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UNIVERSITY OF ILLINOIS,
Agricultural Experiment Station.

URBANA, APRIL, 1895.

BULLETIN NO. 39.

THE RUSSIAN THISTLE AND SOME PLANTS THAT
ARE MISTAKEN FOR IT.

INTRODUCTION.

The rapid and wide distribution that the Russian thistle has attained during the past few years, together with the great damage that it is said to have caused, has given it a prominence quite beyond that of any ordinary weed pest. The recent discovery that the plant was already an invader in northern Illinois has much increased the interest manifested in this state. To add to the information of the general reader concerning this plant and to aid, as far as possible, in preventing the further spread of so common a foe are the chief aims of this publication. In taking up the subject, it will best serve our aims to consider first the relationships, in a botanical way, of the plant.

DESCRIPTION OF THE PLANT.

Systematic relations. Although usually in this country called the Russian thistle, this plant has applied to it a variety of common names, such as Russian cactus, Russian tumbleweed, prickly saltwort, Tartar thistle, Hector weed, wind witch, leap-the-field, etc. Scientifically it is known as *Salsola Kali Tragus* (L.) Moq. It is one of the members of the goosefoot family. In this state the best known representative of the family is the lamb's-quarters, common in waste places; while of the cultivated plants, the beet may be mentioned as the most prominent. The common tumbleweed and the pigweed of our gardens, although near relatives, belong to a different family. About half of the members of the goosefoot family occurring in eastern United States are importations from other countries, and it is with these naturalized residents that the Russian thistle belongs. Altogether about eighty genera

belong to this family, and these are represented in various parts of the world by between five and six hundred species. The genus *Salsola*, of which our plant is a member, is said to embrace forty species, of which only one has been found native in the United States. This is the common saltwort found along our eastern coast and occasionally introduced inland. To this plant botanists have given the name *Salsola Kali*, and the Russian thistle is now considered as a variety of it called *Tragus*.

Life history. Let us now turn more directly to a study of the plant, tracing it hastily through its annual steps of development from the germinating seed to maturity. The matured fruit of the plant contains but a single seed, and is peculiar in that the calyx, which forms its covering, is broadly winged on the middle of each of the five lobes with a conspicuous spreading appendage, while the lobes form a sort of central beak covering the remains of the styles. Pulling off the dry, membranous calyx, one finds the obconical seed body, which is about one-sixteenth of an inch in diameter at the upper end. The top is somewhat depressed, and shows by a slight elevation at the center the remains of the styles. The embryonic plant entirely fills the seed, being coiled spirally within it. The primary stem, or caulicle, and the first pair of leaves, or cotyledons, are all easily made out.

In the spring the seed germinates by bursting off its covering and by uncoiling and elongating this primary stem and its pair of leaves. The caulicle elongates considerable, forming a very slender red stem. Soon the development of the root is shown at the lower end by the appearance of the root hairs, and then other cylindrical linear leaves are developed gradually at the growing point between the first pair. Next branching begins from the stem. The growth at first is slow, and the leaves are borne rather closely together. While young the plants are quite succulent, and the soft fleshy leaves, though tipped with their spines, are not obnoxious.

After the plant has grown slowly for some time, varying with season and locality, it gradually loses its succulent character, the leaves and stems becoming somewhat rigid by the abundance of mineral matter gained, and by the proportional loss of water. Drier weather favors a rapid development, and with it the stems lengthen and the floral branches with their short spine-tipped bracts are further developed. The normal leaves are linear bodies approaching somewhat the shape and size of Norway spruce leaves. These fall off in time. The bracts appearing on the floral branches are shorter (about $\frac{1}{4}$ to $\frac{1}{3}$ of an inch) and are expanded into a sessile winged base, so that they have a somewhat triangular shape. At maturity they are quite rigid, and thus form the objectionable feature of the plant, as they are spine-tipped. These bracts are grouped in clusters of threes, arranged numerously around the branches in well developed plants. The lower of the three occupies the position of the normal leaf, and with the other two laterally in

its axil forms a well protected place for the single flower enclosed by them. The flowers are small, lacking the petals of most flowers, but with the rose-colored calyx well developed, and with five stamens and two styles.

The seeds are not matured in this state apparently until the latter part of September or later. If the conditions for development have been favorable, we find large bushy plants, some attaining a diameter of six feet and a height of two. If, however, the plants are crowded or late in germinating, they remain more slender or are more straggling, and do not develop into so large plants. After the plants have begun to mature, they become striped on the stems and bracts with rose-red lines. Later in the fall the stems become twisted near their roots, so that eventually they are broken loose. In the winter the dead plants show no sign of the purple striping.

Identification of the plant. A good many mistakes in calling other plants the Russian thistle have been made. The plant, however, has certain marked features that readily serve to distinguish it from any other weed occurring in this state. The most prominent of these may here be repeated.

1. In the first place the leaves alone are sufficient to distinguish it. Instead of having the normally flat blades that most leaves possess, its leaves are nothing more than needle-shaped bodies one or two inches long by about one twenty-fifth of an inch in diameter, and are provided with a small spiny tip. When young the leaves are soft and juicy.

2. With older plants the ultimate or flowering branches are provided with shorter, rigid leaves having somewhat expanded bases. Each of these leaves has two similar lateral bracts, or leaves, in its axil, so that the three short, somewhat triangular bracts serve as a convenient place for the flower, and when the seed is developed it is enclosed rather securely between the bracts and the stem. These bracts are rather numerous on the stem, spreading out at nearly right angles.

3. The fruit is peculiar in that at maturity it is still tightly enclosed by the five parts of the calyx, each of which is winged on the back with a spreading appendage. The lobes of the calyx also meet in the center above the fruit in a sort of beak.

4. The seed is characterized by the embryo, or young plant, which entirely fills it. This embryo, which consists of a slender stem and two green linear leaves, is coiled spirally, so that it gives the seed an obconical shape. These parts can be made out by soaking the seed in water, if dry, and then carefully pulling it apart with needles.

5. The rose-red streaking of the plants as they approach maturity, although common with other members of this family, is also striking.

Comparison of Russian thistle with saltwort. As was stated at first, the Russian thistle is now regarded as a variety of the species of saltwort found native along our eastern coast. When first reported in Dakota, it was thought by botanists to be this saltwort. The variety is

a native of southern Russia, and at that time had never been reported in the United States. Mr. J. N. Rose, of the Division of Botany, Washington, was the first to determine the Dakota specimens as belonging to the variety, reporting this in a paper read before the American Association for the Advancement of Science, in August, 1891.

The saltwort, *Salsola Kali*, seems to be somewhat variable, two or three other varieties having been associated with it. In fact, the variability of the plant is such that European specimens of the species that are in the herbarium of the University of Illinois correspond more in general appearance with the variety as found here than they do with specimens of the species from the coast of this country. This tendency to vary may lead to some confusion of the species and variety in this country when they become inhabitants of the same locality. While the coast form is said never to become an obnoxious weed where now found, if introduced in favorable localities in the West it might possibly develop into one.

The general appearance of the living plants seems to be their most constant point of difference. From an examination of a few pressed specimens, our saltwort seemed to be a coarser plant than the variety. Mr. L. H. Dewey gives the following points of difference between the two forms, the characters given, however, should not be considered as constant in all cases. He says: "The variety *Tragus* differs from the typical form of *Salsola Kali*, which is common along the Atlantic coast, in the following characters: The leaves of the mature plant are very little longer than the leaf-like bracts which they subtend, while in the typical form of the species they are generally two to four times as long. The calyx is membranaceous and nearly always bright rose-colored, and the wings on the backs of the calyx lobes are much larger than the ascending lobes, while in the typical form the calyx is coriaceous and usually dull white or only slightly rose-colored, and the wings are thick, comparatively narrow, and less prominent than the ascending lobes. The species itself is less bushy in habit and less rigid at maturity."

DISTRIBUTION OF THE PLANT.

Means of distribution. Nature has rather liberally provided the Russian thistle with means for the dissemination of its seeds. This fact, taken together with the great number of seeds that some of the plants produce, and the protection afforded the plant by its spiny leaves, accounts in a great measure for the vigor with which the weed has usurped certain territory and spread to such an alarming extent over the country. As has been previously stated, the stems late in the fall become twisted at their bases. This twisting, with the help of the wind, eventually tears the plants free. With their bushy, compact form, the plants are admirably adapted to be carried by the wind rolling over the ground. Thus, as the seeds become loosened, they are scattered over a

much greater territory than those of many plants. Again, the winged condition of the covering is such that it may aid, by means of the wind, the further distribution of the seed. Prof. C. S. Crandall states that in Colorado irrigating ditches have been active means in spreading the plant in some places.

