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The Russian Thistle in California.

MAY, 1895.

By CHARLES H. SHINN, Inspector of Experiment Stations.



RUSSIAN THISTLE, LOOSELY BRANCHED.

Prepared and printed at request of the Board of Regents.

BOTANY OF THE RUSSIAN THISTLE.

(See Plate.)

Detailed figures of the Russian thistle: Fig. *a*, branch of mature plant, natural size; *b*, seedling about two weeks after germination, natural size; *c*, flower detached from the axil and remaining suspended by minute hairs, in the ordinary inverted position on a rolling plant, enlarged three diameters; *d*, flower viewed from above and in front, showing the calyx lobes connivent into a cone-shaped body, and the large, membranaceous, spreading wings, enlarged three diameters; *e*, seed with flower parts removed, enlarged five diameters; *f*, embryo removed from the seed, enlarged seven diameters. (This cut, as well as that upon the cover, was furnished by the Agricultural Department, Washington.)



RUSSIAN THISTLE—Detailed Figures.

THE RUSSIAN THISTLE IN CALIFORNIA.

Comparatively small modifications in the structure, habits and environment of a plant are capable of changing it from a harmless dweller by the wayside to a most aggressive enemy of the agriculturist. The law of evolution holds in the case of weeds as certainly as with flowers and fruit; Nature is producing new varieties of our common garden weeds which every now and then appear, and temporarily conquer wide territories of cultivated land. The so-called Russian thistle, or Russian cactus, poetically called by the Russian *moujiks*, "the wind witch" belongs to the class of "tumble-weeds" and furnishes an excellent illustration of these dangerous modifications in plant structure.

When we look for the parentage of this Russian "tumble-weed" we find that there is a common salt-wort, *Salsola kali*, known since early settlement along the Atlantic sea-coast, and described by Linnæus as growing in eastern Europe. The *Salsola* does not spread rapidly, and has never developed dangerous qualities as a weed, so far as studied in its normal form. But a sub-species or variety,—botanists have hardly determined which to call it,—seems to have been developed in the course of centuries on the immense plains of Russia and Siberia. This sub-species, slowly adapting itself to its environment, and struggling for life with other native plants of the desert and the "black-lands," became the *Salsola kali tragus*, the so-called Russian thistle of to-day, a weed whose eradication now taxes the best energies of the American farmer in Dakota.

The *Salsola* belongs to the *Chenopodiaceæ* family. Among its relations are several species of *Atriplex*, shrubby plants of the desert; the pig-weed, *Chenopodium*; the grease-wood, *Sarcobatus*; and another rolling weed, *Cycloloma atriplicifolia*. Botanically, therefore, it belongs with some of the worst weeds known to agriculture. It is an herbaceous annual, diffusely branching from the base and forming, under favorable conditions, a round, firm head, from one and a half to three feet high and twice as broad. Its growth is extremely rapid and the plant hardens so as to be quite thorny as early as August. Like the common tumble-weeds of California and the Middle West, the season of rolling is in the fall, when the action of the wind causes the root to break at the surface of the ground, and the plant is blown about over many miles of territory and often for many successive weeks. The seeds are held in place in the axils of the bracts, by two minute tufts of coiled hairs, which prevent them from falling all at once. A large, mature plant will sometimes bear from 100,000 to 200,000 seeds, and the method in which these seeds are borne, as explained above, distributes them over an immense area. The popular literature of the subject is full of stories which illustrate this point. In one instance a farmer is said to have labeled a Russian thistle and twenty-four hours afterward the plant was discovered sixty miles away!

