeds requiring a period of rest, this delay may be a matter of days, weeks, or years; therefore there is a distribution for seeds through time as well as through space. Many seeds germinate immediately if conditions are favorable. Many young plants must be lost by this autumnal vegetating, in case of seedlings overtaken by frost before they can bear seeds or establish roots; but the hardy habit of the winter annual, the biennial and perennial, protects for the most part such young plants after fall germination.

Quack grass has a crop of seedlings of the same season as the ripening of seed; this is true also of wild carrot, burdock, thistles, horse nettle and ribgrass, all of which being biennial or perennial persist throughout the winter.

The freezing and thawing of winter facilitates germination of weed seeds in the spring; and very early one may note, in the location of the parent of last season, as soon as the soil grows warm enough, many flourishing young colonies of seedlings, such as spurge, oxalis, pigweed and smartweed crowding each other for foothold. The culturist is greatly influenced by considerations of blooming-time, seed-time, and time of seed-germination in his efforts to control and to exterminate weeds.

BLOOMING PERIOD OF COMMON WEEDS

	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.
Stellaria media A. Chickweed	+	+	+	+	+	+	+	+	+
Capsella bursa-pastoris A. Shepherd's purse	+	+	+	+	+	+	+	+	+
Medicago lupulina A. Yellow trefoil	+	+	+	+	+	+	+	+	+
Oxalis corniculata A. & P. Lady's sorrel	+	+	+	+	+	+	+	+	+
Taraxacum officinale P. Dandelion	+	+	+	+	+	+	+	+	+
Nepeta hederacea P. Ground ivy		+	+						
Barbarea vulgaris B. Yellow rocket		+	+	+					
Cynoglossum boreale B. Hound's tongue		+	+						
Plantago lanceolata P. Buckhorn		+	+	+	+	+	+	+	+
Ranunculus abortivus B. Small-flowered buttercup		+	+	+					
Ranunculus septentrionalis P. Buttercup		+	+	+	+				
Rumex altissimus P. Smooth dock		+	+	+					
Taraxacum erythrospermum P. Small-flowered dandelion		+	+	+					
Allium canadense A. & P. Wild garlic			+	+					
Asclepias speciosa P. Showy milkweed			+	+	+				
Brassica arvensis A. Wild mustard			+	+	+	+	+	+	+
Bromus tectorum A. Downy brome grass			+	+					
Carum carvi B. Caraway			+	+	+				
Cerastium viscosum A. & P. Mouse-ear chickweed			+	+	+	+	+		
Convolvulus arvensis P. European morning-glory			+	+	+	+	+		
Convolvulus sepium P. Wild morning-glory			+	+	+	+	+		
Datura tatula A. Purple thorn-apple			+	+	+	+	+		
Euphorbia marginata A. Snow-on-the-mountain			+	+	+	+	+	+	
Euphorbia preslii A. Spurge			+	+	+	+	+	+	
Glycyrrhiza lepidota P. Wild liquorice			+	+	+	+			
Hierochloe odorata P. Vanilla grass			+	+	+				
Hordeum pusillum A. Small squirrel-tail grass			+	+					
Lepidium apetalum A. Apetalous peppergrass			+	+	+	+			
Lepidium virginicum A. Wild peppergrass			+	+	+	+	+	+	+
Lithospermum arvense A. Corn gromwell			+	+	+	+			
Lolium italicum B. or P. Italian rye-grass			+	+	+				
Malva rotundifolia P. Common mallow			+	+	+	+	+	+	+
Oxybaphus nyctagineus P. Wild four-o'clock			+	+	+	+			
Plantago major P. Door-yard plantain			+	+	+	+	+		
Plantago purshii A. Pursh's plantain			+	+	+	+			
Potentilla anserina P. Silverweed			+	+	+	+	+		
Radicula palustris A. or B. Marsh cress			+	+	+	+			
Rhus toxicodendron P. Poison ivy			+	+					
Rudbeckia hirta B. Black-eyed Susan			+	+	+	+	+		
Rumex acetosella P. Sheep sorrel			+	+	+	+	+		
Sisymbrium officinale A. Hedge mustard			+	+	+	+	+	+	+
Solanum carolinense P. Horse nettle			+	+	+	+	+		
Solanum rostratum A. Buffalo-bur			+	+	+	+	+		
Sonchus oleraceus A. Sow thistle			+	+	+	+	+	+	+
Trifolium procumbens A. Hop clover			+	+	+	+	+		
Verbena bracteosa P. Bracted verbena			+	+	+	+			
Veronica peregrina A. Speedwell			+	+	+	+	+	+	
Vicia sativa A. Vetch			+	+	+	+			
Achillea millefolium P. Yarrow				+	+	+	+	+	+

A. Annual.

B. Biennial.

P. Perennial.

BLOOMING PERIOD OF COMMON WEEDS—CONTINUED.

	Mar.	Apr	May	June	July	Aug.	Sept.	Oct.	Nov.
Acalypha virginica A. Three-seeded mercury......				+	+	+	+	+	
Amaranthus graecizans A. Tumbleweed...........				+	+	+	+		
Amaranthus blitoides A. Spreading pigweed.....				+	+	+	+	+	
Anthemis cotula A. Mayweed.....................				+	+	+	+	+	+
Apocynum cannabinum P. Dogbane...............				+	+	+	+		
Asclepias syriaca P. Milkweed....................				+	+	+			
Berteroa incana A. or P. Berteroa.................				+	+	+	+		
Brassica nigra A. Black mustard..................				+	+	+	+	+	+
Bromus secalinus A. Cheat.......................				+	+	+			
Camelina sativa A. False flax.....................				+	+				
Carex vulpinoidea P. Sedge.......................				+	+	+			
Chenopodium album A. Lamb's quarter............				+	+	+	+		
Cicuta maculata P. Cowbane.....................				+	+	+			
Cirsium arvense P. Canada thistle................				+	+	+	+		
Cirsium undulatum B. Wavy-leaved thistle.........				+	+	+	+		
Crotalaria sagittalis A. Rattle-box................				+	+	+	+		
Cycloloma atriplicifolium A. Winged pigweed......				+	+	+	+		
Datura stramonium A. Jimson weed..............				+	+	+	+		
Daucus carota B. Wild carrot....................				+	+	+	+		
Erigeron annuus A. Fleabane....................				+	+	+	+	+	
Erigeron canadensis A. Horseweed...............				+	+	+	+	+	+
Erigeron ramosus A. Branched fleabane............				+	+	+	+	+	
Euphorbia maculata Spotted-leaved spurge				+	+	+	+	+	+
Geum canadense P. Avens.......................				+	+	+			
Helianthus petiolaris A. Petiolate sunflower.....				+	+	+	+		
Hordeum jubatum A. or B. Squirrel-tail............				+	+	+			
Hypericum perforatum P. St. John's-wort..........				+	+	+	+		
Lactuca canadensis A. or B. Wild lettuce..........				+	+	+	+	+	+
Lactuca pulchella P. Blue lettuce..................				+	+	+	+		
Lappula virginiana A. Beggar's lice...............				+	+	+	+		
Leonurus cardiaca P. Mother-wort...............				+	+	+	+		
Lygodesmia juncea P. Lygodesmia................				+	+	+	+		
Melanthium virginicum P. Bunch flower...........				+	+	+			
Melilotus alba B. White sweet clover.............				+	+	+	+	+	+
Oenothera biennis B. Evening primrose.......				+	+	+	+	+	
Parietaria pennsylvanica A. Pellitory..............				+	+	+			
Pastinaca sativa P. Parsnip......................				+	+	+	+		
Plantago rugelii P. Rugel's plantain..............				+	+	+	+		
Polanisia trachysperma A. Polanisia..............				+	+	+			
Polygonum aviculare A. Dooryard knotgrass.......				+	+	+	+	+	
Polygonum hydropiperoides P. Mild water pepper..				+	+	+	+		
Polygonum lapathifolium A. Slender smartweed....				+	+	+	+		
Eleusine indica A. Goose-grass....................				+	+	+	+		
Eragrostis megastachya A. Candy-grass...........				+	+	+	+		
Linaria vulgaris P. Toadflax......................				+	+	+	+	+	
Silene antirrhina A. Sleepy catchfly..............				+	+	+	+		
Thlaspi arvense A. Pennycress...................				+	+	+			
Urtica gracilis P. Nettle.........................				+	+	+	+	+	
Conringia orientalis A. Hare's-ear mustard.........				+	+	+	+	+	
Polygonum persicaria A. Lady's thumb...........				+	+	+	+	+	
Portulaca oleracea A. Purslane..................				+	+	+			
Radicula armoracia P. Horseradish...............				+	+	+			
Raphanus sativus A. or B. Radish................				+	+	+	+	+	
Rumex crispus P. Curled dock....................				+	+	+			

BLOOMING PERIOD OF COMMON WEEDS—CONTINUED.

	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.
Rumex obtusifolius P. Bitter dock				+	+	+			
Saponaria vaccaria A. Cow-herb				+	+	+			
Sida spinosa A. Prickly sida				+	+	+			
Sisymbrium altissimum A. or B. Tall hedge mustard				+	+	+			
Stachys palustris P. Woundwort				+	+	+	+		
Teucrium canadense P. Germander				+	+	+	+		
Tribulus terrestris A. Caltrop				+	+	+	+		
Verbascum thapsus B. Mullein				+	+	+	+		
Verbena hastata P. Blue vervain				+	+	+	+		
Bromus hordeaceus A. Soft chess				+	+	+			
Agrostemma githago A. Corn cockle				+	+	+	+		
Verbena stricta P. Hoary vervain				+	+	+	+		
Atriplex patula A. Orach					+	+			
Acnida tuberculata A. Water hemp					+	+	+	+	
Avena fatua A. Wild oats					+	+	+		
Ambrosia artemisiifolia A. Small ragweed					+	+	+	+	
Ambrosia trifida A. Large ragweed					+	+	+	+	
Arctium lappa B. Burdock					+	+	+	+	
Bidens cernua A. Sticktight					+	+	+	+	
Bidens discoidea A. Sticktight					+	+	+	+	
Bidens frondosa A. Sticktight					+	+	+	+	
Chenopodium hybridum A. Maple-leaved goosefoot					+	+	+		
Cichorium intybus P. Chicory					+	+	+	+	
Cirsium discolor B. Field thistle					+	+	+	+	
Cirsium ioense B. Iowa Thistle					+	+	+	+	
Cirsium lanceolatum B. Bull thistle					+	+	+	+	
Cleome serrulata A. Stinking clover					+	+	+		
Cuscuta arvensis A. Field dodder					+	+	+		
Digitaria humifusa A. Smooth crab grass					+	+	+		
Dyssodia papposa A. Fetid marigold					+	+	+	+	
Eragrostis pilosa A. Pilose eragrostis					+	+			
Erechtites hieracifolia A. Fireweed					+	+	+		
Eupatorium urticaefolium P. White snakeroot					+	+	+	+	+
Gaura biennis B. Gaura					+	+	+		
Gonolobus laevis P. Angle-pod					+	+	+		
Helianthus annuus A. (Wild) Sunflower					+	+	+		
Ipomoea hederacea A. Wild morning-glory					+	+	+		
Iva xanthifolia A. Poverty weed					+	+	+		
Kochia scoparia A. Kochia					+	+	+		
Lolium perenne P. Rye grass					+	+			
Melilotus officinalis A. or B. Yellow sweet clover					+	+	+	+	+
Mentha spicata P. Spearmint					+	+			
Physalis subglabrata P. Smoothish ground cherry					+	+	+		
Polygonum convolvulus A. Black bindweed					+	+	+		
Polygonum erectum A. Erect knotweed					+	+	+		
Polygonum hydropiper A. Water pepper					+	+	+		
Polygonum muhlenbergii P. Tanweed					+	+	+		
Polygonum pennsylvanicum A. Pennsylvania smartweed									
Polygonum ramosissimum A. Branching knotweed					+	+	+		
Potentilla monspeliensis B. or P. Five-finger					+	+	+		
Salsola kali var. *tenuifolia* A. Russian thistle					+	+	+		
Scrophularia marylandica P. Simpson's honey plant					+	+	+		
Setaria glauca A. Yellow foxtail					+	+	+		

BLOOMING PERIOD OF COMMON WEEDS—Concluded.

	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.
Setaria verticillata A. Whorled foxtail					+	+	+		
Setaria viridis A. Green foxtail					+	+	+		
Silene noctiflora A. Night-flowering catchfly					+	+	+		
Solanum nigrum A. Night-shade					+	+	+	+	
Sonchus arvensis P. Field thistle					+	+	+	+	
Saponaria officinalis P. Bouncing Bet					+	+	+		
Stipa spartea P. Needle grass					+	+			
Strophostyles helvola A. Wild pea					+	+	+	+	
Symphoricarpos orbiculata P. Indian currant					+	+	+		
Tanacetum vulgare P. Tansy					+	+	+		
Lactuca scariola A. Prickly lettuce					+	+	+		
Hibiscus trionum A. Shoo-fly					+	+	+		
Urtica dioica P. Stinging nettle					+	+	+		
Vernonia fasciculata P. Iron-weed					+	+	+		
Abutilon theophrasti A. Velvet leaf						+	+	+	
Amaranthus retroflexus A. Tumbling pigweed						+	+	+	
Aristida dichotoma A. Poverty grass						+	+	+	
Artemisia biennis B. Wormwood						+	+	+	
Artemisia ludoviciana P. Western mugwort						+	+	+	
Aster multifloris A. Many-flowered aster						+	+	+	+
Aster salicifolius A. Willow-leaved aster						+	+	+	+
Bidens aristosa A. or B. Sticktight						+	+	+	
Cenchrus tribuloides A. Sandbur						+	+		
Chenopodium ambrosioides A. Mexican tea						+	+	+	
Cirsium altissimum B. Tall thistle						+	+		
Cirsium canescens B. Woolly thistle						+	+	+	
Cyperus esculentus P. Northern nut grass						+	+	+	
Dalea alopecuroides A. Foxtail dalea						+	+		
Digitaria sanguinalis A. Crab grass						+	+		
Echinochloa crusgalli A. Barnyard grass						+	+	+	
Helianthus grosseserratus P. Wild prairie sunflower						+	+	+	
Helianthus maximiliani P. Maxmilian's sunflower						+	+	+	
Helenium antumnale P. Sneezeweed						+	+	+	
Muhlenbergia mexicana P. Mexican dropseed						+	+		
Muhlenbergia racemosa P. Dropseed grass						+	+		
Solidago canadensis P. Canada goldenrod						+	+	+	+
Solidago rigida P. Stiff goldenrod						+	+	+	
Solidago serotina P. Goldenrod						+	+	+	
Panicum capillare A. Hair grass						+	+	+	
Sporobolus neglectus A. Small rush grass						+	+		
Sporobulus vaginiflorus A. Sheathed rush grass						+	+		
Xanthium canadense A. Cocklebur						+	+	+	
Xanthium spinosum A. Spined cocklebur						+	+	+	+
Helianthus tuberosus P. Artichoke						+	+		

CHAPTER XII.