Besides these natural means, the plant has had an active helper in man. Obnoxious weeds, like some animals, follow man in his travels. In this case the railroad has been the most important factor in the distribution of the pest, especially in its advance eastward. Plants adhering to the trucks of trains, seed carried in the manure of stock cars, grain seeds brought from infected localities, all have been common means of introduction.

Distribution in foreign countries. The United States is not alone a sufferer from this plant. It has long been known as a foe in southern parts of European and Asiatic Russia. The species *Salsola Kali*, from which possibly it is not always distinguished, is found on sandy soil scattered over Europe, as well as in Asia, Australia, and North and South America.

Distribution in America. According to the best authorities the plant was introduced into the United States about 1873, at Scotland, Bonhomme county, South Dakota. This county has a settlement of Russian Jews who originally came from an infected region in southern Russia. It is thought that the plant was imported by them through impure flax seed brought from their native home. From this point in the southern part of the state, and possibly from others, the pest at first gradually and later rapidly spread until now it has been reported in seventeen states, and in Manitoba, Ontario, and Quebec, Canada. Something of the present distribution of the plant may be gained from the following notes, gathered chiefly from the publications of the government and the various experiment stations.

SOUTH DAKOTA, introduced about 1873; now found over the greater part of the state, in some places causing abandonment of cultivated fields.

NEBRASKA, found as early as 1888, probably introduced earlier; now occurring in over thirty counties.

IOWA, reported in 1888; now found in a number of widely separated localities.

NORTH DAKOTA, noticed in 1888 or earlier; now spread considerably over the state, being especially bad in several counties.

MINNESOTA, introduced at least as early as 1891; now reported from many localities, especially along railroads.

WISCONSIN, introduced probably previous to 1890 when first noticed; now found in widely separated parts of the state.

INDIANA, first found in 1890; now occurring in at least three counties, being abundant in places at Illinois line near Lake Michigan.

COLORADO, noticed in 1892 first; in 1894 reported from seventeen counties, being very abundant in places.

KANSAS, in 1894 reported as occurring in six counties.

MONTANA, reported by Dewey as having one infected locality in 1894.

WYOMING, for 1894 given by Dewey as having two infected localities.

IDAHO, reported by Dewey in 1894 as having the plant.

CALIFORNIA, credited now with a single locality.

MICHIGAN, in 1894 reported as having the plant in several localities.

OHIO, first found in 1894 along a railroad in one county.

NEW YORK, now reported by Dewey as having the plant.

MANITOBA, reported as having the plant the past season as a new-comer.

ONTARIO, given by Dewey as now possessing the plant in two localities.

QUEBEC, now credited by Dewey with a single locality.

The distribution of the plant is shown graphically by the map accompanying this bulletin. The map, which is by Mr. L. H. Dewey, has been revised by him for use here.

Distribution in Illinois. The Russian thistle has existed in this state during a much longer period than has been supposed. Owing to the confusion of specimens occurring in the vicinity of Chicago with the saltwort of the Atlantic coast, the Russian thistle was not reported in this state until the summer of 1894. The first mention of the plant as such, so far as has been found, is that made by Professor L. H. Pammel in the *Orange Judd Farmer* of July 28, 1894, in which he calls attention to the finding of specimens at Turner by Mr. G. Carver. The plants were collected by Mr. Carver about June 20th. On the 14th of August of the same summer the writer discovered about forty plants growing along the Chicago, Burlington & Northern Railroad at Polo, at which time the plants were reported as the first found in the state. Shortly after, specimens were received at this Experiment Station from St. Charles. All these collections, however, have been antedated by the collections from the lake shore region of Chicago, investigation having proved that the plants there are the Russian thistle.

The first mention of *Salsola Kali*, the saltwort, as occurring in Illinois is in the "Catalogue of Phænogamous Plants of Evanston and Vicinity," published by C. S. Raddin in 1883. In the "Flora of Cook County," etc., published in 1891 by Professor Higley and Mr. Raddin, the same plant is spoken of as follows: "Frequent on the lake shore, near the University grounds, Evanston." As yet none of the specimens from Evanston have been critically examined to see if they were the true Russian thistle. The Evanston specimens do not seem to be very abundant at the present time, and there seem to be no specimens preserved in any herbarium, so that it cannot be definitely stated that they were Russian thistles. Concerning the presence of the plants there at the present time, Mr. Raddin writes: "Up to 1887-8 the plants were frequent on the lake shore about Evanston, but were not noticed inland. They had been found in this vicinity for a good many years, and very likely came in from the lake, as quite a good number of plants have done. For the last three or four years the plants have become infrequent, and lately rare." Professor C. B. Atwell, of Evanston, also writes: "I am unable to learn, after considerable conversation with Dr. Marcy, that there is any authority whatever for saying that *Salsola Kali* is found upon the college campus or near it." During the summer of 1894 plants said to be the Russian thistle were noticed at Edgewater

and Rogers Park, these places being a short distance south of Evanston.

In the appendix to the Flora of Cook county, before mentioned, Mr. E. J. Hill is given as finding *Salsola Kali* at the ice-house near Wolf Lake within the limits of Chicago. It has lately been shown that these plants were the true Russian thistle, and that it was from this locality, or some near one, that most of the places in Chicago and northern Indiana have obtained their thistles. In a recent letter Mr. Hill writes: "I first saw the plant at Wolf Lake in August, 1890. The little patch was on a side-track of the Pennsylvania Railroad, which was built for the use of ice-houses on the lake. As the boundary between Illinois and Indiana here crossed the track, I concluded that both states were represented in the plants. A month later I found some about ten miles east in Indiana along the main line of the railroad. I did not at the time consider them different from *Salsola Kali*, as published in the Manual, but a couple of years later, after the agitation about the Russian thistle became prominent, I looked the matter over and decided that they were identical."

It would seem, then, that August, 1890, was the first date on which plants now definitely known to be the Russian thistle were noticed in the state, the identity of the Evanston plants reported in 1883 being as yet uncertain.

At the present time the Russian thistle has been reported from twenty towns, located in thirteen counties, all in the northern part of the state. In some of these only a few plants were found, and in many of the places the plants discovered were all destroyed, so that next year, quite likely, plants may not be found at all of the places. In Chicago the weed has been found in over a dozen different localities. Undoubtedly the railroads have been the chief means of introduction, for it is along the tracks, especially of lines running to the north and west, that the plants have been found. With one or two exceptions, the plants have not as yet spread away from the railroads into the towns or the country. With the exception of some of those found in the vicinity of Chicago, the year 1894 seems to have been the first or second year of their introduction. In three towns plants have been reported as abundant.

In the southeastern part of Chicago, in the vicinity of Wolf Lake, the plant seems to have taken its strongest hold. At the head of Wolf Lake, where the plant was first discovered in 1890 by Mr. Hill, its spread has been chiefly in Indiana. Mr. C. B. Shedd, of the Knickerbocker Ice Company, upon whose land the plants are found, states that they did not attract his attention until he saw some tumbling about in January of 1894. In the fall of that year he found that there were several acres infested. An effort was made then to destroy them, and at one time a pile the size of a small house was gathered and burned. The land here is quite sandy, is low and wet in places, and has a poor sod. When visited by the writer in December, many small plants were

yet to be found, so that the task of eradicating the weed may be one of some years. It is believed that the plants were started here from seed that was carried in stock cars, such cars having been emptied of their contents along the side-track, where specimens were first found. West of this place, along the railroad, running from Colehour south and then east into Indiana, the plant is also abundant. Mr. Hill says of the thistle in this locality: "It is most abundant a little west of where I originally saw it. There is a good deal along this road, between Colehour and Hegewisch station. At this place it has got into the fields somewhat, but is mostly by the railway." In some of the counties of northern Indiana, in this vicinity, the plant has become quite abundant.

At Turner, Du Page county, Mr. G. W. Carver, who found the plant there in June, 1894, reports that it was very abundant. It is said to have escaped along the streets at this place.

In August of 1894, the writer, while looking for the plant at Savanna, Carroll county, found that the yards of the Chicago, Burlington & Northern Railroad, west of the town, were very badly infested. The plants were so crowded in most places that they were quite small. Some very large plants, however, were found. Some few plants were also found along the Chicago, Milwaukee & St. Paul Railway, and southwest of the town plants were occasionally found on that road to Sabula, Iowa. The plant had not yet escaped from the railroads.

In the following list are given all those localities in the state where it is known that this pest has been found. A few places have been reported as having the plant, when investigation proved that they did not. Undoubtedly there are other places in these northern counties where plants have been or may be found. It is desired that all such places be reported to the botanist of the Experiment Station, accompanied by a small piece of the plant. The list gives the locality, abundance of specimens, source of information, and collector, when known.