TECHNICAL DESCRIPTION.—The United States Department of Agriculture, Division of Botany, Bulletin No. 15, (1894) publishes the following technical description as drawn by Professor L. H. Dewey:

"*Salsola kali tragus* (L.) Moq. in D. C. Prod. XIII, 2, 187, (1849). Herbaceous annual, smooth or slightly puberulent; tap root dull white, slightly twisted near the crown;

leaves alternate, sessile; those of the young plant deciduous, succulent, linear or subterete, 3 to 6 cm. (one to two inches) long, spine pointed, and with narrow, denticulate membranaceous margins near the base; leaves of the mature plant persistent, each subtending to leaf-like bracts and a flower at intervals of 2 to 10 mm. (about one-twelfth to five-twelfths of an inch), rigid, narrowly ovate, often denticulate near the base, spine-pointed, usually striped with red like the branches, 6 to 10 mm. (three-twelfths to five-twelfths of an inch) long; bracts, divergent like the leaves of the mature plant in size and form; flowers solitary and sessile, perfect, apetalous, about 10 mm. (five-twelfths of an inch) in diameter; calyx membranaceous, persistent, inclosing the depressed fruit, usually rose-colored, gamosepalous, cleft nearly to the base into five unequal divisions about 4 mm. (one-sixth of an inch) long, the upper one broadest, bearing on each margin near the base a minute tuft of very slender coiled hairs, the two nearest the subtending leaf next in size, and the lateral ones narrow, each with a beak-like, connivent apex, and bearing mid-way on the back a membranaceous striate, erose-margined horizontal wing about 2 mm. (one-twelfth of an inch) long, the upper and two lower wings much broader than the lateral ones; stamens five, about equaling the calyx lobe; pistil simple; styles two, slender, about 1 mm. (one-twenty-fifth of an inch) long; seed one, obconical, depressed, nearly 2 mm. in diameter, dull gray or green, exalbumenous, the thin seed-coat closely covering the spirally-coiled embryo; embryo green, slender, about 12 mm. long when uncoiled, with two linear, subterete cotyledons."

INTRODUCTION INTO THE UNITED STATES.—For many years the thistle has been a destructive weed in the barley, wheat and flax fields of Russia. It is even said that large areas near the Caspian Sea have been abandoned to this weed, which is continually extending to new territory. In 1873, some impure flax-seed brought from Russia and sold in Scotland township, Bon Homme county, South Dakota, contained seeds of this dangerous tumbleweed. A map compiled by the Agricultural Department in 1894, affords an easy means of tracing its gradual extension from Bon Homme. It seems to have taken it nearly ten years for it to extend over the adjacent counties of Yankton, Douglas, Davison, Hutchinson, Hanson and Aurora. Probably during this decade it really obtained foothold in a small way over the larger part of North and South Dakota, but it hardly excited much serious alarm until 1880. After 1884, its advance was much more rapid, and by the close of that decade (1884-94), it was causing extensive damage over half the area of the Dakotas, and was recognized as rapidly gaining possession of the other half. Following along the lines of travel, and carried downward by irrigation ditches, it had appeared in many widely-isolated spots, each one of which was a new center of infection. It was already recognized as extremely dangerous in Minnesota, Wisconsin, Iowa, Nebraska, Illinois, Ohio and Colorado. It had reached the British line on the north, Kansas on the south, and Oregon on the west. The Government reports from which these facts have been obtained state that "the rapidity with which the thistle has spread, both in infecting new territories, and in thoroughly covering that already infected, far exceeds that of any weed known in America. Throughout about 25,000 square miles it is very troublesome, and is causing a large amount of damage." Other official reports place the losses of the wheat farmers of Dakota from this cause in 1894 at over two million dollars, a sum nearly equal to their annual State and county taxes.

The local distribution of the Russian thistle is chiefly by means of the winds. When the ground is hard, the light round masses, as previously noted, are driven for miles, scattering seeds along their track. Gusts of wind beat them back and forth, covering all the intermediate areas and sometimes the light seeds are blown from place to place independently. But this local distribution would not of itself have brought the weed to California for many years to come. The seeds are sent abroad in badly cleaned cereals, flax and other field crops, although they are small, and so easily separated, that only gross carelessness can cause much danger from this source. The seeds, however, are more often carried long distances in the bedding and litter of stock cars, or in crevices in freight or machinery packed on flat cars. Emigrants may also convey such seeds over considerable areas in the feed of their animals, and in their wagons. A moment's

thought will suggest almost an infinite number of methods by which such seeds can be disseminated, and carried from one part of the country to another in a very brief space of time.