WEED AND SEED LAWS

L. H. PAMMEL

CHAPTER XII.

PURE SEED AND WEED LAWS.

Many states of the United States have weed and seed laws and similar laws are on the statute books of the principal agricultural countries of the world. Long, who in "Common Weeds of the Farm and Garden" has summarized the legislation, states, in Appendix III, that the laws are quite stringent in Australia, and in the South African Colonies; that the only laws requiring the destruction of weeds in the British Islands are in Ireland and the Isle of Man; that no laws or regulations are in force in Great Britain although there is an Adulteration and Seeds Act.

Canada has a good general seed law; Manitoba has a noxious weed act passed in 1906 which included common wild mustard, Canada thistle, perennial sow thistle, wild oats, "stink-weed" or penny cress, and false flax. The law provides that owners and occupants of land shall be compelled to cut down, or destroy weeds, to prevent seeding.

In Ontario the law provides that every occupier must cut down all Canada thistles, ox-eye daisies, wild oats, ragweed, burdock and all other noxious weeds to which the act may be extended by municipal law to prevent the ripening of seed, provided it does not destroy the growing grain.

The law of the Northwest Territories is similar to that of Manitoba, excepting that inspectors are appointed who have the power to act in the case of the occupier's default. It is further provided that threshing machines shall be cleaned before being removed from one place to another.

The law of Quebec includes daisies, wild endive, chicory, celandine and wild mustards as weeds.

In Saskatchewan the Noxious Weed Ordinance schedules nineteen species including six species of mustard and three of thistles. This province also provides for the appointment of weed inspectors.

The province of Alberta, Act of 1907 amended in 1908, mentions 22 noxious weeds. Inspectors are also appointed. The sale of seed containing 5 per 1,000 noxious weed seeds is forbidden and the germinating power of all weed seed must be destroyed before cleanings, etc., can be removed from any premises. Threshing machines must be thoroughly cleaned before being removed to another place.

WEED LEGISLATION.

Various states have legislated in regard to certain weeds as follows: Arizona on cockleburs and sunflowers; California on Canada thistles and any and all weeds that are spread by the wind; Connecticut on Canada thistle and wild carrot; Delaware, Canada thistle; Illinois, Canada thistle on highways, cockleburs and all weeds before maturity; Iowa, Canada thistle, cocklebur, burdock, curled dock, smooth dock, wild parsnip, quack grass, velvet weed, horse nettle, Russian thistle and shoo-fly; Indiana, Canada thistle; Kansas, on highways, cockleburs, Rocky Mountain sandburs, burdocks, sunflower, and such other weeds as may be injurious to the best interests of the farming community; Kentucky, Canada thistle; Maryland, Canada thistle; Michigan, to remove noxious weeds on highways, Canada thistle, milkweed (*Asclepias syriaca*); Minnesota, weeds in three groups: first group, wild mustard, wild oats, cocklebur, burdock, tumble mustard, second group, Canada thistle, ox-eye daisy and quack grass, third group, French weed; a section prohibits the spread of weeds from empty freight cars; the following weeds must be destroyed on highways: Russian thistle, Canada thistle or other thistles, burdock, ox-eye daisy, wild mustard, snap dragon or toad flax, cocklebur, sow thistle, sour dock, yellow dock and other noxious weeds; Missouri, Canada thistle; Nebraska, Canada thistle; New Jersey, Canada thistle; New York, Canada thistle and other noxious weeds along canals; North Dakota, Canada thistle, cocklebur, mustard, wild oats, French weed, Russian thistle; Ohio, brush briers, thistles or other noxious weeds, Canada thistle, wild parsnip, sweet clover, wild carrots, teasel, burdock, cockleburs; Oregon, dagger cocklebur, Canada thistle; Pennsylvania, Canada thistle; South Dakota, Russian thistle, Canada thistle, and cocklebur; Vermont, all thistles and noxious weeds; Washington, Canada thistles; in West Virginia, the county court may offer reasonable bounties or rewards for birds of prey or weeds; Wisconsin, Canada thistle, burdock, ox-eye daisy, toad flax, cocklebur, sow thistle, sour dock, and yellow dock, mustard, wild parsnip, sweet clover, and Russian thistle.

Many states have passed supplementary legislation. Many other countries besides those mentioned here have rather stringent laws on the extermination of weeds. There are laws in France and Germany but most of the European countries appear to have no legislation on the destruction of weeds.

Denmark awards prizes to members of societies for weedless fields. In most countries and most states of the United States the laws are flagrantly violated. In the Canadian Provinces, where weed commissioners are appointed, they seem to have remedied this defect.

A few years ago these laws were compiled by Dewey.* The present Iowa law is as follows:

IOWA.

SENATE FILE NO. 136.

AN ACT TO PROVIDE FOR THE DESTRUCTION OF NOXIOUS WEEDS AND OTHER WEEDS UPON LANDS, HIGHWAYS AND OTHER PLACES; PRESCRIBING PENALTIES FOR THE VIOLATION THEREOF; ASSESSING THE COSTS AND EXPENSES OF THE DESTRUCTION OF THE SAME TO THE LANDS AND OWNERS THEREOF; AND PROVIDING FUNDS WITH WHICH TO DESTROY THE SAME, AND REPEALING ALL OF CHAPTER NINETY-SIX (96) OF THE ACTS OF THE THIRTY-THIRD GENERAL ASSEMBLY RELATING TO WEEDS UPON LANDS AND HIGHWAYS.

Be it Enacted by the General Assembly of the State of Iowa:

Section 1. It shall be the duty of each owner, occupant, person, company or corporation in control of any lands within the state of Iowa, whether the same shall consist of improved or unimproved lands, town or city lots, lands used for highways, railway right of way or depot grounds, lands in which the public has an easement for road, street or other right of way, or lands used for any other purpose whatsoever, to cut, burn, or otherwise entirely destroy all noxious weeds as defined in section two (2) hereof at such times in each year and in such manner as shall prevent the said weeds from blooming or coming to maturity, and to keep the said lands free from such growths of other weeds as shall render the streets or highways adjoining the same unsafe for public travel or shall interfere in any manner with the proper construction or repair of the said streets or highways, and shall cause to be cut, near the surface, all weeds on the streets or highways adjoining said lands between the fifteenth day of July and the fifteenth day of August of each year. But nothing herein shall prevent the land owner from har-

*Bull. U. S. Dept. Agr. Div. Bot. 17:60.

vesting the grass grown upon the roads along his land in proper season.

Sec. 2. The following weeds are hereby declared to be noxious weeds; namely, quack grass (*Agropyron repens*), Canada thistle (*Cirsium arvense*), cocklebur (*Xanthium canadense*), wild mustard (*Brassica arvensis*), sour or curled dock (*Rumex crispus*), smooth dock (*Rumex altissimus*), buckhorn or ribbed plantain (*Plantago lanceolata*), wild parsnip (*Pastinaca sativa*), horse nettle (*Solanum carolinense*), velvet weed or button weed (*Abutilon theophrasti*), burdock (*Arctium lappa*), shoo-fly (*Hibiscus trionum*), wild carrot (*Daucus carota*) and Russian thistle (*Salsola kali* L. var. *tenuifolia*).

Sec. 3. If any such owner, occupant, person, company or corporation in control of any such land shall fail or neglect to do the things necessary to prevent the said noxious weeds on any such land from blooming or coming to maturity, or shall permit weeds thereon contrary to the provisions of section one (1) hereof, or if it shall appear that there is danger that any such noxious weeds on any such land may mature, then upon their own motion or upon complaint made to any member thereof, it shall be the duty of the board of trustees of the township in which such land lies or to which such land may be adjacent and within the same county, or of the town council or board of commissioners if within the limits of an incorporated town or city, to make investigation of such condition or complaint, and if it appears that there is danger that any such noxious weeds may mature or that weeds thereon render or are about to render the streets or highways adjoining the land unsafe for public travel or interfere or are about to interfere in any manner with the proper construction or repair of the said streets or highways, the said board of trustees, town council or commissioners, as the case may be, shall make an order fixing the time within which the weeds shall be prevented from maturing seed or the said weeds shall be destroyed, prescribing the manner of their destruction, and shall forthwith give notice in writing of the said order personally to the owner of the land upon which the same exist if service of such notice can be made within the township in which such land is situated, and if it can not be so served, then by mailing said notice by registered mail to the owner at his last known address, and also by giving a copy of the notice to the person, company or corporation in the apparent control or occupancy of the said land, whose duty it shall also be to mail said notice to the owner, and if the order so made is not substantially complied with by the time fixed in the order and after reasonable notice as herein provided, then it shall be the duty of the board of trustees, town council or commissioners, as the case may be, forthwith to cause said order to be fully performed, and the expense of the same, including the costs of serving said notice and the special meetings of the board of trustees, town council or commissioners, if any were required, shall be advanced out of the township road fund, or town or city general fund, as the case may be; or if the said fund shall be insufficient therefor, the town council, commissioners, or the board of trustees may borrow the money necessary to advance the same by issuing warrants of a like amount upon the road fund, or upon the town or city general fund, and at any meeting of the board they shall assess all of the same against the said land and the owner thereof by a special tax which shall be certified and collected together with interest and penalty after due in the same manner as road taxes unpaid and shall be collected by the county treasurer and when collected shall be paid into the fund upon which said warrants were drawn. Before making said assessment, ten days' notice shall be given such owner of the time and place of meeting of the trustees, council or commissioners, which notice shall also contain a statement of the work done and the expense thereof with costs, and shall be given in the same manner as originally given to owners as hereinbefore provided. At said time and place such owner may appear with the same rights given by law before boards of review upon increase in assessments.

Sec. 4. It shall be the duty of the board of trustees of each township to consider the conditions of all lands and highways within the township and outside of incorporated towns and cities as to noxious weeds, and the town councils and commissions shall have the same duties with reference to lands within their respective towns or cities, and on complaint made to them or on their own motion, whenever it may appear that any of such lands within their jurisdiction are infested with noxious weeds or other weeds, whether about to bloom and mature or not, they shall order their destruction before a date to be fixed in the said notice and prescribe the manner in which the destruction shall be accomplished, notice of which order shall be given as provided in section three (3) hereof, and if the said order shall not be complied with the board may proceed to cause the said order to be performed and shall certify the expense thereof and it shall be paid and assessed to the lands upon which the same shall have been destroyed and to the owners or owner thereof and be collected in the same manner as is provided for the expense of proceeding under section three (3) hereof.

Sec. 5. It shall be the duty of all officers directly responsible for the care of public highways to make complaint to the proper township trustees or town councils or commissions, as the case may be, whenever it shall appear that the provisions of section one (1) hereof may not be complied with in time to prevent the blooming and maturing of noxious weeds or the unlawful growth of weeds, whether in the streets or highways for which they are responsible or upon lands adjacent to the same.

Sec. 6. All of the provisions of this section relating to the duty of the owner of the lands to prevent the blooming and maturing of noxious weeds thereon and to destroy such growths of other weeds thereon as may interfere with the use of highways shall apply also to cities and towns and the proper officers there as to all streets, highways and lands of any kind within their borders the fee of which shall rest in the public.

Sec. 7. It shall be the duty of the township clerk between the first and fifteenth days of May of each year to post in two conspicuous places in each school district of the township a notice calling attention to the weed law of the state of Iowa and giving a list of the noxious weeds contained therein and notifying the property owners to meet the requirements of the law.

Sec. 8. It shall be the duty of the township clerk between the fifteenth and thirteenth days of October of each year to make a report to the board of supervisors of the county in which this township is situated as to the presence and location of noxious weeds that have been reported or found within the township and the steps taken to bring about the destruction thereof, a copy of which report shall be forwarded to the board of supervisors to be kept on file and a copy of same to be forwarded by them to the secretary of the Iowa department of agriculture not later than the first day of December following.

Sec. 9. Any township trustee or road officer or other officer who neglects or fails to perform the duties incumbent upon him under the provisions of this act shall be guilty of a misdemeanor and shall be punished by a fine not exceeding one hundred dollars ($100.00).

Sec. 10. Chapter ninety-six (96) of the acts of the Thirty-third General Assembly is hereby repealed.

Sec. 11. This act being deemed of immediate importance shall take effect and be in full force after its publication in the Register and Leader and the Des Moines Capital, newspapers published in Des Moines, Iowa.*

Approved April 23, A. D. 1913, and became effective by publication May 1, 1913.

The law which was in force until repealed by the above act is as follows:

Section 1. Land owners or tenants to destroy weeds--when.—It shall be the duty of every person, firm or corporation owning, occupying or controlling lands, town and city lots, land used as right of way, depot grounds or for other purposes to cut, burn or otherwise entirely destroy all weeds of the kinds mentioned in section two (2) hereof at such times in each year and in such manner as shall prevent the said weeds from blooming or coming to maturity.

Section 2. Noxious weeds.—The following weeds are hereby declared to be noxious weeds, namely, quack grass (*Agropyron repens*), Canada thistle (*Cirsium arvense*), cocklebur (*Xanthium canadense*), wild mustard (*Brassica arvensis*), sour or curled dock (*Rumex crispus*), smooth dock (*Rumex altissimus*), buckhorn or ribbed plantain (*Plantago lanceolata*), and wild parsnip (*Pastinaca sativa*), horse nettle (*Solanum carolinense*), and velvet weed or button weed (*Abutilon theophrasti*) and burdock (*Arctium lappa*).