CHICAGO, COOK CO., along side-track belonging to Knickerbocker Ice Co., south of 118th street near state line, spreading northeast along Wolf Lake, in Indiana. At first a dozen or so plants, increasing to thousands in 1894. Collected in Ag., 1890; published in *Flora*, Cook County, 1891; in letter to G. P. Clinton, 20 N., 1894. Collected and reported by E. J. Hill, Englewood.

Along branch Pennsylvania Railroad, from Colehour south and east into Indiana, spreading somewhat into fields. Very common, especially between 110th street and Hegewisch. Collected in 1893; published in *Bot. Gaz.*, 26 D. 1894; in letter to G. P. Clinton, 20 N., 1894. Collected and reported by E. J. Hill, Englewood.

Along L. S. & M. S. and P., Ft. W. & C. railways, from Englewood to state line, and along former as far east as Ohio. Plants scattered along the tracks. In letter to G. P. Clinton, 11 S., 1894. Reported by C. B. Shedd, Chicago.

Along Pan Handle railroad, between West Pullman and the Calumet River. Considerable. In letter to G. P. Clinton, 20 N., 1894. Reported by E. J. Hill, Englewood.

On commons near Eggleston Station. Rather abundant. In letter to G. P. Clinton, 20 N., 1894. Reported by E. J. Hill, Englewood.

Along switch-tracks of L. S. & M. S. Railway near Sixty-fifth street, Englewood. A few plants. Collected 10 O., 1891; in letter to Ill. Agr. Exp. Sta., 1894. Reported by W. S. Moffatt, Chicago.

At Sixty-third street and Oglesby avenue. Published in the *Tribune*, Chicago, 30 Ag., 1894. Reported by W. K. Higley, Chicago.

At Fifty-fifth street, between Cottage Grove and Greenwood avenues. Common along both sides of street. In letter to Bot. Ill. Agr. Exp. Sta., 16 O., 1894. Reported by W. S. Moffatt, Chicago.

Along tracks in Union Stock Yards. Two small plants. Collected 30 Ag., 1894; reported in the *Inter Ocean*, Chicago, 13 S., 1894. Collected and reported by G. P. Clinton, Urbana.

Brighton Park, near Belt Line Railroad. A few plants. Collected 19 S., 1891; in letter to Bot. Ill. Agr. Exp. Sta., 16 O., 1894. Collected and reported by W. S. Moffatt, Chicago.

At foot of Ontario street. In letter to Bot. Ill. Agr. Exp. Sta., 29 Ag., 1894. Reported by W. S. Moffatt, Chicago.

At Indiana street dump, on Lake Michigan. Published in the *Tribune*, Chicago, 30 Ag., 1894. Reported by E. J. Hill, Englewood.

Shore of Lake Michigan, south of Marine Hospital. In letter to Bot. Ill. Agr. Exp. Sta., 16 O., 1894. Reported by W. S. Moffatt, Chicago.

Edgewater, along lake shore. In letter to G. P. Clinton, 11 Mr., 1895. Reported by C. S. Raddin, Evanston.

Rogers Park. In letter to G. P. Clinton, 11 Mr., '95. Reported by C. S. Raddin, Evanston.

DAVIS JUNCTION, OGLE CO., along main and side-tracks of C., B. & Q. Railroad. In letter to G. E. Morrow, 24 Ag., 1894; published by G. E. Morrow, in the *Breeders' Gazette*, 29 Ag. Reported by F. M. Worcester, Davis Junction.

EAST DUBUQUE, JO DAVIESS CO., two and one-half miles north of town, on C., B. & N. Railroad. Two bunches. In letter to G. P. Clinton, 7 Mr., 1895. Reported by C. H. Harris, East Dubuque.

EVANSTON, COOK CO., on lake shore, near Northwestern Univ.; also south of town in 1894. At first frequent, now rare. Reported in List of Plants of Evanston and Vicinity, 1883; in Flora, Cook County, 1891; in letters to G. P. Clinton. Reported by C. S. Raddin, Evanston.

GURNEE, LAKE CO., in Stock Yards. Three plants. In letter to S. A. Forbes, 1 O., 1894. Reported by G. H. Stafford, Gurnee.

HAMPSHIRE, KANE CO., along C., M. & St. P. Railway. At first one plant, afterward others found within six miles of town. Collected 19 Ag., 1894; in letter to G. E. Morrow, 20 Ag.; published by G. E. Morrow in the *Breeders' Gazette*, 29 Ag. Reported by M. E. Howe, later by E. E. Rich, Hampshire.

MORRISON, WHITESIDE CO., along C. & N.W. Railway. At first two, later other specimens found. Published in the *Breeders' Gazette*, 19 S., 1894; in letter to G. P. Clinton, 24 S. Reported by E. W. Payne, Morrison.

NACHUSA, LEE CO., on C. & N. W. Railway. One plant. In letter to G. E. Morrow, 21 Ag., 1894; published by G. E. Morrow in the *Breeders' Gazette*, 29 Ag. Reported by Ira Raff, Nachusa.

NEW LEBANON, DE KALB CO., on C., M. & St. P. Railway. One plant. In letter to G. E. Morrow, 14 S., 1894. Reported by Vangalder and Boies, Sycamore.

OREGON, OGLE CO., east of depot C., B. & N. Railroad. Two small plants. Collected Ag., 1894; reported in Ogle Co. *Press*, Polo, 1 S. Collected and reported by G. P. Clinton, Urbana.

OTTAWA, LA SALLE CO., near glass works on switch connecting with C., R. I & P. and C., B. & Q. railways. Forty plants. In letter to T. J. Burrill, 27 S., 1894. Reported by J. W. Huett.

PEOTONE, WILL CO., along I. C. Railroad. Several plants. In letter to G. E. Morrow, 22 Ag., 1894; published by G. E. Morrow in the *Breeders' Gazette*, 29 Ag. Reported by J. J. McMahan, Peotone.

POLO, OGLE CO., near depot C., B. & N. Railroad. Forty plants, mostly small. Collected 14 Ag., 1894; reported in Ogle Co. *Press*, Polo, 18 Ag. Collected and reported by G. P. Clinton, Urbana.

ROCKFORD, WINNEBAGO CO., in C., M. & St. P. freight yards. One plant only mentioned. In letter to G. E. Morrow, 28 S, 1894. Reported by Dugald Clark, Rockford.

ROCKTON, WINNEBAGO CO., in gravel pit on railway near town. Large number of plants. First noticed during season of 1894; letter to G. P. Clinton, Mr. 1895. Reported by W. W. Austin, Rockton.

ROSECRANS, LAKE CO., a few miles from C., M. & St. P. Railway. Several specimens. In letter to S. A. Forbes, 1 O., 1894. Reported by G. H. Stafford, Gurnee.

SAVANNA, CARROLL CO., south yards of C., B. & N. Railroad; also along C., M. & St. P. Railway southwest to Sabula, Iowa. Along C., B. & N. very abundant. Collected 28 Au., 1894; reported in Ogle Co. *Press*, Polo, 1 S. Collected and reported by G. P. Clinton, Urbana.

ST. CHARLES, KANE CO., in rear of iron foundry, on a pile of refuse along river bank. About a dozen plants. In letter to G. E. Morrow, 17 Ag., 1894; published by G. E. Morrow in the *Daily Gazette*, Champaign, 18 Ag. Reported by E. C. Cook, St. Charles.

TURNER DU PAGE CO., in streets and along railroad. Very numerous. Reported by L. H. Pammel in the *Orange Judd Farmer*, 28 Jl., 1894; in letter to G. P. Clinton. collected Je. 20, by George Carver, Ames, Iowa.

WADSWORTH, LAKE CO., one mile north of station. Several plants. In letter to G. P. Clinton, 16 O., 1894. Reported by G. H. Stafford, Gurnee.

WAUKEGAN, LAKE CO., along C. & N. W. yards. Fifty or more plants, mostly small. In letter to Exp. Sta. 21 S., 1894. Reported by L. O. Mattheias, Waukegan.

Besides the preceding, the following towns have been reported as having the plant, but as insufficient information was had concerning the positive identification of the plant, they are merely mentioned here. The places are as follows: Forreston, North Forreston, Ogle Co.; DeKalb, DeKalb Co.; Warren, Jo Daviess Co.; LaFox, Kane Co.

INFLUENCE OF THE PLANT.

Injurious. Weeds are always a bad thing for the agriculturalist. Although there has been a great variety of opinions expressed as to the degree of damage caused by the Russian thistle, there can be no doubt that in general it is a thoroughly bad weed. In fact, in some localities it has already caused more mischief than any other weed occurring in the United States. It remains, however, to be seen whether this pest shall become as prominent a nuisance in all the localities to which it has spread as it is in the Dakotas. As different seasons seem to have some effect on its prominence as a weed-pest, so it seems highly probable that the widely differing environments of the various states and localities to which it has spread will also greatly affect it. However, there is no doubt as to its being a costly intruder in many localities, and it must be met everywhere, for the present, with the assumption that it may prove harmful.