INJURY CAUSED BY THE PLANTS.—Like any other weeds, the thistle, when quite small, is often eaten by stock, especially sheep, but this is for so short a period in the flush of spring when grass is abundant that its value as a forage plant is not worth considering. Whenever it becomes established it excludes all other plants and draws much nourishment from the soil. In this it is like all other weeds, but it increases more rapidly, hence taking more space than others, and it seldom decays on the ground where it grows. In fields of hay and wheat it pushes up into long, straggling stems which can not blow over the country, but which ripen very early in the season, greatly lessening the value of the crop, or sometimes entirely ruining it. The stiff, thorny weeds make it hard to run harvesting machinery, and very much annoy both horses and men. The plant thrives on high, dry soil, and will also grow on strong alkali. In fact it is difficult to mention any kind of soil unsuitable to the Russian thistle. The injury done in cultivated crops is less than in wheat fields, because the thistle is easily killed by cultivation. But the recognized presence of the thistle in California should put an end forever to the system of slovenly summer fallows which one so often sees. Unless summer-fallowed land is kept free from weeds all the season, one cannot be sure of having a clean grain plot the following year.

STATION LITERATURE ON THE SUBJECT.—The first official report respecting this tumble-weed thistle in America was in 1891 (Report of the Secretary of Agriculture). Therein the plant was described; early fall plowing was recommended as a check to its progress, and State legislation was suggested. A bulletin was published in 1892, and a more complete one, with maps and illustrations, appeared in 1894, portions of which have been largely republished, and plates from which appear in the present bulletin. Meanwhile other students were in the field. Professor Bessey, of the Nebraska Station, published a bulletin in 1893 on the Russian thistle in that State, and Professor Bolley published another, from the North Dakota Experiment Station. Professor Goff issued two bulletins from the Wisconsin Experiment Station. In July last year the Minnesota Experiment Station issued an extremely practical bulletin, and in September the Colorado Experiment Station at Fort Collins followed with another well-illustrated bulletin. The Ohio Experiment Station, in October, issued a bulletin on the thistle in that State, describing its entry from the West, and saying that it had obtained foothold in but one county, but was rapidly spreading to others. The Iowa State Agricultural Society, the leading newspapers of the Northwest and numbers of private individuals have been publishing articles upon the enemy, and sometime last year the Oregon Experiment Station issued a bulletin. Last winter a bill was introduced into Congress providing for an appropriation of a million dollars to destroy the thistle, and Congressman Hansbrough spoke in its favor, as noted in volume 26 of the Congressional Record, but the opinion prevailed that it was better to depend upon the townships, counties and States more directly interested.

One of the most graphic papers upon the subject is a brief memorandum by Professor Budd, of Ames, Iowa, upon the "*Russian Thistle in Its Native Home.*" He quotes from Professor Henfrey's book, "*The Vegetation of Europe, Its Condition and Causes,*" as follows: "On the steppes east of the Volga one curious thorny plant has attracted the attention of most travelers, the 'Wind Witch,' or 'Leap the Field.' It forms a large, globular mass of light, wiry branches interlaced together, and in autumn decays off at the roots, the upper part drying. It is then at the mercy of the

autumn blasts, and thousands of them may be seen coursing over the steppes, rolling, dancing and leaping, often looking at a distance like a troop of wild horses. It is not uncommon for twenty or more to become entangled into a mass and roll away like a huge giant in seven-league boots." Professor Budd says that east of the Volga, and south of the Caspian, he met with it everywhere. In the fields of cereals it was not regarded as specially troublesome, quite contrary to American experience, because the Russian varieties of grain appear to tiller out more than with us, and are sowed very early and thickly, so that the thistle plants are said to make little progress. In this region are found vast alkali tracts which are used for pasturage, and here the thistle is found mingled with wormwoods, sages, mulleins, true desert thistles, and a multitude of other plants. West of the Volga, in the black soil section, the plant was found everywhere, but none were permitted to ripen along the railways or roadsides. The officials enforced very stringent enactments, and have so far protected the immense sugar-beet fields. In southeast Orel and Kiev the sandy and the heavy clay soils are alike said to be overrun with the Russian thistle. Professor Budd thinks that it is a comparatively harmless annual as managed in most parts of Russia, but he recognizes the fact that it is a far more serious pest in the United States, where people will not accept the severe legislation of East Europe. He says: "It will spread over the unfenced pastures more rapidly than any weed yet introduced, but in fenced regions it will not in the end prove as serious a pest as the Canada thistle." The worst danger point, he thinks, will be the alkaline plains of the Northwest and West. This may be considered as a timely warning to the people of the San Joaquin and Sacramento valleys.