Section 3. Destruction on highways—neglect or refusal to destroy.—It shall be the duty of the township trustees or other officers responsible for the care of public highways in each township or county in this state to destroy or cause to be destroyed all noxious weeds mentioned in section two (2) hereof or unnecessary brush on the highways in such a manner as to effectually prevent the production of their seeds or their propagation in any other manner, to warn out labor or to employ labor for this purpose in the same manner as for repairs to the highways, and for neglect or failure to perform this work they shall be subjected to the penalties in this act. If any occupant of lands adjacent to the public highways neglect or refuse to destroy the noxious weeds upon his land, or shall fail to prevent the said noxious weeds from blooming or coming to maturity, when such weeds are likely to be the means of infesting the public highway, or upon complaint of any land owner to the township trustees that his lands have been or are likely to be infested by weeds from the lands of another including railway right of way, the trustees shall make an investigation of such condition or complaint and if the same appears to be well founded they shall make an order fixing the time within which the weeds shall be prevented from maturing seed, and an order that within one year such noxious weeds shall be permanently destroyed, and prescribing the manner of their destruction and shall forthwith give notice to the occupant of the lands where the noxious weeds exist, and if he shall neglect to obey such order within the time so ordered the trustees may cause such noxious weeds to be prevented from maturing seeds or may cause such noxious weeds to be permanently destroyed and the cost of the work shall be recovered from the owner by a special tax to be certified by the township clerk in the same manner as other road tax not paid.

Section 4. Road funds may be expended.—The destruction of noxious weeds in the public highway and other public places is hereby made a part of the road work of the township trustees and the county supervisors and they shall have authority to expend road funds for the destruction of weeds.

Section 5. Property tax.—The law as it appears in section fifteen hundred and twenty-eight (1528) of the supplement to the code, 1907, is hereby amended as follows, namely: By inserting after the comma in the eighth line thereof the following words: "and for the destruction of noxious weeds in public highways and other public places," and by striking out the word "four" in the tenth line of said section and inserting the word "six" in lieu thereof.

Section 6. School of instruction.—Between November and the succeeding April of each year the county supervisors shall call a meeting of the township trustees and the road supervisors of the county to consider the best methods of road work and weed destruction, and in the public interest may secure the services of experts to give instruction in road building and weed destruction. For such attendance the same compensation shall be allowed to the trustees and road supervisors and the county supervisors as is allowed by law for other services, to be paid as other expenses. The expenses of experts herein provided for may be paid from the county road fund.

Section 7. Cutting of weeds on highways.—It shall be the duty of township trustees and other officers directly responsible for the care of public highways to cause to be cut near the surface all weeds on the public highways in their respective districts at such times and in such manner as to prevent seeds from maturing.

Section 8. Penalty.—Any person, firm or corporation violating any of the provisions of this act, or any township trustees, inspector or other officer who neglects or fails to perform the duties incumbent on him under the provisions of this act, shall be guilty of a misdemeanor and shall be punished by a fine not exceeding one hundred dollars ($100.00).

Section 9. Repeal.—The law as it appears in sections fifteen hundred and sixty-two (1562), fifteen hundred sixty-two-a (1562-a) and fifteen hundred sixty-three (1563) of the supplement to the code, 1907, and sections fifteen hundred and sixty-four (1564) and fifteen hundred and sixty-five (1565) and section five thousand and twenty-four (5024) of the code are hereby repealed.

Approved April 21, A. D. 1909.

Hon. C. R. Brenton and the writer framed a bill with the aid of Robert Hunter, an attorney in Des Moines, which would meet all requirement. This provided for weed inspectors. The bill was introduced into the Senate by Mr. McColl and in the house by Mr. Brady; however this bill failed to pass. As the subject is so important and is likely to come up again at a future session of the Legislature, I insert the bill.

A BILL

FOR AN ACT TO AMEND CHAPTER NINETY-SIX (96) OF THE ACTS OF THE THIRTY-THIRD (33) GENERAL ASSEMBLY, AND TO CREATE THE OFFICE OF COUNTY WEED COMMISSIONER, AND TO PROVIDE FOR HIS APPOINTMENT AND DUTIES.

Be it Enacted by the General Assembly of the State of Iowa:

That Section One (1) of said chapter be amended by adding thereto the following:

Section 1-a. The office of County Weed Commissioner is hereby created. It shall be the duty of the County Board of Supervisors, at a regular or special meeting of the Board, not later than the first day of April in each year, to appoint a County Weed Commissioner whose term of office shall be from the first day of May after his appointment to the first day of November following.

Section 1-b. The County Weed Commissioner shall devote his entire time to the duties of his office, and shall receive as full compensation for his services a salary not exceeding seventy-five dollars ($75.00) per month and his actual and necessary traveling expenses incurred while performing his official duties, payable in like manner as the salaries of other county officers.

Section 1-c. The Board shall furnish such weed commissioner an office at the county seat, and all stationery, blanks and supplies necessary in the performance of his official duties.

That Section Two (2) of said chapter be amended by changing the period at the end of said section to a comma, and adding immediately thereafter the following:

And shoo-fly (Hibiscus Trionum), and wild carrot (Daucus Carota).

That all of Section Three (3) of said chapter following the words "in this act," in the ninth line thereof, be stricken out and the following enacted in lieu thereof:

Section 3-a. It shall be the duty of the County Weed Commissioner during the first thirty (30) days of his term of office, to post in public places in each township of the county, at least fifteen (15) notices setting forth therein, in substance, the law of the State of Iowa in reference to noxious weeds and the destruction thereof; to inspect all lands, including highways and railway rights-of-way within the county, for noxious weeds, as defined in Section Two (2) hereof, and give to the owners or occupants of said land, and to the officers responsible for the care of the highways on which any such noxious weeds be found, information in reference to the presence of such weeds and the manner of destruction thereof.

Section 3-b. If any occupant or owner of land, or any owner or operator of a railway right-of-way, neglect or refuse to destroy the noxious weeds upon his land or right-of-way or shall fail to prevent the said noxious weeds from blooming or coming to maturity, when such weeds are likely to be the means of infesting the public highways, or the lands of adjoining owners, the County Weed Commissioner shall cause such noxious weeds to be prevented from maturing seed, or shall cause such noxious weeds to be permanently destroyed and the cost thereof, not exceeding (30) cents per hour for each man so employed, shall be recovered from the owner of the land, or owner or operator of such railway right-of-way by a special tax certified to the county auditor by the County Weed Commissioner to be paid by the owner or operator of the land or railway right-of-way as the case might be, and collected by the county treasurer the same as other taxes.

Section 3-c. If any township trustee or other officer, or officers, responsible for the care of the public highways in each township or county in this state, neglect or refuse to destroy any noxious weeds upon such highway, or shall fail to prevent the said noxious weeds from blooming or coming to maturity, when such weeds are likely to be the means of infesting the land adjoining such highways, the County Weed Commissioner shall forthwith give written notice to such officer or officers, responsible for the care of such highways, to destroy such noxious weeds, and if such officer or officers shall neglect for ten (10) days after such notice to destroy such weeds, or to prevent the same from maturing seed, then such officer, or officers, shall be subject to the penalty provided in Section Eight (8) of this chapter.

Section 3-d. The County Weed Commissioner shall make a report of the work of his term to the Board of Supervisors, not later than the thirtieth (30th) day of October of the year for which he was appointed, such report to contain a statement in detail on the presence and location of Canada thistle, horse nettle and quack grass, and the board shall forward a copy of such statement to the Secretary of the Iowa Department of Agriculture not later than the first day of December following:

Section 3-e. It shall be the duty of the Secretary of the Iowa Department of Agriculture to furnish to the Board of Supervisors of each county, the notices described in Section 3-a hereof, as well as all necessary blanks for reports to be made to said department, and to keep on file in his office all reports of such noxious weeds furnished him by County Boards of Supervisors, and include in his annual report a summary of the report furnished by such boards.

This act being deemed of immediate importance shall take effect and be in force from and after its publication in the Register and Leader and the Des Moines Capital, newspapers published in Des Moines, Iowa.

ILLINOIS.

In Illinois the criminal code statutes provide a penalty of not less than $10.00 nor more than $100.00 for bringing Canada thistle in packing material or in grain, grass or vegetable seed on any land in this state; nor shall it be permitted to go to seed. The same law also applies to railroads. This includes other noxious weeds growing on the right-of-way of other land operated by railways, but the fine is placed at not less than $50.00 nor more than $200.00.

An Illinois statute provides for the appointment of a commissioner of Canada thistles by the board of town auditors in counties under township organization and by the county commissioner in counties not under township organization for each township or election precinct and by the city council of any city or by the president and trustees of any town or village as the case may be, the former to hold his term of office for three years. Compensation $2.00 per day. The commissioner shall diligently enquire concerning the introduction and existence of Canada thistles in his township or precinct. He shall take care that they do not go to seed, or otherwise spread. The commissioner shall advise with the owner of the land concerning treatment. The limit of money to be expended by the commissioner shall not be more than $100 on any one infested tract. The commissioner shall make out a written report to the supervisor of the town or to the county commissioner. The report shall be read publicly at the annual town meeting, as to whether any thistles are growing; if growing, where; it shall contain a statement as to the treatment of the infested tract and shall make such other suggestions as may seem proper. He shall forward a copy to the secretary of the state Board of Agriculture.

A land owner shall not deposit weeds or trash on the public road. The same chapter provides that the commissioners of highways in their respective towns shall enforce the law with reference to cocklebur, Canada thistle and Russian thistle.

INDIANA.

The Indiana law makes it a misdemeanor for any person or corporation, on property belonging to the person or corporation, to allow Canada thistles to grow until they become the length of 6 inches from the surface of the ground to the tip of the stem. The law makes it a misdemeanor for persons having charge of highways to allow Canada thistle to grow to the length of 6 inches or to mature. It makes it the duty of the road supervisor or of the president of the board of trustees, to notify the occupant of the land on which Canada thistle grows to cut said thistles below the surface of the ground within 5 days of notice. Penalty is attached for not complying with the notice. A penalty is also attached to non-performance of the duties of the supervisor, township trustee or mayor.

KANSAS.

The state of Kansas has several statutes in regard to the destruction of weeds: one on Canada thistle and Russian thistle; another on Johnson grass. Chapter 17: 923, of the revised statutes, requires cities of the first class to enforce the cutting and destruction of weeds on vacant lots, pieces of land, streets and alleys. A five days' written notice shall be given; if not removed the city may make a special assessment the same as for sidewalks. Chapter 16 gives cities of the first class the power to pass an ordinance on the removal of rank grass and weeds. Chapter 41 makes it the duty of the owner of real estate to cut the weeds along said real estate before they go to seed. The Canada thistle and Russian thistle laws make it the duty of every corporation, owner of land, or the occupier of lands where these weeds occur to remove the same at such times as the board and county commissioners may direct. When not removed, notice shall be published in one or more county papers not less than three weeks before the fixed time of destruction. The highway overseer of every township or county shall also cut or destroy all noxious weeds on the highway. The Johnson grass statute makes it unlawful to introduce into or sell or offer for sale within the state any seeds or roots of Johnson grass. It is made the duty of the county commissioner of each county within the state where Johnson grass occurs to prescribe the jurisdiction of each road overseer; each township to be included within the jurisdiction of some road-overseer. It is made the duty of the road overseer to prevent its spreading and if he receives written notice from any person in writing that the grass is seeding he shall investigate; if found to be the case he shall give 5 days' time in which to destroy it, if not destroyed he shall remove it and tax the costs against the land. If the owner of the land fails to notify tenant, on execution of lease, the owner shall be responsible for any damages. "Full tassel," as contained in law, shall mean seed.

MINNESOTA.

In regard to the suppression of noxious weeds in Minnesota the law is as follows: "Where the dean of the department of agriculture of the university of Minnesota deems it necessary for the suppression of noxious weeds and for experimental purposes to sow timothy, clover, red top or other seeds on burned-over state lands, said department is hereby authorized to do so with seed purchased under this act."

"Any county commissioner who knowingly allows or aids in allowing to any such applicant under this act any timothy, clover, red top or other seed, unless such applicant belongs to the class referred to, who is destitute of needed seeds, shall be guilty of a misdemeanor."

MISSOURI.

The revised statutes of Missouri make it the duty of the owner, lessee or other occupant of lands and every railroad company or corporation in the state to destroy Canada thistle and Scotch thistle, prevent the formation of seed, and prevent said thistles from spreading. A penalty of ten dollars is attached for every offence. Notice shall be given to the agent, overseer or other person having charge of the streets, roads or highways or places where such thistles occur. Cases of violation may be brought before any justice of the peace of the county or city. Said fine when recovered shall be paid into the county school fund. Where such cutting is done on land by the overseer the cost is charged as a tax against the property and collected as other taxes. The law prohibits the throwing away of material with Canada thistle and Scotch thistle seed and provides for the burning of straw or grass packing containing thistle.

NEBRASKA.

In the state of Nebraska, there are two statutes concerning the destruction of weeds, one pertaining to the destroying of weeds in public roads, the main provisions in the law being as follows: It is the duty of land owners in the state to mow or otherwise destroy all weeds to the middle of all public roads running along their lands, at least once each year, namely, between the fifteenth day of July and the fifteenth of August. The overseer of roads has authority to cut the weeds when complaint is made; expenses connected therewith shall be sent to the county clerk who shall make an assessment against the land. The usual penalty is also provided.

In a second statute there is provision for the city of Omaha for the destruction of weeds and worthless vegetation upon vacant lots or land in the city of Omaha.

NORTH DAKOTA.

The state of North Dakota has a law which seeks to prevent the spread of noxious weeds by threshing machines. This act provides that any owner, or teamster employed in hauling grain, either threshed or unthreshed, shall upon completing any threshing engagement and before leaving the premises on which said work was done take all reasonable care to prevent the conveying and carrying away and scattering of noxious weeds which may have accumulated in or on the machines. The law provides how this shall be done by operating the machine and sweeping. A printed copy of the law shall be kept posted on every machine operating in the state. A fine, or imprisonment, or both, is provided for violation of the law. I am told the law is not enforced.

OHIO.