No other weed has caused such widespread discussion, or been the subject of such general fear. National aid was asked to help in its

eradication. In North Dakota a state meeting was called by the Governor at La Moure to consider the subject of fighting the pest, and in January of the present year an interstate conference was held at St. Paul for a similar purpose. Mr. L. H. Dewey, of the Division of Botany, Washington, who has made the most careful study of the plant in this country, estimated that the damage it caused during 1892 was more than two million dollars, while in 1893 the loss must have been greater.

The following in regard to the loss caused by the plant in North Dakota is taken from the report of the Cactus Committee appointed in that state for 1893. "Reliable estimates from the counties infested—although somewhat incomplete, as some localities where damage occurred were not reported,—at the prevailing low prices of farm products, would indicate a direct crop loss of more than one million dollars for the year 1893 alone. The crop loss in Dickey county is estimated at twenty per cent.; La Moure, twenty per cent.; McIntosh, twenty per cent.; while Richland county reports about 30,000 acres infested with cacti, with a crop loss on this land of fifteen per cent. Much of the land in the worst cacti districts was not plowed last fall because of the mechanical obstruction to machinery presented by the weeds."

The reason that the Russian thistle assumes such importance as a pest is due to the fact that it has much worse features than most weeds, which merely rob the soil of its nourishment. To a prominent degree it possesses the power of crowding out other plants, especially in the case of plants growing on broken land. Another very objectionable feature possessed by the plant in its spiny leaves, which render harvesting infested crops exceedingly difficult. Stock may become injured by coming in contact with mature plants. In the northwest the character of the country and the rolling habit of the plant offer it as a means for spreading prairie fires.

Beneficial. It seems rather paradoxical to speak of such a plant as possessing beneficial qualities. As a grazing plant, however, the weed seems to possess some qualities which adapt it for such purposes in very dry regions. In regard to its value in this direction, a writer in a number of the *Sheep Breeder* said: "Our farm joins a thriving little town of about one thousand people. Now, if I should employ every able-bodied man and boy that could use a hoe and set them to work on our farm to destroy these thistles, I should have to hire them by the year, and then would fail. We do not look upon the Russian thistle as some do. It is one of the very best forage plants known, and certainly is one of the best in Dakota, for when so dry that nothing else will grow, then the thistle grows the quickest, and one acre of Russian thistles will produce more feed than two acres of clover. Our experience teaches us this, for we have kept seventy-five large thoroughbred Shopshire and Delaine rams on less than twenty acres this season, and kept them in fine condition."

While the plant may be valuable for grazing when young, one would not think of raising it for such purpose, but rather to pasture sheep upon it to clear the land and incidentally get out of the thistle what value it may have as a grazing plant. Recent chemical analyses made at the Experiment Stations of Iowa and Minnesota show that the plant during its younger stages really is rather valuable for grazing purposes, but that as it grows older its value materially lessens. The draft made by it on the soil is also shown to be rather severe.

In Illinois. Since the plant has been found in our state at such a number of places, the question naturally arises, "What may we expect of it here?" The fact that the plant during the five or so years that it has occurred in southeast Chicago has been steadily gaining in prominence shows that it can find places in the state favorable for development. However, there are so many conditions in this state different from those of Dakota that they must be taken into account in our estimate of its probable development as a weed pest.

In the first place, then, although the railroads may serve as a favorable means for wide dissemination, the fenced condition of most of our land and the less boisterous winds are against a rapid general invasion of the country. A second condition against its spread is the greater amount of land under cultivation here and the better cultivation of such as is used. The more moist seasons may also be somewhat against the plant, as it is said to develop much more rapidly in dry climates. The raising of crops requiring cultivation and the comparatively small amount of land in wheat and flax, which are said to be those most injured, are also points against its inflicting great loss. Lastly, the fact that very little plowed land is allowed to go to waste will be against the plants gaining strong foothold.

CONTROL OF THE PLANT.

Necessity.—Although we may not expect the plant to play the prominent part in the agriculture of this state that it has in some others, still it is wise to be on our guard against possible injury. The only way to keep the plant from doing possible damage is to prevent it from gaining general distribution. Although it has been reported from a number of localities and may be expected in others, we are now in a condition to prevent it from spreading.

Responsible parties. Doubtless for some time the railroads will be the chief ones to look after the extermination of the plants. With this idea in view, last year the Experiment Station sent to the roads in northern Illinois notice of the appearance of the plant in the state, together with a general description for aid in recognizing it. As a rule, the railroads seem willing to aid in preventing its further spread. Greater care should be given to keeping the right of way free from all weeds. Section men should become acquainted with the plant, so that they can easily distinguish it from our tumbleweed. The yards of the

railroads should be carefully watched, as plants are most apt to make their appearance there. More care on the part of our towns in keeping down the weeds of roads and of waste places will also be a paying investment in more ways than this. Lastly, the owner of any land owes it to himself and his neighborhood to destroy any such troublesome invader.

Methods. Various methods have been suggested for dealing with the plant, according to the locality from which it is reported. In most places in this state, however, the Russian thistle has not become so abundant but that the best means for destroying it is to pull up the plants when young, and when old to cut them down and burn them. Where plants are abundant frequent mowings, if necessary, should be given. In some cases more elaborate treatment might be found essential for success. As importation of seed grain, etc., from localities having the pest is a frequent method of spreading the plant, farmers should be careful to know the origin and condition of such seed.

CONFUSION WITH OTHER PLANTS.

Lack of information. The appearance of the Russian thistle in Illinois has aroused an interest, perhaps somewhat temporary, in the weeds of the state. Through lack of information some of our most common species have been mistaken for this pest. The finding of any new-comer in the weed line has also been received with apprehension lest it be the dreaded foe. The Experiment Station has consequently received an unusually large number of plants for determination, most of which have been sent to see if they were the Russian thistle. In some way the term "thistle" has made such an impression on the people that any unknown plant possessing prickles on any part of it is very apt to be regarded as this intruder. As a consequence most of the plants received were such as were provided with some sort of spines. In this state there really are no plants that upon ordinary examination should be mistaken for the Russian thistle. As they are seen growing or tumbling about at a distance, there are, however, two weeds that bear some resemblance to the plant. In the following paragraphs some of these mistaken forms are briefly described, while somewhat of an idea of their general features may be obtained from the illustrations at the end of this bulletin.

Cycloloma atriplicifolium (Spreng.) Coulter. Winged pigweed. This plant occurs in the United States chiefly on the plains west of the Mississippi river. It is reported as native in western Illinois, and is now found chiefly in the western and northern part of the state. At most of the localities from which it has been reported, it is not found to be a common plant, and perhaps in such cases has been introduced. It is the only one of the plants here described that belongs to the same family as the Russian thistle, the goosefoot family. The plant is much branched, and grows from six to eighteen inches in height. The leaf is easily

told from that of the Russian thistle, being of the ordinary flat type with more or less coarsely toothed margins. The numerous flowers are small, incomplete, and are scattered along the branches. In the fall by the twisting and breaking of the root, the weed may become freed from the soil; it is then carried by the wind rolling over the ground, so it is sometimes called a "tumbleweed." The plant is an annual, and in this state is not common or injurious enough to be considered one of the obnoxious species.

Amaranthus albus L. Tumbleweed. A common weed usually found in waste places or on plowed land is the tumbleweed. This plant occurs scattered not only over the state but now makes no claim to any special part of the United States. It is one of our native weeds that has spread over the country probably from the western plains. This tumbleweed belongs to the amaranth family, which is closely related to the goosefoot family. The common pigweed of the gardens is one of its near relatives. It has the low bushy appearance of the Russian thistle, and so is the plant most frequently mistaken for it. Its leaves, however, serve as an easy means for distinguishing it from that plant. They are flat, rounded at the end, and gradually taper to a petiole at their base. The flowers are very small and rudimentary, being crowded in small clusters in the axils of the leaves. The seed is a small, lens-shaped, shining black body. This weed is also an annual, and while more common than the winged pigweed is not classed with our worst pests.

Amaranthus spinosus L. Thorny amaranth. It is said that this plant was introduced into the United States from tropical America, and now occurs scattered through the eastern half of the country. It has long been known as a resident of this state, and has been reported from a number of localities, though apparently it is not a common plant. As is indicated by its scientific name, it belongs to the same genus as the common tumbleweed. The plant is bushy and grows from one to three feet in height. Its leaves, which are broadest at the base, have rather long petioles. In the axils of these leaves are found two or more well developed spines. The spines form a means for easily determining the plant. The inconspicuous flowers form long sterile clusters at the end of the branches, and shorter, more compact fertile ones in the axils of the leaves. The plant has been feared by some as likely to prove an injurious weed, though as yet it can scarcely be called such.