A brief paper by Professor Bolley, published in March of the present year in Bulletin No. 17 of the North Dakota Experiment Station, gives the results of experiments about the distribution of weed-seed by the winter winds. He says, in speaking of the thistle, that those who advocate the use of hedges or fences to stop its further encroachments have in mind only the rolling character of the weed. All weeds, if allowed to mature, are distributed to some extent by the winter winds, as nearly all are provided with special appliances, such as vanes, lint or light pods, which assist in their dissemination. Professor Bolley measured the surface of an early winter snow-drift on plowed ground ten rods from any standing weeds. The snow was three inches deep. Two square feet of this drift contained thirty-two seeds, representing nine species. In another experiment he poured one peck of mixed seed upon the crusted snow when a wind was blowing at the rate of twenty miles an hour. Thirty rods distant, at right angles, a three-inch trench in the snow served to catch drifting seed. In ten minutes many seeds of all species represented were in the trench, and the lighter seeds had been carried over it. Many similar experiments were carried on, and the conclusion reached was that weed-seed of almost any size, especially the thistle, traveled for miles with drifting snow and were buried in the soil when the snow melted. If the thistle is ever disseminated in the more alpine regions of California, the same method of distribution will be dangerous here. It must also be remembered that seeds will be very easily blown long distances over the hard surface of our plains in the autumn, before the early rains cause the growth of vegetation.

REPRESSIVE LEGISLATION ELSEWHERE.—The weed laws of the several States are seldom well enforced, but perhaps the best laws regarding the Russian thistle are those passed by the Legislatures of the States of North and South Dakota in 1890 and 1891, and still in operation. Similar provisions if placed on the statute books of California, and carried out in every county where the thistle appears, would soon bring it under control. During the two years which must elapse before the next session of the Legislature, the

only remedy in California is to be found in prompt action by county supervisors and local associations.

The South Dakota law provides that "Every person and every corporation shall destroy on all lands which he or it may occupy all weeds of the kind known as Russian thistle, Canada thistle and cocklebur at such time as the township Board of Supervisors or the Board of County Commissioners may direct." The time chosen and the method of destroying weeds is to be in such a manner as to "prevent their bearing seed." Every road overseer is to destroy such noxious weeds on the highways, also upon adjacent unoccupied land neglected by the owners, and the cost of the latter service is to become a lien against the land.

Any land-owner or lessee of land or county or township supervisor or overseers failing to comply with the requirements of the law shall suffer various fines and penalties, said fines going to the general fund of the county in which action is brought by the State or District Attorney.

The laws of North Dakota apply to mustard, wild oats (*Avena fatua*), "French weeds" (*Thlaspi arvense*), as well as the Russian thistle, Canada thistle and cocklebur. Each Board of County Commissioners are ordered to declare the time and manner of destroying noxious weeds at their regular meetings in April each year, and their rules shall be published in the newspapers or posted as election notices are posted. In case of neglect or refusal to destroy these weeds on the part of any individual, firm or corporation owning or occupying land, it shall be the duty of the road officers, after ten days, to destroy the same, and the expense becomes a separate tax against the land, to be made a part of the next tax-roll. The neglect or refusal of any road officer to perform this work subjects him to a fine of fifty dollars.

The laws in Ohio are very complete. An act of February 17, 1884, imposes a fine of twenty dollars upon any dealer who knowingly sells impure seed, and a similar fine is imposed on "whoever, being the owner, occupier or possessor of any land," suffers weed-seed to ripen thereon or on the highway adjoining the same. Another Ohio act of April 29, 1885, gives the township trustees power to destroy noxious weeds, and the cost is collected from the owners as a tax, while the trustees receive one dollar a day for their supervision. A much more complete statute, passed April 25, 1893, requires the superintendent of roads, county supervisors and street commissioners to destroy "all brush, briars, Canada or common thistles, or other noxious weeds" within their jurisdiction, for a fortnight in each of the three months of June, August and September of each year. Any farmer who destroys such weeds on the highway fronting his ground shall be allowed a reasonable compensation credited on his tax-list. Any road company who fails to do this work shall be liable for the costs, together with one hundred per cent penalty together with the cost of action. Similar provisions extend to cities and incorporated villages.