The state of Ohio has several laws relative to the destruction of weeds, briers and brush. With reference to the destruction of these on toll, steam, and electric roads the law provides for the destruction of brush, briers, burs, Russian, Canada, or common thistle, wild lettuce, wild mustard, wild parsnip, ragweed, milkweed, ironweed, and all other noxious weeds growing within the limits of any right of way whether in actual operation or not. If said weeds are not destroyed between the first and twentieth of June and between the first and twentieth of August and if necessary between the first and twentieth of September of each year, the trustees of the township through which such road passes shall cause it to be done and shall have right of action against such toll, steam, or electric road and one hundred per cent penalty; costs of action to be recovered before any justice of the peace of such county. The weed law as applied to the destruction of weeds on graveled or improved roads, turnpikes, county township roads, streets, etc., is essentially the same, putting the enforcement in the hands of pike superintendents and turnpike directors. The amount of money which can be collected is fixed at one dollar and a half per day to destroy these weeds. A street commissioner shall be paid for such services by the proper municipal authorities. The land owner or tenant is allowed to cut the noxious weeds along the highway abutting the property. The superintendent shall fix a reasonable compensation for the work.

Another section provides that upon written information that Canada thistle, Russian thistle, wild lettuce or wild mustard is growing on land in a township and is about to spread or mature seeds between the first day of June and the fifteenth day of October, the trustees of the township shall serve written notice upon the owner, lessee, agent or tenant that such weeds occur and that they must be destroyed within five days after the service of such notice. These laws are not enforced in Ohio.

SOUTH DAKOTA.

The South Dakota law specifies that every person or corporation shall destroy, on all land which he or it may occupy, all weeds of the following kinds: Russian thistle, Canada thistle and cocklebur. The enforcement of the law is in the hands of the board of supervisors. If the weeds are not destroyed a notice for three weeks shall be published in the papers. After such notice the weeds shall be destroyed. Owners must also destroy weeds on highways abutting their property. These weed laws are not enforced.

WISCONSIN.

The state of Wisconsin has a law requiring that every person or corporation shall destroy, on land which he or it shall own, occupy, or control, all weeds known as Canada thistle (*Cirsium arvense*), ox-eye daisy (*Chrysanthemum leucanthemum*) snap dragon (*Linaria vulgaris*), sow thistle (*Sonchus arvensis*), sour dock and yellow dock (*Rumex crispus*), mustard (*Brassica arvensis*), wild parsnip (*Thaspium barbinode*), burdock (*Lappa officinalis*), Russian thistle (*Salsola kali*) and wild barley (*Hordeum jubatum*), at such times and in such manner as shall effectually prevent them from bearing seed. The above weeds shall be destroyed to the middle of the highways by the commissioner of noxious weeds. The corporation or party shall be given notice and if weeds are not removed within 6 days a $5.00 fine is imposed every day thereafter during which such neglect shall continue. The weeds shall be specified; also on what land they occur. The commissioner or commissioners of weeds shall be appointed by the chairman of each town board, the president of each village, or the mayor of each city. The commissioner of weeds shall hold the office for one year. He shall give notice if the weeds are not removed. Then the commissioner shall remove the same. The city of Milwaukee is exempt from these provisions.

SEED LEGISLATION.

Numerous states of the Union and various European countries as well as Canada and other British countries have legislated on the subject of seeds and seed adulteration. Two classes of laws are in vogue in the United States. One requires a guaranty of the seed sold and may be called the Maine idea. The other gives standards of purity and vitality and is the Iowa idea. This law has been passed in many states, among them, Wisconsin, Washington and Wyoming. The Iowa law is as follows:

Section 1. Every lot in bulk, bag, pail, parcel or package of concentrated commercial feeding stuffs as defined in section three (3) of this act; and every parcel, package or lot of agricultural seeds as defined in section nine (9) of this act, and containing one pound or more, offered or exposed for sale in the state of Iowa, for use within this state, shall have affixed thereto, in a conspicuous place on the outside thereof, distinctly printed in the English language, in legible type not smaller than eight point heavy gothic caps, or plainly written, a statement certifying:

In the case of agricultural seeds:

First. The name of the seed.

Second. Full name and address of the seedsman, importer, dealer or agent.

Third. A statement of the purity of the seed contained, specifying the kind and percentage of the impurities as defined in sections eleven (11) and twelve (12) hereof, provided that said seeds are below the standards fixed in this act.

Fourth. Locality where said seed was grown, when known.

Section 6. The state food and dairy commissioner shall cause to be made analyses of all agricultural seeds sold or offered for sale in this state. Said state food and dairy commissioner is hereby authorized, in person or by deputy, to take for analysis a sample from any lot or package of agricultural seeds not exceeding four ounces in weight; but said sample shall be drawn or taken in the presence of the party or parties in interest, or their representative, and shall be taken from a parcel, lot or number of parcels which shall not be less than five per cent of the whole lot inspected and shall be thoroughly mixed and divided into two samples and placed in glass or metal vessels carefully sealed and a label placed on each, stating the name or brand of the agricultural seeds or material sampled, the name of the party from whose stock the sample is drawn, and the date and place of taking such sample, and said label shall be signed by the state food and dairy commissioner, or his authorized agent; or said sample may be taken in the presence of two disinterested witnesses; one of said duplicate samples shall be left on the premises of the party whose stock was sampled and the other retained by the state food and dairy commissioner, for analysis and comparison with the certified statements required by sections one (1) and four (4) of this act. The result of the analysis of the sample, together with additional information shall be published from time to time in bulletins issued by the state food and dairy commissioner upon approval of the executive council.

Section 7. Any person purchasing any agricultural seeds in this state for his own use, may submit fair samples of said seeds to the state food and dairy commissioner, who, upon receipt of an analysis fee of fifty cents (50c) for each sample of agricultural seeds shall cause an analysis of the same to be made.

Section 8. No person shall sell in ground form, wheat or rye screenings containing cockle or other poisonous or deleterious substances.

Section 9. The term, agricultural seeds, as used in this act, shall include the seeds of the red clover, white clover, alsike clover, alfalfa, Kentucky blue grass, timothy, brome grass, orchard grass, red top, meadow fescue, oat grass, rye grass and other grasses and forage plants, flax, rape and other cereals.

Section 10. No person shall sell, offer, or expose for sale, or distribution in this state, for the purpose of seeding, any of the agricultural seeds as defined in section nine (9) of this act, unless the said seeds are free from the seeds of the following weeds: Wild mustard, or charlock (*Brassica sinapistrum*), quack grass (*Agropyron repens*), Canada thistle (*Cnicus arvensis*), wild oats (*Avena fatua*), clover and alfalfa dodder (*Cuscuta epithymum*), field dodder (*Cuscuta arvensis*), and corn cockle (*Lychnis githago*).

Section 11. The seeds of the following weeds shall be considered as impurities in the agricultural seeds as defined in section nine (9) of this act, sold, offered, or exposed for sale, within the state for the purpose of seeding: White cockle (*Lychnis vespertina*), night-flowering catchfly (*Silene noctiflora*), curled dock (*Rumex crispus*), smooth dock (*Rumex altissimus*), sheep sorrel (*Rumex acetosella*), yellow trefoil (*Medicago lupulina*), burr clover (*Medicago denticulata*), sweet clover (*Melilotus alba* and *officinalis*), black mustard (*Brassica nigra*), plantain, buckhorn (*Plantago lanceolata*), bracted plantain (*Plantago aristata*), bindweed (*Convolvulus sepium*), smooth crab grass (*Panicum glabrum*), common chickweed (*Stellaria media*). When such impurities or any of them are present in quantity exceeding a total of two per cent of the weight of said agricultural seeds, the approximate percentage of each shall be plainly indicated in statement specified in section one (1) of this act.

Section 12. Sand, dirt, chaff and foreign substances and seeds other than those specified in sections thirteen (13) and fourteen (14), or broken seed and seed not capable of germinating, shall be considered impurities when present in agricultural seeds sold, offered, or exposed for sale, in this state, for the purpose of seeding, and when such impurities, or any of them, are present in quantity exceeding the standards of purity and viability authorized in section sixteen (16) of this act, the name and approximate percentage of each shall be plainly indicated in the statement specified in section one (1) of this act.

Section 13. For the purposes of this act, seeds shall be deemed to be mixed or adulterated:

First. When orchard grass (*Dactylis glomerata*) seed contains 10 per cent or more by weight of meadow fescue (*Festuca elatior pratensis*) seed, or Italian rye grass (*Lolium italicum*) seed, or English rye grass (*Lolium perenne*) seed.

Second. When blue grass or Kentucky blue grass (*Poa pratensis*) seed contains 5 per cent or more by weight of Canadian blue grass (*Poa compressa*) seed, red top chaff, red top (*Agrostis alba*) seed, or any other seed or foreign substance.

Third. When red clover (*Trifolium pratense*), mammoth red clover (*Trifolium pratense* var.), or alfalfa (*Medicago sativa*), contains 5 per cent or more by weight of yellow trefoil (*Medicago lupulina*), or sweet clover (*Melilotus alba* and *M. officinalis*) seed or bur clover (*Medicago denticulata*) seed.

Fourth. When rape (*Brassica rapa*) contains 5 per cent or more of common mustard (*Brassica sinapistrum*) or black mustard (*B. nigra*).

Section 14. For the purposes of this act, seed shall be deemed to be misbranded:

First. When meadow fescue (*Festuca elatior pratensis*), English rye grass (*Lolium perenne*) or Italian rye grass (*Lolium italicum*) is labeled or sold under name of orchard grass (*Dactylis glomerata*) seed.

Second. When Canadian blue grass (*Poa compressa*) seed, red top (*Agrostis alba*) seed, or any other seed not blue grass seed, is sold under the name of Kentucky blue grass or blue grass (*Poa pratensis*) seed.

Third. When yellow trefoil (*Medicago lupulina*), bur clover (*Medicago denticulata*) or sweet clover (*Melilotus alba*) is sold under the name of clover, June clover, red clover, (*Trifolium pratense*), mammoth red clover, medium red clover, small red clover, sapling clover, peavine clover (*T. pratense* var.). or alfalfa (*Medicago sativa*) seed.

Section 15. The provisions concerning agricultural seeds contained in this act shall not apply to:

First. Any person or persons growing or selling seeds for food purposes only, or having such seeds in possession for sale for such purposes.

Second. Any person or persons growing or selling seeds direct to merchants to be cleaned or graded before being offered for sale for the purpose of seeding. This shall not, however, exempt the seller from the restrictions of section ten (10) of this act.

Third. Seed that is held in storage for the purpose of being recleaned, and which has not been offered, exposed or held in possession of or for sale for the purpose of seeding.

Fourth. Seed marked "not absolutely clean," and held or sold for export outside the state only.

Fifth. The sale of seed that is grown, sold and delivered by any farmer on his own premises for seeding by the purchaser himself, unless the purchaser of said seeds obtains from the seller at the time of the sale thereof a certificate that the said seed is supplied to the purchaser subject to the provisions of this act.

Sixth. Mixtures of seeds for lawn or pasture purposes. This shall not, however, exempt the seller of such mixtures of seeds from the restrictions of sections ten (10) and eleven (11) of this act.

Section 16. The following standards of purity (meaning freedom from weed seeds or other seeds) and viability are hereby fixed:

STANDARD OF PURITY AND VIABILITY OF AGRICULTURAL SEEDS.

Name of Seed	Per cent of purity	Per cent oi germinable seeds
Alfalfa (*Medicago sativa*)	96	80
Barley	98	90
Blue grass, Canadian (*Poa compressa*)	90	45
Blue grass, Kentucky (*Poa pratensis*)	80	45
Brome, awnless (*Bromus inermis*)	90	75
Clover, alsike (*Trifolium hybridum*)	90	75
Buckwheat	96	90
Clover, crimson (*Trifolium incarnatum*)	98	85
Clover, red (*Trifolium pratense*)	92	80

STANDARD OF PURITY AND VIABILITY OF AGRICULTURAL SEEDS—CONTINUED.

Name of Seed	Per cent of purity	Per cent of germinable seeds
Clover, white (*Trifolium repens*)	90	75
Corn, field (*Zea mays*)	99	94
Corn, sweet	99	75
Fescue, meadow (*Festuca pratensis*)	95	85
Flax (*Linum usitatissimum*)	96	89
Millet, common (*Setaria italica*)	90	85
Millet, hog (*Panicum miliaceum*)	90	85
Millet, pearl (*Pennisetum typhoideum*)	99	65
Oats (*Avena sativa*)	98	90
Oat grass, tall (*Arrhenatherum avenaceum*).	72	70
Orchard grass (*Dactylis glomerata*)	70	70
Rape (*Brassica rapa*)	99	90
Red top (*Agrostis alba*)	90	70
Rye (*Secale cereale*)	98	90
Rye grass, perennial (*Lolium perenne*)	96	90
Rye grass, Italian (*Lolium italicum*)	95	80
Sorghum (*Andropogon sorghum*)	96	80
Sorghum, for fodder	90	60
Timothy (*Phleum pratense*)	96	85
Wheat (*Triticum*)	98	90

Section 17. It is hereby made the duty of the state food and dairy commissioner to enforce the provisions of this act. The inspectors, assistants and chemists appointed by the state food and dairy commissioner shall perform the same duties and have the same authority under this act as are prescribed by chapter one hundred and sixty-six (166), laws of the thirty-first general assembly, and the said state food and dairy commissioner may appoint, with the approval of the executive council, such analysts and chemists as may be necessary to carry out the provisions of this act.

Section 18. Whoever sells, offers or exposes for sale any of the seeds specified in sections thirteen (13) and fourteen (14) of this act which are mixed, adulterated or misbranded, or any agricultural seeds which do not comply with sections ten (10), eleven (11) and twelve (12) of this act, or who shall counterfeit or use a counterfeit of any of the tags prescribed by this act; or who shall prevent or attempt to prevent any inspector in the discharge of his duty from collecting samples or who shall violate any of the provisions of this act shall be guilty of a misdemeanor, and upon conviction, shall be fined not more than one hundred dollars ($100) and costs of prosecution; provided, that no one shall be convicted for violation of the provisions of section ten (10) of this act if he is able to show that the weed seeds named in section ten (10) are present in quantities not more than one in ten thousand, and that due diligence has been used to find and remove said seeds.

Section 19. There is hereby appropriated, for the purpose of enforcing the provisions of this act, a sum not exceeding three thousand dollars ($3,000) annually. Such expense shall be paid by warrant of the state auditor upon bills filed by the state food and dairy commissioner with the executive council and approved by them. All fees collected under the provisions of this act shall be paid into the state treasury.