Solanum Carolinense L. Horse-nettle. The plant bearing this name is a native of the state, and is found in the United States chiefly east of the Mississippi river. It usually occurs in sandy or dry waste places. From its general appearance one would scarcely believe that it is a very close relative of the potato, yet an examination of the floral parts shows many points of resemblance. The plants generally grow from one to one and a half feet high and are more or less covered with short coarse hairs. The leaves, which are comparatively large, are

usually lobed in a somewhat angular manner. The striking feature of the plant is the strong yellow prickles found on the stems and ribs of the leaves. When in fruit the small yellow berries in a way resemble tomatoes, which are also botanically related to the horse-nettle. The perennial nature of the plant, together with its prickles, cause it in some places in the state (Gibson, Ford county) to become quite obnoxious, though it is not frequent enough to be so considered in most localities. It is said that in Delaware the plant has taken hold of some fields with such vigor that they have been abandoned temporarily.

Solanum rostratum Dunal. Sand-bur. The native home of this plant is the plains of the west. For years, however, it has gradually been working its way eastward. Its first appearance in this state seems to have been in Adams county, specimens having been collected on waste ground at Camp Point in August of 1878. It has since been reported from a number of widely separated localities, and at one place near Eagle Point, Ogle county, has taken possession of several acres of land. Like the horse-nettle, the sand-bur belongs to the nightshade family. It forms a branched plant one or two feet high, and presents a striking appearance because of the stout yellow prickles which densely cover the stems, leaves, and fruit. The flowers are yellow, about an inch in diameter, and at maturity produce numerous seeds. It is one of our annual plants. Before the introduction of the potato in the west, the sand-bur is said to have formed the chief food of the potato-bugs there. Although as yet the plant has not caused much trouble here, it is one to be regarded as quite undesirable because of the liberal manner in which nature has armed it.

Carduus arvensis (L.) Robs. Canada thistle. This plant was introduced into the United States from Europe, by the way of Canada, probably during the latter part of the last century. It has now become rather widely distributed over the northeastern part of the country. In Illinois it was reported as early as 1859 by Dr. Vasey, though probably introduced some years previous to that date. In 1867 the first laws concerning it were passed by the legislature. In his catalogue of plants of Illinois, published in 1876, Mr. H. N. Patterson gives the following note on the distribution of the plant: "Along the railroads about Chicago, Babcock, Vasey; in one locality near Peoria, Brendel; Fulton county, Wolf. Fortunately rare as yet. Since the enactment of the Canada thistle law most of the other species have suffered at the hands of the commissioners, especially *lanceolatum*." At the present time the plant is found in quite a number of localities and, especially in the vicinity of Chicago, is quite abundant. It seems to be introduced along railroads most commonly. The Canada thistle belongs to the composite family of plants, and has our very common bull-thistle as one of its near relatives. Though usually one or two feet high, it sometimes attains a height of three or four feet. It is frequently confused with the bull-thistle, from which it can be told by the leaves, which are

thinner, more crinkled and without the rough hairs on their upper sides, and are not decurrent. The floral heads are also much smaller and surrounded at their bases by rows of scales not tipped with the long prickles of the bull thistle. Like it, however, the margins of the leaves are well provided with prickles. On account of the ease with which the seeds are distributed by the wind and the extensive spreading of the perennial underground parts, the plant is one of the most difficult to eradicate that has yet made its appearance in this country. In this state, while the pest is bad enough in places, it is not so injurious as it might be, because of the failure of most plants to produce any seed. All means for eradicating the plant must be aimed at the destruction of the perennial underground parts. There are yet on our statute books rather elaborate though apparently much neglected laws concerning the control of the plant.

Lactuca Scariola L. Prickly lettuce. Perhaps no plant has attracted more attention by its apparently very rapid spread than has this during the past two or three years. It is said that the plant was introduced into this country from Europe, the first specimen being found at Cambridge, Mass., in 1863. In this state, while to many it appears as a new weed, it has been observed in several localities for a number of years. Dr. W. S. Moffatt in a letter states that he has known the plant to occur in the vicinity of Chicago for at least fifteen years, and as early as 1879 plants were collected at Rockford by Mr. M. S. Bebb. At the present time the plant is one of the most common in waste places. It belongs to the composite family, and is thought by some to be a wild form of cultivated lettuce to which at least it bears very close relationship. The seeds begin to germinate either in the fall or early spring, and at first form a circle of leaves spreading flat on the ground. Eventually from the center of these arises a single erect stem two to six feet high. The oblong leaves are attached directly to the stem by a somewhat clasping base, and are peculiar in that they are generally twisted at the base so that the margins are directed up and down. Toward the base of the stem and on the normally lower side of the leaves along the ribs are found coarse prickles, which are also means for identifying the plants. The small yellow flowers are borne in numerous heads on the branches, and at maturity produce a bountiful supply of seeds, which are provided with a little tuft of hairs to aid in their dissemination by the wind. Mowing plants instead of killing them usually results in several stems being sent up to take the place of the one destroyed. It is said that cutting off the plants beneath the ground is sometimes a means for destroying them.

WEED LAWS.

Aim and use. Upon the statute books of a number of states are laws directed against their weeds. In most cases these are enacted against the most prominent pests only, which are usually mentioned by

name. In North and South Dakota and Iowa the Russian thistle has been the subject of special attention in such laws. In Minnesota and Illinois bills against this plant have also been introduced in their legislatures, and it seems probable that they will soon become laws. Whether or not the laws as they have been made and enforced in most states are a very valuable aid in keeping down weeds is an open question. When they are enacted, however, they should be as short and simple as possible; they should be flexible enough to provide against the variable place as a pest that any weed may assume; they should be general enough to include any form that may suddenly become obnoxious.

In Illinois. At present there are in this state laws that provide against the Canada thistle and the cocklebur. The Canada thistle law is quite cumbersome, and at present apparently not much use is made of it. This law was approved in March, 1872, and was amended in June, 1885. A further amendment to include the Russian thistle in the act is now under consideration by the legislature, having been introduced by Senator David Hunter. The proposed amendment changes the present law by the insertion of the words "and Russian" between the words "Canada thistles" where they occur in the different sections of the law. As this amendment has already passed the senate, and is said to be favorably considered by the house, the law with the proposed amendments inserted is given here in full.

AN ACT concerning Canada and Russian Thistles.

SECTION 1. *Be it enacted by the People of the State of Illinois represented in the General Assembly:* That there may be appointed by the board of town auditors in counties under township organization, and by the county commissioners 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, some competent person, to be styled "Commissioner of Canada and Russian Thistles," who shall take the oath required of township or precinct officers, and shall hold his office for the term of three years, and until his successor is appointed and qualified, and he shall receive for his compensation the sum of two dollars a day, for each full day necessarily spent in the performance of his duty, to be verified by affidavit. The board of appointment may at any time, for good cause, remove the commissioner from office, and appoint his successor, to serve the remaining portion of his time.

SECTION 2. The commissioner of Canada and Russian thistles shall diligently inquire concerning the introduction and existence of Canada and Russian thistles in his township or precinct, and if any are found growing therein he shall take charge of all such growing in the highway and on uninclosed lands, and take care that they do not go to seed, or otherwise spread; and he shall carefully seek and learn, so far as practicable, the best methods for their destruction, and he shall persistently apply, in proper time, such remedy or treatment as he shall deem best calculated to prevent their spread and to eradicate the same.

SECTION 3. In case said thistles are found growing on inclosed lands, the commissioner shall advise with the owner, agent or occupant on their treatment, and if the said commissioner shall deem it necessary and expedient for him to fully control the same, he shall agree with the owner, agent or occupant on the boundaries of the tract so infected, which it is expedient for him to control, and he shall mark the same

by stakes, or fence if thought best; and thereafter such infected tract, or so much as from time to time remains infected shall be managed and controlled by the said commissioner, for the purpose of destroying said thistles, and so long as it may be necessary to complete the work. In case the commissioner and the owner, agent or occupant of said land cannot agree as regards the propriety of the commissioner controlling such tract or the boundaries of the same, then the commissioner shall proceed to stake out or mark such boundaries as he deems proper, and file a copy of his decision with the town clerk, or, in counties not under township organization, with the county clerk. The owner, agent or occupant of the land may, if he feels aggrieved, appeal from such decision of the commissioner, without bonds, within twenty days, to the commissioners of highways of the town, or to the county commissioners, as the case may be, who shall proceed to view the same, and to hear the reasons for and against the decision of the commissioner, and a majority of such board of appeal shall decide as to the propriety of taking possession of the tract alleged to be infected, and if they decide to take such possession, what shall constitute the boundaries of the same, and shall direct said commissioner to exterminate said thistles (which are hereby declared a public nuisance) without unnecessarily depriving the owner of the land of any legitimate use and enjoyment of the same; and the owner or occupant of said land shall pay all cost and expense of labor for said extermination, which shall not exceed the sum of one hundred dollars for each infected tract in one year, without the consent of the supervisor of said town, or county commissioners, as the case may be, and that the sum so expended shall be a lien upon said tract so infected; and if the owner or occupant shall not pay the same to said commissioner on or before the first Monday of September of the year the work was performed by the commissioner on said tract, the commissioner shall report the same to the board of town auditors, in towns under township organization, or county commissioners, as the case may be, and certify to the same, and that said board of town auditors or county commissioners shall certify to the county clerk the amount so due on each tract; and it shall be the duty of the county clerk to cause the amount so returned to be levied on the lands as certified by said board of auditors or commissioners, as the case may be, and that said amount so certified shall be collected in the same manner that taxes of the county are levied and collected, and the same, when collected, to be paid over to the supervisor of the town or towns under township organization, and to the county commissioner, as the case may be, who shall pay the same out on the order of the commissioner to the parties entitled to the same, for the labor employed in destroying the thistles on each tract for which the money was collected.