The Michigan law permits the sale of cereal grasses, clover, and forage plants containing two per cent of quack grass, charlock, black mustard, Canada thistles, chicory, toad flax, buckhorn, Rugel's plantain, night-flowering catchfly, and pennycress. The adulteration shall not be more than five per cent of any other distinguishable seed, sand, crushed rock or any other materials to be found mixed with agricultural seed. When found to be wilfully adulterated or not as clean as it is commercially practicable to make it, the results should be published in a bulletin together with names of the persons selling the same.

The Canadian act requires that no person shall sell or offer for sale, seed, cereals, grasses, clovers or forage plants unless they are free from any seeds of wild mustard, hare's-ear mustard, bull mustard, field pennycress, wild oats, bindweed, perennial sow thistle, ragweed, greater ragweed, purple cockle, cow cockle, orange hawkweed, and ergot. This law has done much to stimulate the sale of good seed.

The enforcement of the Wisconsin law is placed in the hands of the Agricultural Experiment Station.

The Maine law requiring a guaranty of seed sold in that state is working out well and has greatly improved the quality of seed sold in that state.

The North Dakota law has the following forbidden weed seeds: couch or quack grass, Canada thistle, sow thistle, and dodder. Also the sale of agricultural or garden seeds containing more than a reasonable trace of the seeds of greater ragweed, cornflower, marsh elder, Russian pigweed, dandelion, chicory, Russian thistle, plantain, buck plantain, bracted plantain, white cockle, cow cockle, curled dock, sorrel, sheep-sorrel, purslane, bindweed, wild buckwheat, wild onion, wild oats, pigeon grass, holy grass, chess, mustard, tumbling mustard, hare's-ear mustard, pennycress, peppergrass, shepherd's purse, false-flax, bird's-foot, trefoil, yellow trefoil, bur clover, sweet clover, ergot, or of the seeds of any other noxious weed is unlawful. The inspection of the law is in the hands of the botanists of the North Dakota Agricultural College. The law has greatly improved the quality of seeds sold in that state. The forbidden list of weed seeds is large and probably difficult to enforce.

The only way to enforce any seed law is to have fields in which commercial seed is grown inspected by some competent botanist. The seed should not be sold unless the weed seeds can be removed.

CHAPTER XIII.

HISTORY AND BIBLIOGRAPHY

L. H. PAMMEL HARRIETTE S. KELLOGG
and
CHARLOTTE M. KING

CHAPTER XIII.

HISTORY AND BIBLIOGRAPHY.

Perhaps the best known of the modern German treatises on the subject of weeds is that of Thaer of the University of Giessen on the Agricultural Weeds, in which some 27 species are described with colored figures, methods of extermination being given. Many of the weeds here described, as the sheep sorrel, corn cockle, Canada thistle, quack grass, and horse-tail, are common to North America. This work passed through several editions; the first appearing in 1881 and the last in 1905.

L. Danger in 1887 published a treatise of 166 pages on the subject of Weed and Plant Parasites. This work discussed the more important weeds of Germany, frequently giving methods of extermination, and numerous notes on the origin of weeds, including also, under the head of Geographical Botany, a list of weeds found in different soils. The following soils are characterized: (1) Gravelly soils containing 80 per cent of gravel; under this head he names such weeds as the horse weed (*Erigeron canadensis*) and spurge (*Euphorbia peplus*). On the whole, however, the list is a short one. (2) Sandy soils, in which there is 80 per cent of sand of smaller diameter than in gravel soils. The weeds found here are awned brome grass (*Bromus tectorum*), sheep sorrel (*Rumex acetosella*), common evening primrose (*Oenothera biennis*), corn cockle (*Agrostemma githago*), horse weed (*Erigeron canadensis*), and spurge (*Euphorbia cyparissias*). (3) Loamy soils with some sand, lacking lime. Some of the weeds found here are sow thistle (*Sonchus arvensis*), Canada thistle (*Cirsium arvense*), shepherd's purse (*Capsella bursa-pastoris*), dandelion, (*Taraxacum officinale*), wild carrot (*Daucus carota*) and chess (*Bromus secalinus*). (4) Clay soils. This class contains only one of our common weeds, namely horse-tail (*Equisetum arvense*). (5) Marl soils, containing from 5 to 50 per cent of carbonate of lime. The only weed given in this list that we have in Iowa is prickly lettuce (*Lactuca scariola*). (6) Limy soils, containing more than 50 per cent of calcium carbonate, are represented by some *Cruciferae,* and *Leguminosae.* (7) Humus soils, the organic matter consisting of about 50 per cent of humus; the humus mentioned must be in the nature of peat, as the list of plants mentioned all belong to the peat flora. (8) Alkali soils. The plants mentioned here are hardly characteristic in this state, only a few of the species being reported in old lake beds in northern Iowa. Some of the weeds mentioned by him are *Triglochin maritima* and *Juncus balticus*. This author also gives more or less extended accounts of the methods of extermination of these weeds in Germany.

Sorauer and Frank discuss the weeds of Germany. Stebler and Schroeter discuss, in an extended way, in a work appearing in 1891, the weeds of Switzerland, giving many colored illustrations and good descriptions. Numerous other papers also have appeared in German technical agricultural journals and in the transactions of societies.

William Darlington of West-Chester, Pennsylvania, was a pioneer along the line of writing a special treatise on the subject of weeds; for in 1847 he wrote a work on agricultural botany, an enumeration and description of "useful plants and weeds, which merit the notice or require the attention of American agriculturalists." He says in the preface:

The study of Botany, in its widest sense—comprising, as it does, the entire vegetable creation,—will ever have its select votaries in those who can appreciate its manifold charms, and find their reward in the pleasures incident to the pursuit; but when regarded in a more limited and practical point of view, it may fairly challenge the attention even of the most inveterate Utilitarians....... In my humble opinion, no education can be deemed sufficient without some acquaintance with the rudiments, or first principles, of Botanical Science—some rational knowledge of the vast and multiform creation around us, known as the Vegetable Kingdom. ....If our American youths who are being educated with a view to Agricultural pursuits, were thoroughly instructed in the admirable Textbook, above referred to, (Botanical Textbook by Prof. A. Gray),—and were then required to make themselves botanically acquainted with that portion of the vegetable kingdom which annually demands their attention, on the farm,—the Profession would speedily assume a new and engaging aspect. The labors of the field would be blended with the contemplation of facts and phenomena of the deepest interest to inquiring minds,—and Agriculture—instead of being shunned, as an irksome drudgery—would be justly esteemed as one of the noblest employments of a free and intellectual people.

In the revised second edition a weed is defined as follows: In popular language, any homely plant which is not noticeable for the beauty of its flowers, not entitled to respect by a reputation for medicinal or other useful qualities, is designated by the epithet weed. In an agricultural sense, the term is used with a more restricted meaning, and is applied to those intrusive and unwelcome individuals that will persist in growing where they are not wanted,—in short, the best definition that has yet been given of a weed is the old one, "a plant out of place." Most of the weeds troublesome in our agriculture are immigrants, either from the Old World, or from the warmer portions of this continent. The number of plants indigenous to our country, that are entitled to rank as pernicious weeds, is comparatively small. As the aborigines disappear with the advance of the whites, so do the native plants generally yield their possession as cultivation extends, and the majority of the plants to be met with along the lanes and streets of villages, and upon farms, are naturalized strangers, who appear to be quite at home, and are with difficulty to be persuaded or driven away.

Weeds are introduced upon a farm in a variety of ways. Many have their seeds sown with those of the crops; this is particularly the case where the seeds of the weeds and of the grain are so nearly alike in size that their separation is difficult. Proper care in procuring and preserving clean seed will often save much future trouble and vexation. The observing farmer will notice the means which nature has provided for the scattering of seeds, and he will find that the most pernicious weeds seem to have been especially furnished with contrivances to facilitate their dispersion. The Clot-bur, Beggar's Lice, and others, have barbs or hooks by which they adhere to clothing and the coats of animals, and are widely distributed by this agency. All of the thistles, and many others of the same family, have a tuft of fine silky hair attached to the seed, or more properly fruit, by which they are buoyed upon the air, and wafted from place to place. So numerous are the ways by which seeds are dispersed, that, however careful a farmer may be upon his own premises, a slovenly and neglectful neighbor may cause him infinite annoyance by furnishing his lands with an abundant supply. In some European countries a farmer may sue his neighbor for neglecting to destroy the weeds upon his lands, or may employ people to do it at the delinquent's expense.

The vitality of seeds, particularly if buried in the earth below the reach of the influences which cause germination, in some cases, endures through many years; hence, an old field, after deep plowing, has often a fine crop of weeds from the seeds thus brought to the surface. Weeds that have been cut or pulled after they have flowered, should not be thrown into the barnyard or hogstye, unless the farmer wishes to have the work to do over again with their progeny, as the seeds will be thoroughly distributed in the manuring of the land. In England they dry the pernicious weeds and burn them, not only destroying root and branch, but seed also.

He introduces the subject by giving an account of the structure of plants. Throughout this admirable treatise, under the head of observations, Dr. Darlington gives an account of the troublesome weeds. The book describes such weeds as Indian mallow, bladder ketmia, common mallow, quack grass, horse nettle, boot jack, cocklebur, ragweed, dead nettle, smartweeds and European morning-glory. Strangely enough, however, the common morning-glory is not mentioned, nor is the field dodder or the clover dodder. This work passed through another edition revised by Dr. George Thurber, a botanist of some note who was editor for a time of the American Agriculturist and died in 1863. The second edition of the book, under the title of American Weeds and Useful Plants, appeared in 1859. This work filled a splendid place in American agricultural literature and did much to stimulate a study of the weeds which are injurious to agriculture.

Mr. Thomas Shaw in 1893 published a small book in which he discussed the prevalence of weeds, the evils which arise from the presence of weeds, the possibility of destroying weeds, the agencies concerned in the distribution and propagation of noxious weeds, methods and principles generally applicable in the destruction of weeds and finally specific modes of eradicating certain troublesome weeds, which should generally be adopted to keep a field free from weeds. He makes many excellent suggestions, among which are the following:

(1) The persistent and careful study of the habits of growth of all the various sorts of weeds with which one's farm is infested, so as to be able to deal with them in the most rational way possible.

(2) The modification (when necessary) of the scheme of rotation that has been adopted, so that such crops as allow the seeds of the weeds which infest them to ripen, may for a time, be omitted from the rotation.

(3) When certain methods of eradication have been fixed upon, the careful and wise adaptation of these methods to such conditions of soil and climate as are found in the locality concerned.

(4) The exercise of due care when seeds are purchased, to see that they are perfectly pure, that is, perfectly free from the seeds of weeds; and also the exercise of due care with respect to such seeds as are grown at home to see that they, too, are perfectly free from weed seeds.

(5) and (6) * * *

(7) The growing of hoed crops upon the farm infested, to the largest extent that is practicable.

(8) The growing of clover and lucerne, so far as this can be done with profit.

(9) The growing of soiling crops, to the extent that may be found practicable, both because of the fact that they can be cut almost at any time that is desirable, and also because of their "smothering" properties.

(10) The utilizing of sheep for the destruction of weeds in pastures.

(11) The growing, as far as possible, at home, of the food required by the live stock of the farm, instead of purchasing it elsewhere.

(12) The keeping of the land of the farm constantly at work, so far as this possibly can be effected.

(13) The stimulation of the soil to a constantly vigorous production by means of thorough working and a large use of manure.

(14) The practice of autumn cultivation to the largest extent that is possible.

(15) The exercise of the utmost possible precaution that no weed seeds ripen upon the farm, if by any means whatever their ripening can be prevented.

(16) The giving of due heed to all the agencies by which weeds are distributed and propagated, so as always to be able to counteract or defeat those agencies.

(17) When once the work of eradication has been undertaken, the making of it as thorough as possible, and the accomplishment of it in the shortest possible time.

(18) When once a state of cleanliness has been secured, the maintenance of it thereafter as perfectly as possible under all circumstances.

In 1911 Orange Judd & Co. published a book on Weeds of the Farm and Garden, which was written by L. H. Pammel. This book contains, in addition to a number of half tone plates, figures of a great many weeds of North America, discusses their geographical distribution and the best methods of extermination, and the most important noxious weeds with their distribution. The table of contents of the book is as follows:

1. Weeds. Injury to Crops and Nature of. 2. Kinds of Weeds as to Duration. 3. Dispersal of Weed Seeds. 4. The Farmer's Interest in Good Seed, and How to Test Seed. 5. Weed Impurities in Agricultural Seeds. 6. Some Weed Laws and Seed-Control

Laws. 7. Weeds of Special Crops. 8. Poisonous Weeds. 9. Table of Noxious Weeds. 10. Migration of Weeds. 11. Extermination of Weeds. 12. Treatment for Special Weeds. 13. Morphology of Weeds. 14. Descriptions of Some Common Weeds. 15. Partial Bibliography, Consisting of Easily Accessible References, Arranged by Harriette S. Kellogg. This lists the important papers on the subject.

A little treatise, "A Talk on Weeds," an address given before the County Road School, Clinton County, 1910, gives an account of a few of the important weeds and notes for the teacher. A somewhat similar paper especially adapted for schools was published by Miss Caroline Forgrave of Dallas county. This little paper gives suggestions of what school children may do to study weeds. Both of these were written by Mr. Pammel.

Bulletin 70 of the Iowa Agricultural Experiment Station, by the same writer, discusses a few of the more important Iowa weeds with an account of the dissemination of seeds and the pollination of a few plants; subsequently Mr. Pammel and Miss King published an extensive bulletin on the treatment of weeds, especially with iron sulphate.

Prof. H. L. Bolley also published an extensive treatise on "Weeds of North Dakota," particularly with reference to the treatment with iron sulphate.

Attention may also be called to a little semi-occasional publication by the American Steel and Wire Company on "Weeds," particularly on treatment with iron sulphate. This little journal is well illustrated. Many of the nature study works like those of Hodge, Stevens, Birkett and Hall, Goff and Mayne, such as "Weeds," "Farm Friends and Farm Foes," as well as the Agricultural botany of John Percival, give short accounts of weeds.

W. S. Blatchley, in the "Indiana Weed Book," 1912, describes one hundred and fifty common weedy plants; including an account of their nature and habits, as well as suggestions for eradication. Of the weeds considered, it is interesting to note that seventy-seven are natives of Indiana, while seventy-three are introduced species.

Of the more important treatises on weeds the recent bulletin by J. W. Beal, who was formerly botanist of the Michigan Agricultural College should be mentioned. This book of 167 pages describes and figures the important weeds of Michigan. This is a most helpful treatise, and with the excellent figures one will be able to recognize any of the common weeds of that state. Another special bulletin is the Ohio weed manual by Prof. Selby. This excellent manual describes and gives the distribution of Ohio weeds as well as hints on extermination of the common weeds of that state. The discussions on weeds by Crozier, Dewey and other botanists of the United States Department of Agriculture, are most helpful as regards the more common weeds of eastern North America.

The most recent extensive account of weeds in Canada is a book by Clark and Fletcher. This work describes many families of weeds, one or more species of each genus being illustrated with colored figures. In addition many weed seeds are described. Some of the headings are as follows: Losses Due to Weeds, How Weeds Spread, Weed Seeds in the Soil, Commercial Seeds and Feeding Stuffs. This book will enable one to recognize the more or less common weeds found in Canada. It has passed through two editions, the first having been published in 1906 and the second in 1909.

The most recent English publication is a book by H. C. Long and John Percival, "Common Weeds of the Farm and Garden." This book of 451 pages contains many half tone illustrations and figures of weeds that are common to the British Isles, treated under the following heads: Weeds of Rivers and Ditches also Drives, Worst Weeds, Weeds and the Improvement of Grass Land, Weeds of the Arable Land, What Weeds Are and How They Affect our Crops and Stock, Parasite Plants and Poisonous Plants, Principles of Seed Testing, besides a Bibliography of 5 pages referring to the more important papers published in Europe, England and Canada. In addition to this English publication there have been published by M. G. Smith "One Hundred Yorkshire Weeds," and "A Contribution to our Knowledge of the Influence of Manures on the Botanical Composition of the Herbage of Permanent Grass-Land."

Many weeds have received special attention in the United States. Of these, perhaps the Russian thistle, some 20 years ago, received more attention for a few years than any other weed. The earliest account of this weed was made by J. N. Rose in 1891, followed by a more extensive bulletin on the same weed by Dewey in 1893, and another paper by the same author in 1894. Papers were also published by Bessey of Nebraska, Goff of Wisconsin, Pammel and Wilson of Iowa, Hays of Minnesota, Bolley of North Dakota, Williams of South Dakota, Clinton of Illinois, Selby of Ohio, and Wooten of New Mexico; in addition press notices on the subject were published in agricultural journals during the years 1891-1895. Since then there have been comparatively few accounts, excepting a few notes in 1911 and 1912 in the agricultural journals. The chemistry of the weed has also been discussed by G. E. Patrick of Iowa and by the Colorado Experiment Station. This weed was considered so important that a number of northern states passed laws looking for its extermination. A bill was introduced into Congress by Senator Hansbrough in which congressional aid was asked to exterminate it.

The Canada thistle has been discussed by numerous writers both in Europe and in the United States. The spread of this weed is considered in another connection. We find, however, that mention of this weed is made by Linnaeus in his Flora Lapponica, by Ratzeburg in 1859, and by Darlington in 1853. More recently the weed has received attention from such botanists as H. L. Bolley of North Dakota, T. J. Burrill of Illinois, E. S. Goff of Wisconsin, Fletcher and Clark of Canada, L. F. Henderson of Idaho, L. H. Dewey of Washington, D. C., Prof. Howitt of Canada, and L. H. Pammel. There have been many press notices in the agricultural papers, particularly in the northern Mississippi Valley. Attention may be called to those in Wallace's Farmer, Iowa Homestead, Breeders' Gazette, Farmers' Review, Prairie Farmer and Successful Farming.

Another weed that attracted much attention a few years ago was squirrel-tail grass or wild barley. This was discussed by C. S. Crandall of Colorado, Hillman of Nevada, Nelson of Wyoming, Wooten of New Mexico and Pammel of Iowa.

Prickly lettuce has been discussed by Arthur of Indiana, Weed of Ohio, Dewey of Washington, D. C., Morrow of Illinois, Pammel of Iowa, and Fernald of Massachusetts.

Buffalo bur has been discussed by Henry of Wisconsin, Halsted and Pammel of Iowa, Clinton of Illinois, Harvey of Maine, and in numerous press notices in the agricultural journals.

Mustards of various kinds have been discussed by Dewey of Washington, D. C., Clark and Fletcher of Canada, Hitchcock of Kansas, Howitt of Canada and Pammel of Iowa.

The perennial sow thistle has been discussed by the agricultural press of Canada and in special treatises by Howitt and Fletcher and Clark of the Dominion of Canada and in numerous notices in the agricultural press of the northern United States.

Broom rape has been discussed by Garman of Kentucky and by the United States Department of Agriculture.

Much has been published on the subject of weed seeds. The more important contributions are the following:*

European work.—The importance of this work has long been recognized in Europe. The pioneer work in this line was carried on first in Germany, a station for testing commercial seeds having been organized in 1867 in connection with an academy located in Tharandt. Dr. Nobbe was its first director. Early in his work he saw the importance of making careful examination for the impurities of various grass and clover seeds. In 1876 appeared his classical book, Handbuch der Samenkunde. In addition to this work he was the author of many other important papers on viability of seeds and other physiological seed problems.

Among other important contributions along this line, we may mention the papers and work of Kraft, Luhn, and Harz. The work of Harz summarizes not only the facts pertaining to the anatomy of seeds but also to many other important topics; the literature bearing on the subject of seeds is also given.

The work of Burchard on the adulteration of seed with special reference to their origin is particularly noteworthy. In his book he has published statistical records showing the origin of clover seed and the weed seeds found in the same from Middle Europe, Eastern Europe, Southern Europe and North and South America. He sometimes missed the important weed species that are found in our American clover seed, but on the whole it is true that the character of the weed seeds found in our clover and other seeds will enable one to tell where they were grown.

Burchard, in his account published in a contribution from the Seed Control Station of Hamburg, states that a large number of seeds investigated by him had impurities. Of two hundred and eighty seeds tested, one hundred and sixty-seven belonged to the pulse family, seventy-nine to the grass family, twenty-three to forest seeds, and eleven were miscellaneous. He found the minimum purity of the clover seed was 54.2 per cent. The highest percentage of purity was found in timothy, 99.42. The lowest germinative energy was found in fescue grass, 0.17 per cent, and

*The more important references here given upon the history of seed investigation are taken from bulletins 88, 99 and 105, issued by the Iowa State Agricultural Experiment Station, which are more completely listed in the bibliography.

the highest in clover, 97.25 per cent. Of the sixty samples of red clover examined for dodder, twenty-eight were free. The most common species was clover dodder, although others were also found. One lot of alfalfa from South America contained the Chilian dodder. In this investigation as in others, he emphasizes the importance of determining the kinds of weeds found in the seed, thus: In Australian orchard grass the hairy brome grass was common, and in North American seed, orchard grass, timothy, blue grass and tickle grass.

The work of Settegast treats extensively the subject of agricultural seeds and seed testing, especially with reference to vitality and seed production.

Vandevelde's work treats of the morphology and physiology of germination and includes a splendid bibliography.

Attention should be called to the excellent contributions of Wollny whose reports of his splendid work on seeds and the care of agricultural crops often give considerable detail on the germination and viability of various agricultural seeds.

Kienitz gives a detailed account of the methods to be followed in the study of germination of seeds.

Fruwirth carried out a study on the color and specific gravity of clover seeds. He found that the dark violet seeds were heavier than the light colored ones of the same head, and perhaps had greater germinative energy.

Samek carried on an experiment, testing seeds for a period of eleven years, showing the results of germination after the first and eleventh years.

Hiltner in a somewhat recent paper discusses the limitations of seed testing and the importance of obtaining pure seed.

H. von Guttenberg gives the description of five species of *Cuscata* and a key for their identification. Von Degen notes the germination of dodder under varying conditions. Kinzel has made a study of the effect of freezing seed and its bearing upon agricultural weeds. Pieper discusses the method of testing the germination of seeds and presents a new method of determining the germination of grass seed. Dorph-Petersen gives a summary of seed tests carried on by the Danish Seed Control Station, during which 9,024 samples of clover, grass, and other seeds were analyzed. The paper gives a list of weed seeds found and includes notes on germination and purity. F. G. Stebler, of the Zurich Seed Control Station, Switzerland, gives the results of tests made of 10,335 seeds examined in 1908, with reference to adulteration, purity, vitality, and the presence of *Cuscuta.* Vilke gives an account of the presence of weed seeds found in Swedish seeds. J. Paczoski notes the important weeds found in the Cherson Government. A. Malzew reports on the more important weeds found in Russia; black bindweed (*Polygonum convolvulus*) and corn cockle (*Agrostemma githago*) were common in wheat; oats had, in addition, wild oats (*Avena fatua, glabrata*), and *Neslia paniculata.* In rye, the black bindweed (*Polygonum convolvulus*), lamb's quarters (*Chenopodium album*), stickweed (*Echinospermum lappula*), and *Neslia paniculata* were found. Lesage made a study upon the effect of solutions of common salt and alcohol on the germination of garden cress. O. Munerati and T. V. Zapparoli of Italy have made a study of weed seeds with hard coats. F. Johnson and R. Hensman discuss the source of the alien flora of Ireland through weed impurities found in agricultural seed. A. J. Ewart made tests of various grass and garden seeds with reference to the vitality of seeds after a sea voyage. In a lengthy report on the prolonged vitality of seeds it was found that quite a per cent of seeds germinated after half a century. Rees made a study of hard seeds with reference to the cuticular layer. This layer repelled the water, and for this reason seeds retained their vitality.

A recent paper by E. Lehmann on the temperature and light relations and the germination of seeds, gives both an exhaustive summary of the subject and a great deal of original matter.

It is difficult to say under what conditions seed will germinate. Older investigators regarded light as having no definite action on the germination of seeds. Crocker found that the structure of the seed coats retarded germination in the case of Xanthium. Shull, Crocker, and others found that oxygen hastened the process. In a recent paper by E. Lehmann, attention is called to the action of light and temperature on the germination of seeds, both of which influence this action. The seeds of *Whitlavia grandiflora* indicated that germination is retarded at higher temperatures but not at lower. He designates some seeds, such as *Epilobium roseum, E. hirsutum* (Lehmann), and *Veronica peregrina* (Heinricher) as light germinating seeds. Dark germinating seeds are represented by *Phlox drummondii.* Lehmann found that 4 per cent germinate in light and 31 per cent in darkness. Maturity also influences germination of seed. When wheat is ripened at a lower temperature, it requires a longer optimum temperature for germination than seed ripened at a higher temperature. The seeds of blue grass when planted soon after maturity did not germinate in darkness but under the influence of light 88 per cent germinated. In spring, however, the germination was equally good in darkness and light.

Cieslar found that light influenced germination. It would seem from this and other investigations that structure, the oxygen, substratum moisture, temperature, light, in short, the ecology and structure as well as physiology play an important part in germination.

There are many other contributions, but most of these papers will be found recorded in the literature cited by Vandevelde, Harz and Nobbe.

American work.—Connecticut.—The pioneer work in this country was done by Profs. E. H. Jenkins and Warneke, of the Connecticut Agricultural Experiment Station.

Miss Mary G. Jagger and E. H. Jenkins report the results of analyses for 1908-1909-1910-1911, and note the character of the impurities of seed found in the Connecticut market.

North Carolina.—Gerald McCarthy, of the North Carolina Agricultural Experiment Station, published an elaborate paper on the subject in which he gave the details of an extensive investigation carried on in North Carolina on germination of seeds.

Michigan.—Some excellent work was done by Prof. W. J. Beal who reported results of germination of clover seeds furnished by seedsmen. From seeds grown on moist paper the results of the germination showed that large red clover had a germination of 88 per cent, medium red clover 88 per cent, white clover 84 per cent and alsike clover 64 per cent. Prof. Beal called attention to the difference in germination of seeds when grown in sand and in blotting paper. From seeds grown in sand the following results were obtained: Medium clover had a germination of 76 per cent, white clover 92 per cent, red clover (two separate lots) 70 and 56 per cent.

A later report of Prof. Beal gives two tests of twelve years old clover seeds in both of which the germination was 35.8 per cent.

Subsequent reports on the vitality of clover and other seeds were also made.

Prof. Beal also reports tests on seeds sent by farmers. Fifty-eight samples ranged from 25 to 97 per cent, seventeen being above 90 per cent. He early called attention to the presence of rib grass in clover seed. Recently he has published an exhaustive bulletin on the seeds of Michigan weeds with excellent figures made by

F. H. Hillman. Dr. R. Zceuw has published the results on the comparative viability of seeds, fungi, and bacteria, when subjected to various chemical agents. Ernest Bessey gives the results of seed analysis for 1911 and 1912 from which it appears that buckhorn and plantain were frequent. The paper gives the number of weed seeds in a pound.

Mr. Parsons in 1893 made some interesting tabulations in a summary of American seed vitality tests. In the results offered by him we find the following: Alsike 72.7 per cent, crimson clover 59 per cent, red clover 84.8 per cent, mammoth clover 82.5 per cent, white clover 72.1 per cent, alfalfa 61.6 per cent.

Pennsylvania.—Prof. Butz studied many hundreds of samples of seeds, chiefly with respect to their germinative power. In many cases the percentage of germination was very low. Thus we find recorded the following: Alfalfa 52 per cent, alsike clover 61 per cent, Japan clover 69 per cent and seradella 13 per cent.

Ohio.—Mr. Devol early recognized and emphasized the importance of the experiment station in studying the viability of seeds. In tests conducted by him clover showed a germination of 93 per cent.

Later Selby and Hicks made a study of fifty-two samples of clover and alfalfa seeds sold in Ohio. They found not only that the seeds had a low vitality but that they contained considerable impurities.

Nevada.—Several very important papers have been published by Mr. Hillman on clover seeds and their impurities. One of his earlier bulletins deals with the descriptions of weed seeds and their distribution, together with an incidental account of the occurrence of these seeds in commerce. In a later publication he considers the weed seeds found as impurities in various types of seeds, including alfalfa, red clover, white clover, alsike clover, crimson clover, Japan clover, Bokhara clover, yellow trefoil and esparcette. In his investigations a large number of samples was examined. The paper therefore gives a fair estimate of the impurities generally found in the various clover seeds offered for sale in this country.