SECTION 4. The commissioner shall apply the best known means, and use the utmost diligence, in eradicating the thistles; but he shall not have power to expend in work or materials more than one hundred dollars on any one infected tract, without the advice and consent, in writing, of the supervisor of the town, or of the county commissioners, as the case may be.

SECTION 5. It shall be the duty of the commissioner to prosecute or complain to the proper authorities of any person or corporation who may violate any law now existing, or which may hereafter be passed, on the subject of Canada and Russian thistles.

SECTION 6. The commissioner shall, annually, before the first day of November, make a written report to the supervisor of the town, or to the county commissioners, as the case may be—which report shall be filed with the town clerk, or in counties not under township organization, with the county clerk. The report made to the supervisor shall be publicly read at the annual town meeting. Said report shall state—

First—Whether there are or not any Canada or Russian thistles growing in the town or precinct.

Second—If any are growing, where and how many, and when and how introduced.

Third—A detailed statement of his treatment of each infected tract, with cost and result.

Fourth—He shall report such other matters as may be required of him by the board of town auditors, or by the county commissioners.

Fifth—He shall state his views on their further treatment, and make such suggestions and recommendations as he may deem proper and useful.

And he shall also forward a copy of said report to the secretary of the State Board of Agriculture, who shall collate and report the same to the governor by the first day of December of each year.

SECTION 7. The board of town auditors, and the county commissioners in counties not under township organization, shall audit the accounts of the commissioner, both for his services and for the money expended or labor employed by him; and they shall provide for their payment as they now do for other town or county expenses.

SECTION 8. The boards of supervisors and county commissioners may make appropriations from the county treasury to aid in destroying the Canada and Russian thistle in any one or more towns or precincts of the county; and in case they deem it expedient, they may assume control over any one tract or of all the Canada and Russian thistles in the county, and make such provision as they may deem necessary, and impose penalties, not exceeding \$100 for each offense, for a violation of any provisions, by-laws or regulations made by them on this subject, to be sued for by the commissioner, in the name and for the use of the proper county, before any justice of the peace having jurisdiction. Whenever the board of supervisors or county commissioners shall decide to assume control, and so long as they exercise it, their jurisdiction shall be superior to that of the commissioner.

SECTION 8½. And it is hereby made the duty of county boards in counties under township organization, where town auditors have failed or refused to appoint a commissioner of Canada and Russian thistles, upon the petition of twenty-five land owners, of said town or adjoining town or towns, stating the failure of said board of auditors to appoint a commissioner for said town, and of the necessity for the same; to appoint a commissioner for said town (who shall be a resident of said town), who shall hold his office for the same length of time as if appointed by the board of auditors, and shall receive the same compensation, and said compensation shall be audited and allowed, and paid by the township for which he was appointed, the same as if he had been appointed by the board of auditors of said town; and his duties shall be the same, and the board of town auditors or county board may appoint so many assistant commissioners as they may deem necessary to thoroughly perform the duties in any town, which assistants shall receive the same compensation for like services as the commissioner, and whose duties shall be the same, and the commissioner of Canada and Russian thistles or assistants refusing or neglecting to perform their respective duties shall be fined in a sum not less than ten dollars nor more than one hundred dollars for each offense, such fine to be sued for in any court of competent jurisdiction in the name of the town on complaint of any land owner of the town; said fine when collected to be paid to the supervisor or county commissioner and become a part of the town or precinct fund.

SECTION 9. Whereas, Canada and Russian thistles are now growing in various parts of the state, requiring attention before the first day of July, therefore an emergency exists, and this act shall take effect and be in force from and after its passage.

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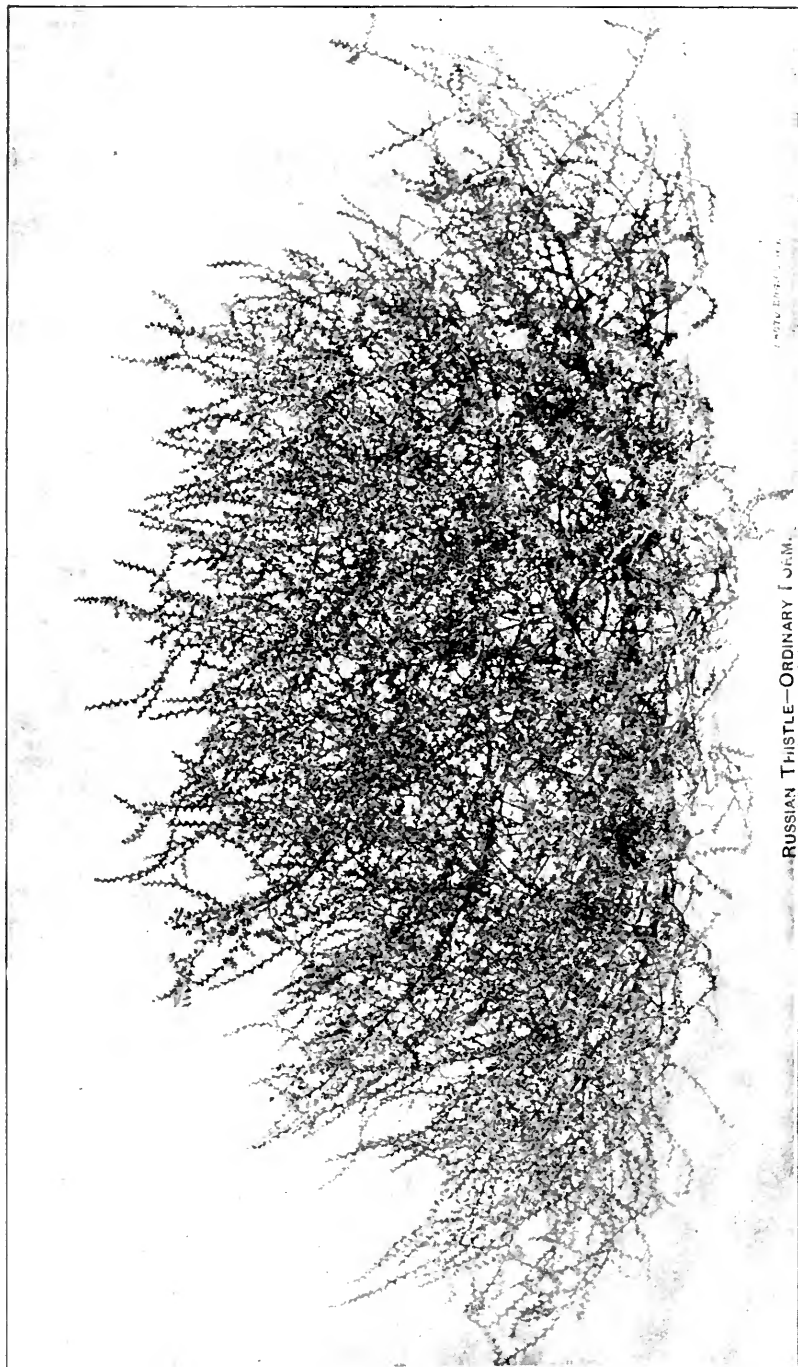
Notes appointment of agent to investigate the Russian thistle.

G. P. CLINTON, M. S.,

Assistant Botanist.

EXPLANATION OF ILLUSTRATIONS.

- Fig. 1. Mature plant of Russian thistle. From illustration used by Wis. Exp. Sta.
- Fig. 2. Details of Russian thistle. a. Flowering branch. b. Germinating plant. c. Relation of bracts and flower. d. Flower showing wings of calyx. e. Fruit or seed. f. Coiled embryo removed from seed. From illustrations used by U. S. Dep. Agr.
- Fig. 3. Small plant showing winter appearance. Collected at Wolf Lake, Ill.
- Fig. 4. Details of Fig. 3.
- Fig. 5. Plants germinated indoors. a. Plants two weeks old, showing slender caulicle with cotyledons. b. Plant several weeks old.
- Fig. 6. Slender specimens of Russian thistle collected at Polo, Ill., during latter part of August, 1894.
- Fig. 7. A part of a plant of the saltwort found along the coast in the east.
- Fig. 8. Map showing distribution of the Russian thistle in North America, so far as known at the U. S. Dep. Agr., Feb. 26, 1895.
- Fig. 9. Map showing distribution of Russian thistle in northern Illinois, as far as known at this Exp. Sta.
- Fig. 10. Pressed specimen of winged pigweed showing the flowering stage.
- Fig. 11. Pressed specimen showing part of a thorny amaranth.
- Fig. 12. Pressed specimen showing leaves, spiny stem, and fruit of part of a horse-nettle.
- Fig. 13. Pressed specimen showing flower heads and leaves of Canada thistle.
- Fig. 14. Mature tumbleweed.
- Fig. 15. Details of Fig. 14.
- Fig. 16. Pressed specimen of the sand-bur.
- Fig. 17. Fruit details of Fig. 16.
- Fig. 18. Prickly lettuce. a. Ordinary form. b. Form with several stems resulting from mowing the plant earlier in the season.
- Fig. 19. Details of Fig. 18.

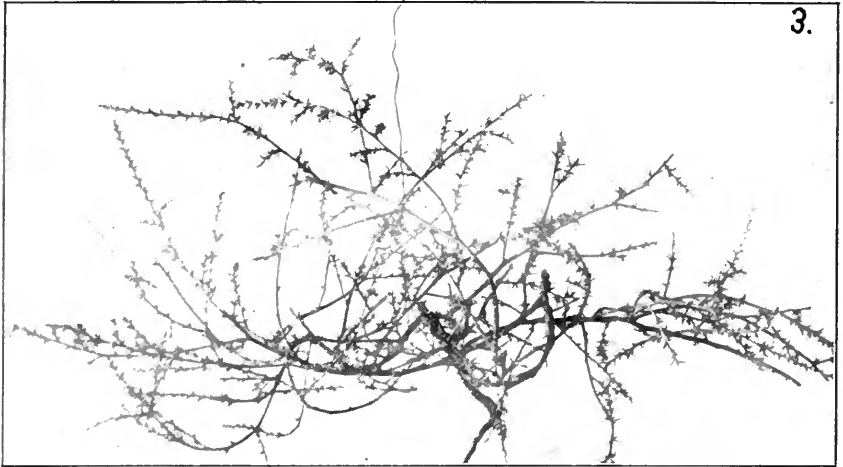


RUSSIAN THISTLE—ORDINARY [J.F.M.]



RUSSIAN THISTLE—DETAILED FIGURES.

3.

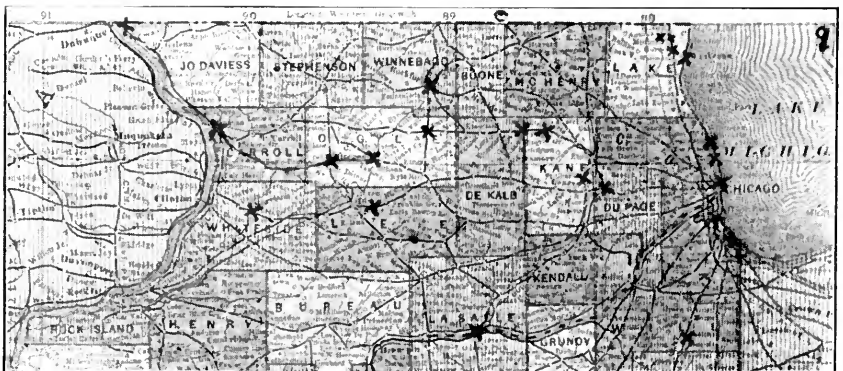
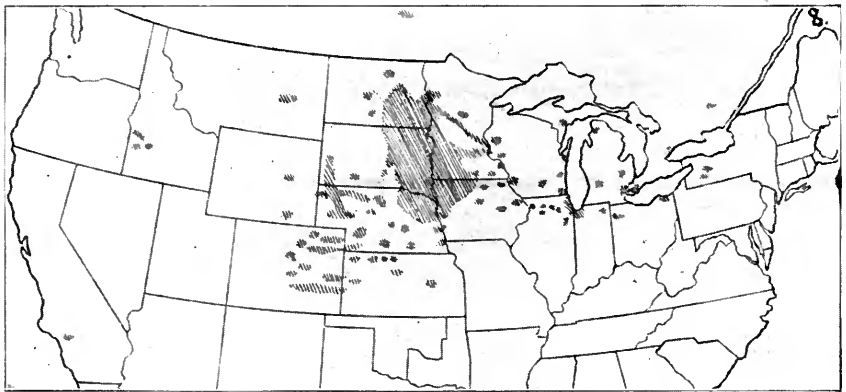
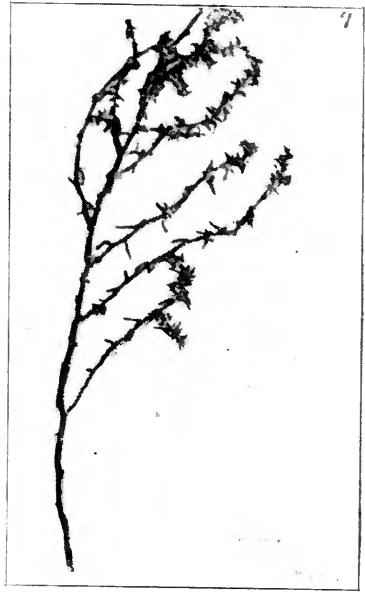
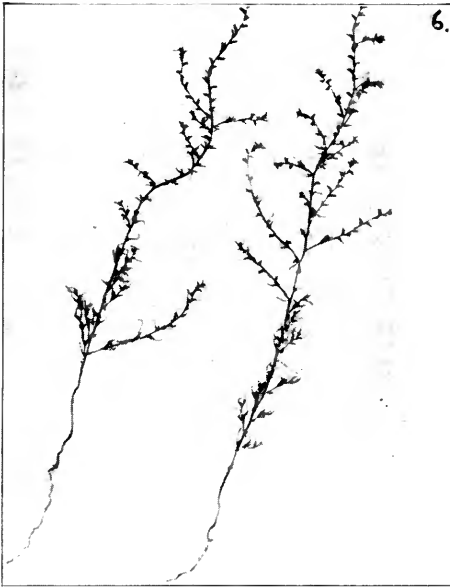


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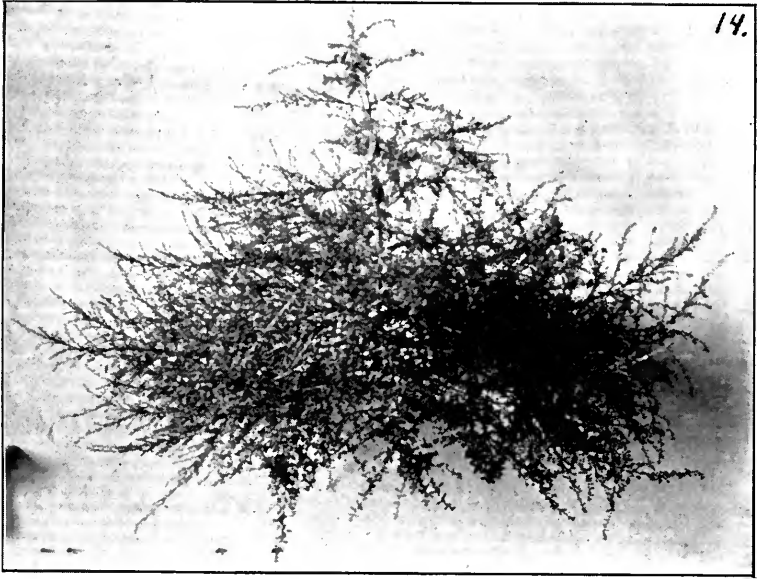