Kansas.—Prof. Roberts and Mr. Freeman carried on an extensive investigation of alfalfa seed, showing adulteration, substitutes and impurities; and the methods of detecting the latter. They found some adulteration in alfalfa seed. The yellow trefoil (*Medicago lupulina*) was most frequent though there were occasional instances in which burr clover (*Medicago denticulata*) and sweet clover (*Melilotus alba*) occurred. The most noxious weed seeds found were the docks and the English plantain. The average germination of alfalfa seed was 83 per cent. The subject is also briefly discussed by Ten Eyck.

Prof. Roberts and Mr. Freeman also made quite an exhaustive study of the grass seeds commonly sold in Kansas. The dodder may prove to be a destructive clover parasite in the United States. Mr. Brown, in a paper on legal and customary weights per bushel of seeds, has also brought together much important matter on the subject of the weight of commercial seeds.

Maine.—Prof. Harvey and other members of the staff of the Maine Experiment Station investigated the vitality and the impurity found in the agricultural seeds offered for sale in that state. The results of Prof. Harvey's investigations disclosed the advisability of having a law to regulate the sale of seeds. Such a law was passed by the state of Maine and the work of carrying on this law was placed in the hands of the director of the Station.

The results of the tests and regulations concerning the seed testing for Maine were published by Charles D. Woods, director of the Station. In a subsequent bulletin he discusses seed inspection and lists 79 kinds of weed seed. With Hammond the requirements of the law are given as well as results of seed testing.

Minnesota.—W. L. Oswald, Bulletin 127 of the Minnesota Station gives the results of purity and germination tests for 1275 samples of commercial seed.

North Carolina.—McCarthy in an early bulletin of the North Carolina Station reported on the analyses of seed in 1912. O. I. Tillman reported on the analyses of commercial seed in accordance with the North Carolina pure seed act.

Kentucky.—Prof. Garman and others, of the Kentucky Experiment Station, have investigated the impurities in grass and other forage plants sold in Kentucky. It was found that thirty-six of the five hundred samples examined were adulterated; among these were red clover, blue grass, timothy and orchard grass. They concluded that the greatest fraud perpetrated is in the sale of certain varieties under an assumed name. In several publications Prof. Garman discussed the impurities and adulterations of grass seed sold in Kentucky and recommended that no field seeds should be sold in Kentucky containing more than 5 per cent weed seeds. He also gave a comprehensive account of seed testing apparatus and the conditions under which germination tests are made, with special reference to work in Kentucky.

Kentucky now has in consequence of this work an admirable law forbidding adulteration or misbranding of the clovers and timothy sold for seed in the state. Its effects have been most salutary and have been studied with profit by other commonwealths.

Vermont.—Mr. L. W. Barton, under the direction of Profs. Jones and Orton of the Vermont Experiment Station, made an examination of thirty-four samples of clover seed in Vermont. He reports the total percentage of impurities in red clover as being from .3 to 5.3, with an average of 1.8 per cent; alfalfa as having a maximum of 7.1 per cent and a minimum of .6 per cent. Sorrel was found in 60 per cent of the red clover samples and wild carrot in a few, the rib plantain occurred in 77 per cent, dodder in 5 per cent, and Canada thistle in 5 per cent. Dodder did not occur in the alfalfa, but in 8 per cent of the samples Canada thistle was found.

Massachusetts.—G. E. Stone reports on seed tests made in 1908 and 1910. Smith, Chapman, and Stone describe fourteen weed seeds most commonly found in grass seed and cattle foods, with a brief account of the weeds of the state.

Maryland.—E. I. Oswald made a series of experiments to determine the vitality of seeds when placed in manure under different conditions. It was found that weed seeds when left for six months in manure had lost their vitality completely. When left there for one month under conditions usually followed by dairymen, the seeds of ribgrass, horse nettle, dock, and a few others were still firm. Mention of weed seeds is made in the treatise by J. B. S. Norton on Maryland weeds. The same author gives the result of seed analysis of various commercial seed.

Nebraska.—E. M. Wilcox in a paper on dodder in alfalfa seed discusses the frequency of the impurities and means of eradicating the weed.

New Hampshire.—F. W. Taylor in reports of seed tests for 1910 and 1911 discusses the New Hampshire law giving results of purity and germination tests.

New York.—F. C. Stewart under the head of alfalfa troubles discussed dodder in alfalfa seed and subsequently gave a method of screening dodder out of alfalfa seed. In 1910 G. T. French reported on an examination of several hundred samples of seed with special reference to the occurrence of dodder, Russian thistle, and *Centaurea repens;* an earlier report by the same author reported on seed tests made at the station. Further discussion is found in the New York Agricultural Experiment Station Circular 8:1-4, Dodder in Alfalfa, by F. C. Stewart and G. T. French. Mr. M. T. Munn in Bulletin 362 gives the seed tests made in 1912, giving results of examinations made for purity of commercial samples.

North Dakota.—H. L. Bolley discussed the pure seed law of North Dakota and seed work ending December 31, 1909, with an account of weed seeds found.

Wisconsin.—A. L. Stone in a circular of information discussed the seed inspection law of the state, adding some general information. With G. T. Moore he also discussed the question of the eradication of farm weeds which have been introduced by means of impure seed.

Mr. George T. Harrington discussed the worst weeds in connection with grass and clover seeds. D. L. Beach made a study of commercial feeds with reference to the germination of weed seeds found in these feeds. Feed subjected to steaming before feeding contained no germinable weed seeds.

Texas.—According to O. M. Ball alfalfa seed sold in Texas contains the following chief impurities: Russian thistle, ribgrass, tumbleweed, pigweed, two kinds of dodder, green foxtail, curled dock, bur clover, and sweet clover. The vitality varied from 49.5 to 96.5 per cent. A subsequent report also on alfalfa seed was made.

Arizona.—Prof. Thornber made an examination of alfalfa seed sold in Arizona. This showed a high percentage of germination.

Iowa.—The Iowa Agricultural Experiment Station has produced several publications relating to weed seeds. Ball discussed impurities in grass seed; Pammel, Buchanan and King have published a bulletin covering impurities of commercial seed. Two bulletins by L. H. Pammel and Charlotte M. King, "Results of seed investigations for 1907" and "Results of seed investigations for 1908 and 1909," give the results of analyses of seed sent by farmers to the Station. The results of the 1907 investigation indicated that the weed seeds were different in many cases from those reported in a previous publication; dropseed grass was common, occurring in 3.3 per cent of the samples; Canada thistle seed was also less frequent. The investigations for 1908-1909 indicated that the seed sold in the state has improved, field tests of germination were lower than laboratory tests. A method of determining the vitality is also given. The subject of delayed germination is discussed by H. S. Fawcett, who found that a relationship exists between the hardness of the seed coat and the dormant period. L. H. Pammel states that different conditions influence the germination of seeds, such as hard coats and freezing of seeds. The delayed vitality of weed seeds is discussed by L. H. Pammel and Charlotte M. King. Weed seeds after freezing germinate more readily when frozen.

Work of the United States Government.—The National Government began a serious investigation of agricultural seeds and their impurities in 1893. Early articles on the subject appeared under the head of "Pure Seed Investigations."

Mr. Hicks called attention to the abuses in the seed trade. The matters that were mentioned by him have evidently not been remedied since 1894. Since then the work of the Department has been immeasurably increased, especially by such contributions as have been made by Mr. Duvel on the vitality of buried seeds and the storage and germination of wild rice; and the paper by Mr. Pieters on "The Farmer's Interest in Good Seed." Among the notes on seed testing in 1897, Prof. Hicks and Mr. Sothoron Key published an account of the germination of several forage plants and flower garden seeds.

A good table on the percentage of germination standards required of seeds will be found in a paper by Mr. Pieters. These seed standards were also published in the Year Book of 1896. Later Mr. Pieters discussed the presence of clover dodder and other impurities in clover seed. In a circular by Prof. Dewey of the same division the dodders found in clover were discussed.

The quality of the seed, especially its germinative energy, depends somewhat on the manner in which seeds are kept. Two articles on this subject are of special interest in this connection, one by Pieters, "Agricultural Seeds, Where Grown and How to Handle," and an article by Pieters and Brown, "Kentucky Blue Grass Seed, Harvesting, Curing and Cleaning."

The United States Department of Agriculture has published rules and described apparatus for seed testing. These were adopted by the standing committee on seed testing of the Association of American Agricultural Colleges and Experiment Stations.

In reports of more recent work, A. F. Woods found dodder seed frequent in alfalfa and red clover seed. The adulteration and misbranding of alfalfa. red clover and grain seeds was discussed by W. A. Taylor and B. T. Galloway. F. H. Hillman in several papers on the impurities, adulteration, etc., of clover and forage plant seeds and vetches, presented admirable figures and good descriptions of weed seeds found as impurities. Westgate, McKee, Evans, and Vinall gave a brief account of impurities found in alfalfa seed and sweet clover. The subject of low grade clover seed was considered by Edgar Brown and Miss Crosby.

In a paper by Brown and Hillman, "The Seed of Red Clover and its Impurities," the more important impurities found in European and American grown clover seed are given. Attention is called to the introduction of bad seeds from Chile. In 1905 two hundred and seventy-five thousand pounds of Chilean red clover seeds were imported into the United States, and this clover seed contained Chilean clover dodder seed.

Canadian work.—In 1892 Prof. J. H. Panton called attention to the importance of making an investigation of seed purity and of carrying on a campaign for better and cleaner seed. He thought a large number of the weeds on the Ontario farms were introduced in clover seed.

He found the number of weed seeds varied greatly, all the way from one to four thousand five hundred and forty per half ounce. Among the weed seeds he reported several that have become troublesome in the Mississippi valley; these include ribgrass and chicory.

Saunders in several reports of the Experiment Farms has discussed the vitality of grass and clover seeds. In 1903 there were tested one hundred and eighty-six samples of clover. The highest percentage of germination was low, the lowest 17 and the average 76.3. A large number of grass seeds were also tested. The work has been continued by Saunders and Grisdale (1910) relative to determining the climatic conditions favorable to high vitality of seeds.

Since 1903 the Department of Agriculture of the Dominion of Canada has created a seed division with Mr. G. H. Clark in charge of the work in purity and vitality tests.

A very notable publication on the subject of weeds and weed seeds has been contributed by Clark and Fletcher who have given colored illustrations of the more important impurities found in clover and other seeds.

A. B. McCready of the Ontario Agricultural College gives the results of germination tests of alfalfa and clover in which the superiority of bright, clean seed is shown.

Australia.—A. J. Ewart made tests of various grass and garden seeds with reference to the vitality of seeds after a sea voyage. In a lengthy report on the prolonged vitality of seeds it was found that quite a per cent of seeds germinated after half a century. Rees made a study of hard seeds with reference to the cuticular layer. This layer repelled the water and for the same reason seeds retain their vitality.

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GLOSSARY.

BY HARRIETTE S. KELLOGG.

Accumbent. Lying against, as when the edges of the cotyledon lie against the caulicle or radicle.

Achene. A dry, hard, 1-celled, 1-seeded, indehiscent fruit.

Acuminate. Tapering somewhat gradually to a point.

Acute. Ending in a sharp angle, not prolonged.

Aerial roots. Those appearing on the stem above ground; may be brace roots as in corn, or clinging roots as in ivy.

Albumen. Nutritive material in seeds accompanying the embryo.

Aleurone grains. Protein grains replacing albumen in a few oily seeds, and starch in others.

Aleurone layer. Outer layer of the endosperm next to the perisperm.

Alternate (leaves). One at a node, not opposite; (flowers) parts of one whorl opposite to intervals of next.

Anatropous. Inverted and straight.

Angiosperms. Higher seed plants.

Angium. Case for pollen grains.

Annual. A plant that performs its life cycle from germination to matured seed in one season.

Annual (Winter). A plant that germinates in the fall, grows until frost; but blooms and matures seed the following spring.

Anther. The part of the stamen which contains the pollen.

Apetalous. Without petals.

Apex. Is opposite to point of attachment.

Appressed. Lying flat against.

Arachnoid. Cobwebby; covered with tangled hairs, fewer and longer than when tomentose.

Arrow-shaped. See Sagittate.

Ascending. Rising obliquely or curving upward.

Auricle. An ear-shaped appendage.

Awn. An appendage composed of bristles.

Axil. The upper angle formed between the leaf and stem.

Axis. The central line of any organ or support of a group of organs.

Axillary. In the axil.

Barbed. With ridged points or short awns usually reflexed.

Base. The part of an organ nearest its point of support.

Beard. Awns of grasses; a tuft of hairs, generally stiff and long.

Biennial. Of two years duration; a plant germinating one season and maturing seed the next.

Bract. A modified leaf subtending a flower or flower branch.

Bracteate. Furnished with bracts.

Bristle. A short stiff hair.

Bulb. A leaf bud with fleshy scales; usually subterranean.

Bulbiferous. Bulb-bearing.

Callus. A hard protuberance or callosity.

Calyx. The outer part of the perianth.

Canescent. Hoary with gray or white pubescence.

Capillary. Hair-like.

Capitate. With a globose head. Collected in a head or dense cluster.

Capsule. Any dry dehiscent fruit composed of more than one carpel.

Carpel. A simple pistil or one element of a compound pistil.

Caryopsis. A dry one-seeded indehiscent fruit with a thin, adherent pericarp as in many of the grasses.

Caulicle. The first internode of the stem above the true root.

Cauline. On the stem.

Cellulose. Primary cell wall substance. A carbohydrate having the general formula $(C_6H_{10}O_5)$ n.

Chaff. A small thin scale or bract becoming dry or membranous as in the glume of grasses or bracts on head of compositæ.

Chalaza. That part of the ovule where all the parts grow together.

Chlorophyll. Green coloring matter of plants.

Chromataphore. The color-granule.

Ciliate. Having hairs or bristles on margin.

Circumscissile. Dividing by a transverse circular line as in capsule of purslane.

Clavate. Club-shaped; gradually thickened away from the point of attachment.

Cleft. Having narrow sinuses extending about half-way to base; as cleft leaf.

Cleistogamous. Fertilized in bud; closed flowers.

Climbing. Rising by laying hold of other objects without twining.

Coma. A tuft of any sort.

Compound. Composed of two or more similar, subordinate parts united into one whole.

Conduplicate. Folded upon itself lengthwise.

Cordate. Heart-shaped with point upward.

Coriaceous. Leathery.

Corolla. Inner part of the perianth.

Corymb. A convex, or flat-topped, indefinite inflorescence, like a raceme with lower pedicels elongated.

Cosmopolitan. Widely distributed.

Cotyledons. The first leaves of a plant as found in the embryo.

Creeping. Running along above ground or beneath the surface, and rooting.

Cremocarp. Fruit of Umbelliferæ.

Crenate. Dentate with rounded teeth.

Crested. Having a ridge or terminal appendage.

Crystalloids. Protein bodies in the form of crystals.

Culm. The stem of grasses.

Cuneate. Wedge-shaped.

Cut. Having divisions deeper than when dentate.

Cyme. A somewhat flat-topped, determinate inflorescence, resembling a corymb.

Decumbent. Reclining but with end rising.

Dehiscent. Opening in a regular manner by valves or slits to discharge seeds.

Dentate. Toothed, usually with teeth directed outward.

Denticulate. Finely dentate.

Determinate Inflorescence. Flowers arise from terminal bud and check growth of axis.

Diadelphous (stamens). Collected in two sets.

Dicotyledonous. Plants producing two cotyledons.

Diffuse. Spreading loosely and irregularly.

Digitate. Compound with parts radiating from apex of support.

Dioecious. Having stamens and pistils in separate flowers upon different plants.

Divided. Having incisions extending to base or midrib.

Dorsal. Pertaining to back or outer surface of organ.

Downy. Having a dense covering of short weak hairs.

Elliptical. Oblong and rounded at ends.

Emarginate. Notched at end.

Embryo. Rudimentary plantlet within the seed.

Endosperm. Albumen of seed in embryo-sac as distinguished from perisperm.

Epicarp. Outer layer of pericarp.

Epiderm. External layer of cells in any organ.

Epigynous. Corolla seems to rise from top of ovary.

Erect. Perpendicular, or nearly so, to the surface to which attachment is made.

Exserted. Protruding beyond margin of envelope as stamens from corolla.

Falcate. Scythe-shaped.

Fertile. Capable of producing fruit.

Fibrovascular Bundle. A bundle of stringlike, woody, fibrovascular tissue, containing xylem and phloem.

Fibrous. Composed of fibers.

Filiform. Thread-shaped.

Floccose. Covered with mats or flocks of soft woolly hairs.

Foliate. Leaved, as trifoliate (three-leaved).

Fruit. The mature ovary and its contents with any closely adhering part.

Funicle. The stalk of a seed or ovule.

Fusiform. Enlarged in the middle and tapering toward each end.

Gamopetalous. Having petals more or less united.

Glabrous. Smooth.

Gland. A secreting surface or structure.

Glandular. Bearing glands or glandlike.

Glaucous. Covered with a whitish bloom, as on cabbage.

Globoids. Granules of calcium-magnesium-phosphate found in grains of aleurone.

Globose. Spherical or nearly so.

Glomerate. Compactly clustered in a head.

Glume. One of the outer floral envelopes of grasses.

Glutinous. Viscid, sticky.

Hairy. Covered with hairs longer and coarser than when pubescent.

Halberd-shaped. See hastate.

Hastate. Describing leaves which have spreading lobes at the base.

Heart-shaped. See cordate.

Herb. A plant which contains but little wood in the stem and which dies down to the ground each year.

Herbaceous. Having the characters of an herb.

Hermaphrodite. Perfect, having both stamens and pistils in the same flower.

Hilum. The scar of the seed; its place of attachment.

Hirsute. Clothed with rather coarse or stiff hairs.

Hispid. Beset with erect stiff hairs or with bristles.

Hypoderm. Beneath the epiderm.

Hypogynous. With parts under pistil.

Imbricated. Overlapping either vertically or spirally like shingles of a roof. In aestivation, one piece is wholly external and one wholly internal.

Imperfect. Applied to a flower lacking either stamens or pistils.

Included. Opposed to exserted; not protruding from the envelope.

Incumbent. Applied to cotyledons when the radicle is folded back against one of them.

Indehiscent. Not opening by valves or slits.

Indeterminate Inflorescence. Flowers arise laterally and successively as floral axis elongates.

Indurated. Hardened.

Inflexed. Bent abruptly inward or downward.

Inflorescence. The flowering part of a plant.

Inserted. Attached to or growing out of.

Integuments. Coats of ovule.

Internode. Any part of a stem situated between two nodes.

Interrupted. Applied to surface or series the continuity of which is broken.

Involucre. A circle or collection of bracts immediately subtending a flower or inflorescence.

Isodiametric. Equal in three dimensions.

Joint. A node.

Keel. A ridge somewhat resembling the keel of a boat; applied especially to the two anterior united petals of a papilionaceous flower.

Lamella. A thin plate.

Lamina. Blade or expanded part of leaf.

Lanceolate. Lance-shaped; tapering abruptly toward the base and gradually toward the apex.

Lenticular. Lentil-shaped; in the shape of a double convex lens.

Ligneous, lignose, lignified. Woody in texture.

Ligulate. Refers to the strap-shaped corolla of composite flowers, as Dandelions.

Ligule. A. A strap-shaped corolla, as in the ray flowers of composites, like the sunflower. B. A membranous projection on inner side of leaf at top of sheath of some grasses.

Linear. Long and narrow with nearly parallel margins.

Lobe. A rounded portion or segment of any organ.

Locule. Cavity within ovule.

Lumen. Internal space or cavity of a cell.

Lyrate. Lyre-shaped.

Membranaceous or membranous. Thin, soft, and generally translucent.

Malpighian Cells. Palisade cells in which one or more light lines are present.

Mesocarp. Middle layer of pericarp.

Mesophyll. All of the fundamental tissue within the epidermis.

Micropyle. Opening through which pollen tube passes.

Monadelphous. Stamens united in one set.

Monocotyledon. One cotyledon.

Monoecious. With stamens and pistils in separate flowers on the same plant.

Mother Cells. Large dense cells in pollen lobes.

Mucronate. Tipped with a short stiff point.

Multiple. Compound.

Muricate. Beset with short and hard or prickly points.

Nerve. Any vein on the floral envelopes of grasses.

Node. The place on a stem where one or more leaves are attached; the joint.

Nucellus. Nucleus of an ovule.

Oblanceolate. Lanceolate with the broadest part toward the apex.

Oblong. Widely linear.

Obovate. Inverted ovate.

Obtuse. Blunt or rounded at the apex.

Orbicular. Circular.

Osteosclerids. Cells generally accompanying Malpighian Cells in Leguminosæ. They vary in shape and length, sometimes marked by longitudinal canals.

Ovary. Seed case of pistil.

Ovate. Outline like that of an egg, with larger part downward.

Ovule. Unripe seeds in ovary.

Palet. Upper bract of the flower in grasses.

Palisade cells. Elongated cells perpendicular to epidermis on upper side of leaf.

Palmate. Radiately lobed or divided.

Panicle. Loosely, irregularly branched raceme.

Papilionaceous. Butterfly-shaped, like the corolla of the pea, etc.

Papilla. A soft elongated projection.

Papillate. Having papillae.

Pappillose. Papillate.

Pappus. The modified limb of the calyx in corn, in Compositæ, especially, when the summit is developed in a feathery or plumose manner.

Parenchyma. All tissue composed of cells not having tapering extremities; soft cellular tissue like that of pith.

Parted. Cleft nearly or quite to the base.

Pedicel. A branch of inflorescence supporting one or more flowers.

Peduncle. A flower-stalk.

Perennial. Living more than two years.

Perfect. Having both pistil and stamens.

Perianth. The floral envelope including calyx and corolla (or calyx alone when corolla is absent) whatever their form.

Pericarp. The matured ovary.

Perigynia. The bodies around the pistil.

Perigynous. Parts around pistil.

Persistent. Remaining longer than usual, as calyx upon fruit, or leaves which die but remain on trees through the winter.

Perisperm. The albumen of a seed.

Petal. A division of the corolla.

Petiole. The stalk of a leaf.

Phloem. Portion of fibrovascular bundle containing the bast and sieve tissues.

Photosynthesis. Process by which sugar and starch are produced in a plant by means of the chlorophyll grain.

Pilose. Covered with long soft hairs.

Pinnate leaf. Compound with leaflets arranged on each side of a common petiole.

Pinnatifid. Pinnately cleft.

Pistil. The central seed-bearing organ of the flower consisting of ovary, style and stigma.

Pistillate. Provided with pistils; properly, without stamens.

Placenta. The part of the ovary to which the ovules are attached.

Plumose. Like a feather, having fine hairs on each side, as in the pappus-bristles of thistles.

Pod. Any dry, dehiscent fruit.

Pollen. The fertilizing powder produced in the anthers.

Pollination. Transferring pollen from anther to stigma.

Polygamous. Plants bearing both perfect flowers and flowers of either sex, or of both, as in the soft maple.

Pore-canal. Passage through a pit between adjoining cells.

Prickles. Short, stiff, spinelike growths from the epidermis, as in the rose.

Procambium. Fibrovascular tissue of an organ formed before it is differentiated into xylem and phloem.

Prostrate. Lying flat on the ground.

Protein. A plant food manufactured in the plant from starch or sugar by the addition of one of the compounds of nitrogen, phosphorus, potassium or other similar substances.

Protogynous or proterogynous. Having pistils ready for fertilization before anthers are matured.

Puberulent. Minutely pubescent.

Pubescent. Covered with fine, soft, short hairs.

Raceme. A simple indeterminate inflorescence of pediceled flowers arranged along a rather long, common axis.

Rachilla. Axis of spikelet in grasses.

Rachis. The axis of a spike or other body.

Radical. Proceeding from the root or base of stem.

Raphe. The continuation of the seed-stalk along the side of an anatropous ovule or seed.

Receptacle. Summit of flower-stalk.

Reflexed. Abruptly bent or turned downward.

Repand. Having a slightly undulating margin.

Respiration. Process of absorption of oxygen and giving out of carbon dioxide.

Reticulated. Net-veined.

Retrose. Directed backward or downward.

Rhizome. Any subterranean stem, usually rooting at the nodes and rising at the apex.

Rib. A primary or prominent vein in a leaf.

Root. The descending axis of the plant, which supplies it with nourishment.

Root-stock. See Rhizome.

Runcinate. Sharply toothed, the teeth directed backward.

Runner. A slender stolon that roots and forms new plants at intervals.

Sagittate (leaves). Arrow-shaped, lobes with acute lobes and apex.

Scabrous. Having a rough surface.

Scale. Any thin appendage, morphologically a modified, degenerated leaf.

Scape. A peduncle rising from the root, without proper foliage.

Scapose. Resembling a scape.

Scarious. Dry and membranous.

Sclerenchyma. Lignified tissue as applied to thick-walled fibers.

Sclerotic. Consisting of sclerenchyma.

Seed. The ripened ovule, enclosing a rudimentary plant, and the food necessary for its germination.

Sepal. A division of the calyx.

Serrate. Having sharp teeth pointing forward.

Serrulate. Finely serrate.

Sessile. Without a stalk; thus a leaf is sessile when the blade is seated directly upon the stem.

Sheath. A tubular envelope as the sheath of grasses.

Shrub. A woody perennial smaller than a tree and usually having several stems.

Simple. Without subdivisions, opposed to compound; leaves, as oak, dock, etc.

Sinuate. Having strongly wavy margin.

Sinuous. Wavy, curving back and forth.

Sinus. The cleft between two lobes or divisions.

Spatulate. Shaped like a druggist's spatula, rounded at the summit and gradually narrowed downward.

Spicate. Arranged in a spike.

Spike. An inflorescence like a raceme, except that the flowers are sessile.

Spikelet. The characteristic inflorescence of grasses.

Spindle-shaped. See Fusiform.

Spine. A sharp, rigid process growing from the stem.

Sporangium. Spore case.

Spore. Pollen grain; reproductive body of flowerless plants.

Spreading. Applied to branches that bend outward at less than a right angle.

Stamen. A pollen-bearing organ of a flower.

Staminate. Applied to a flower or plant which has stamens, but no pistils.

Stellate. Star-shaped.

Sterile. Unfruitful, as a flower without a pistil or antherless stamen.

Stigma. That part of the pistil which receives the pollen.

Stipules. Leaf-like appendages arranged in a pair at the base of the leaf stalk.

Stolon, or stole. A trailing or reclining and rooting shoot.

Stoma. Opening into the epidermis by which air enters and moisture escapes.

Striate. Marked with parallel lines or ridges.

Style. The slender part of a pistil supporting the stigma.

Sub-. A prefix meaning somewhat or slightly.

Succulent. Juicy, fleshy.

Suspensor. Filament of cells in ovary.

Tapetal Cells. Cells surrounding mother cells in pollen and containing food material.

Terete. Long and round.

Terminal. Attached to or pertaining to the extremity or apex, as the terminal bud.

Testa. Outer seed coat. Sometimes both coats are spoken of as the testa.

Tomentose. Densely pubescent with matted wool.

Tomentum. Matted, woolly hairs.

Toothed. See Dentate.

Trailing. Prostrate on the ground but not rooting.

Transpiration. Process by which leaves lose moisture.

Trichome. A plant hair of any kind.

Truncate. Ending abruptly as if cut off transversely.

Tuber. A short thickened subterranean branch.

Turbinate. Top-shaped.

Turgid. Thickened like a tuber, or distended with a liquid (never with air).

Umbel. Any indeterminate inflorescence in which the peduncles or pedicels of a cluster seem to rise from the same point.

Umbellate. Like an umbel.

Undulate. Having a wavy surface.

Urticating. Stinging. A term applied especially to the plant hairs of members of the Urticaceae, some of which are poisonous.

Utricle. A small inflated membranous 1-seeded fruit.

Valve. 1. One of the parts of a dehiscent fruit. 2. Applied also to the top of a pitcher in the Sarracenia.

Vein. A bundle of threads of fibro-vascular tissue in a leaf or other organ.

Verticillate. Whorled.

Villous. Bearing long, soft, straight hairs.

Viscid. Sticky, glutinous.

Wavy. Margin forms wavy line bending inward and outward in succession.

Wedge-shaped. See Cuneate.

Whorl. An arrangement of organs in a circle around a stem.

Wing. 1. Any thin or membranous expansion attached to or bordering an organ. 2. The lateral petal of a papilionaceous flower.

Winter annual. See Annual.

Xylem. Woody part of fibrovascular bundle containing larger continuous air-containing vessels; the water-conducting tissue.

INDEX

ABBREVIATIONS.
f=figure.
m=map.
sp=species.
syn=synonym.