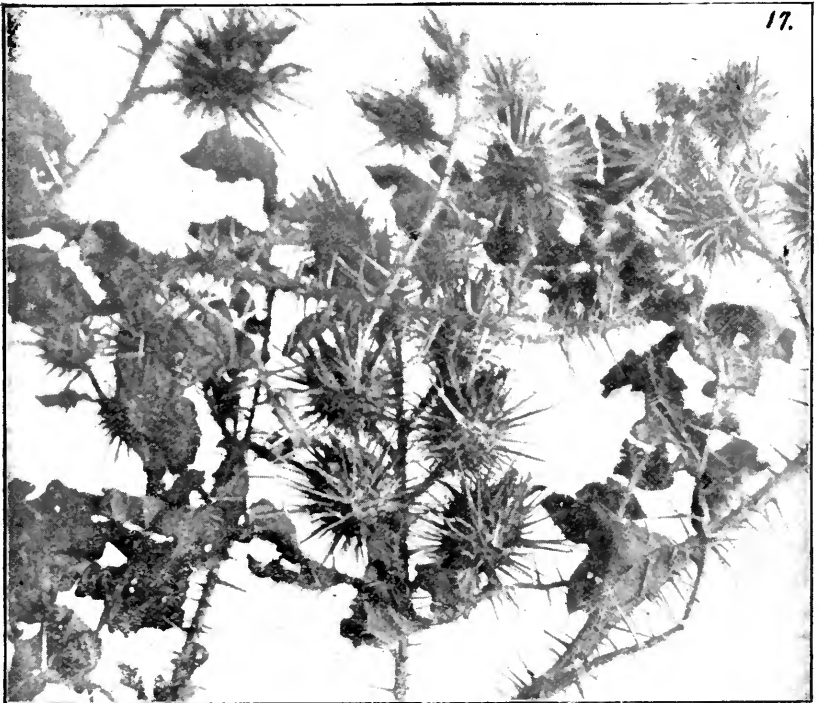
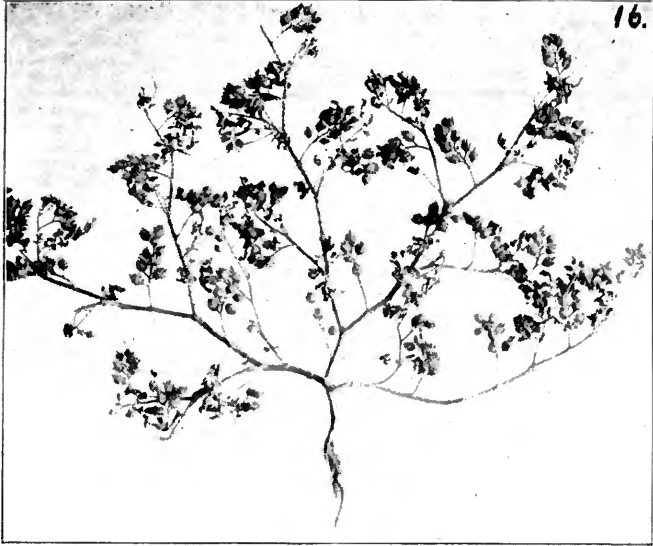
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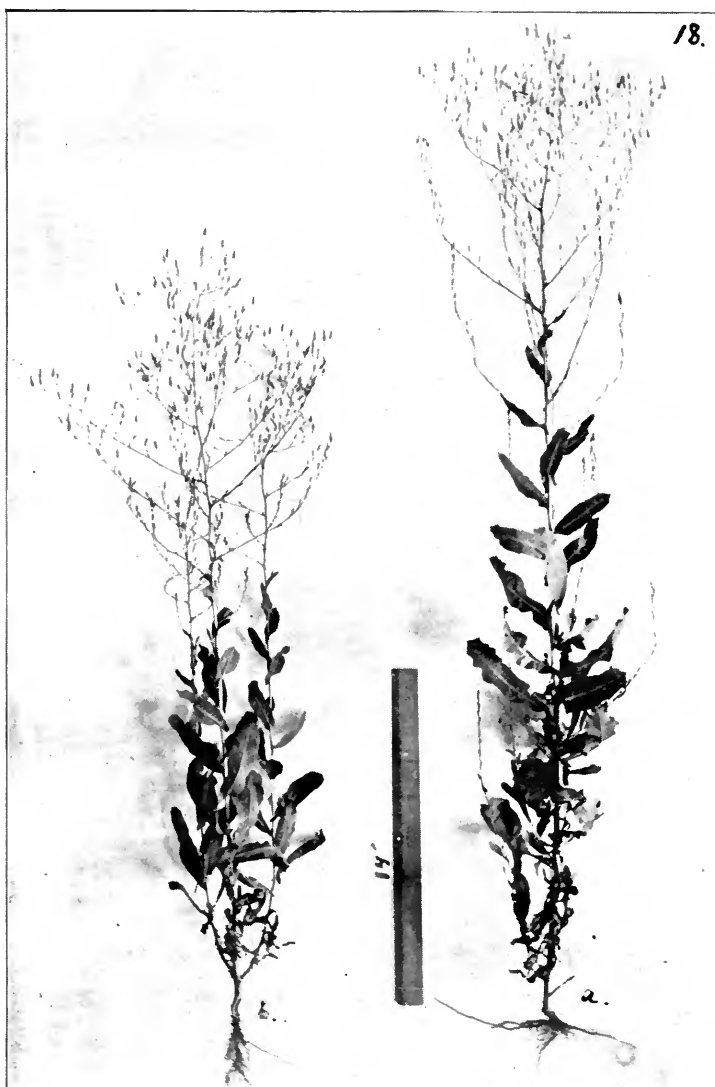




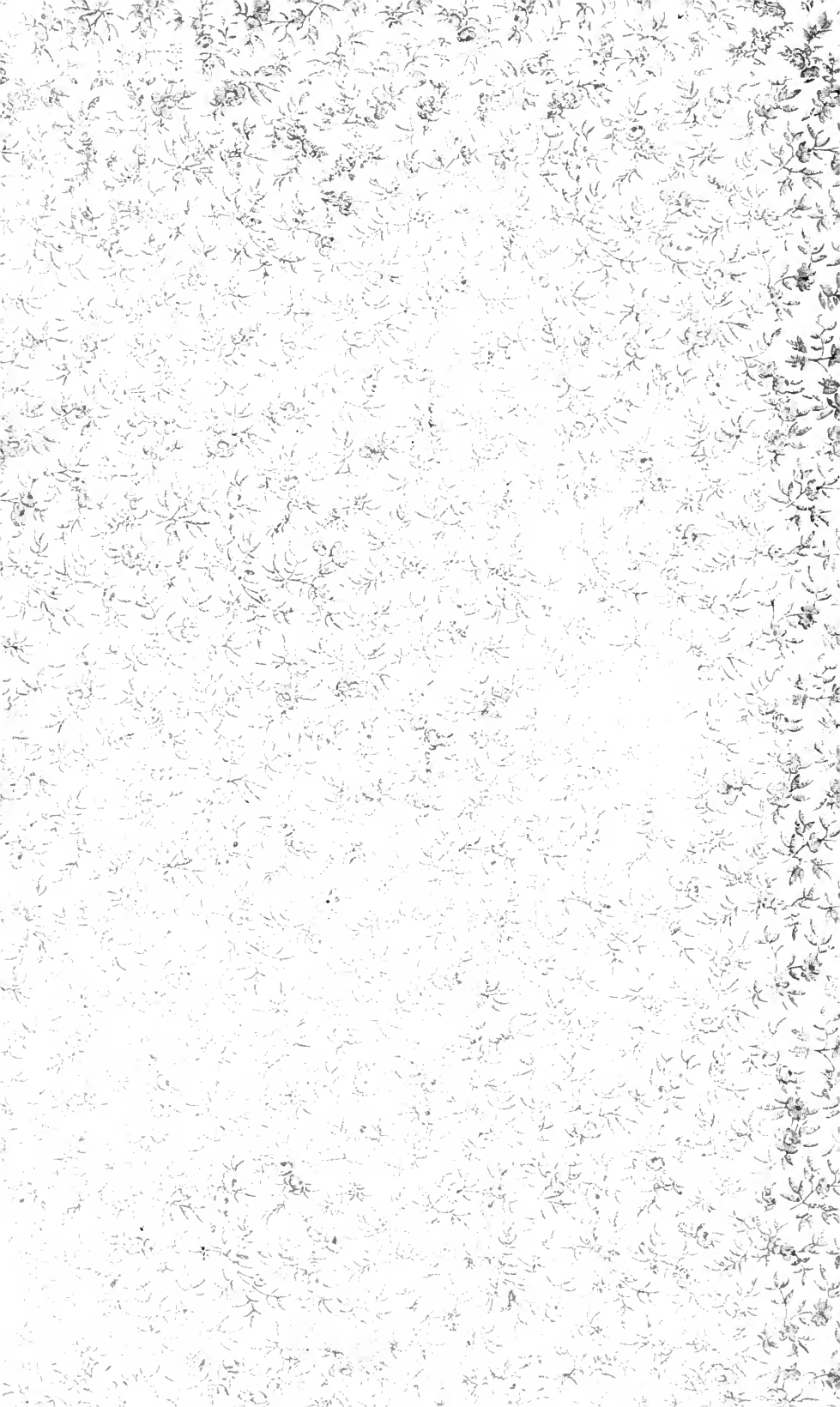












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