CALIFORNIA LEGISLATION.—There are no laws in California which apply by name to the Russian thistle, but there are laws under which the weeds can be eradicated. The first California act aimed at any noxious weed was that of March 2, 1872, which, curiously enough, applied only to Scotch, or Canada, thistle in the counties of Humboldt, Siskiyou, Klamath, Del Norte and Alameda. The act made it unlawful for any land-owner to permit seed to ripen or to be scattered abroad, or to knowingly sell any seed or grain containing thistle seed. It imposed a fine of a hundred dollars for any violation, and the same fine upon road overseers who allowed the thistle to mature along the highways.

Section 28 of the County Government Act of March 14, 1883, also reaffirmed by the act of March 31, 1891, and again in 1893, ordains that supervisors have the power to provide for the destruction of gophers, squirrels,

other wild animals, noxious weeds, and insects injurious to fruit-trees. This is the law under which work must be done at the present time wherever the thistle appears outside of incorporated towns. It is sufficient to authorize extensive and well-considered expenditures of public funds in every county of California, and it is the law under which the supervisors of Los Angeles county have felt themselves justified in spending money in the Lancaster District. The term "noxious weeds" is better in this case than the long list of names of weeds incorporated in the laws of some of the other States, because as long as this law remains in force every new weed that appears can be fought at once, instead of waiting for especial enactment.

A letter received May 2nd from Lancaster states that the Assistant District Attorney of Los Angeles doubts whether the county has a right to spend money to destroy weeds except on public roads and in parks. If this view is sustained by the courts, the result will be disastrous in many districts, but the intention of the County Government Act of 1893, which is still in force, appears very plain, and if any difficulty is going to be made, the matter should be taken to the higher court by the County Horticultural Commissioner or by any public spirited citizen. Any one who reads the law will note that reference is made in the same clause to noxious weeds and to insects injurious to orchards. Fruit trees certainly are seldom or never found in the public highway, and if the law does not limit the power of the supervisors in this respect, it is difficult to see how it can be limited in regard to noxious weeds.

Within incorporated towns, the California Act of March 11th, 1893, is in operation. This act provides for the planting and caring for shade trees in towns, and for the eradication of weeds therein. It provides that the city council or trustees of any municipality "may condemn as public nuisances any and all weeds whose seeds are of a winged or downy nature, and are spread by the winds," and they may compel the eradication of such weeds by the owners of any lot upon which they grow, or may charge the expense against said owner. This law also will be of great service although it is probable that stronger penalties should be attached, not only in the case of municipalities, but in the law defining the powers of supervisors in this regard. It is plain, however, that there need be no difficulty in finding laws under which to organize co-operative efforts to destroy the Russian thistle.

APPEARANCE IN CALIFORNIA.—It has been known for some time that the thistle had obtained a foothold in California, and energetic efforts have been made to destroy it. A sample of the weed was exhibited at the Fruit Growers' Convention at Sacramento last November, and excited a good deal of interest. This led to correspondence with the United States Department of Agriculture. The following letter from one of the Government botanists contains a good deal of practical information :

UNITED STATES DEPARTMENT OF AGRICULTURE, }
DIVISION OF BOTANY,
WASHINGTON, D. C., January 25, 1885. }

Prof. E. W. Hilgard, Director Agricultural Experiment Station, Berkeley, California:

DEAR SIR: During the past two weeks the Division of Botany has obtained two specimens of the Russian thistle from Lancaster, Los Angeles county, California. These specimens confirm the report previously received that this dangerous weed had been introduced at that place. It is said to be distributed over an area of about ten miles long and four or five miles wide in the desert about Lancaster, and to be most abundant about the station of Lancaster where there is water.

The nature of the surroundings are such that it can do but little harm where it is at present. Even if allowed to obtain a foothold, it might not become more troublesome than some of the worst weeds you have at present. Its behavior in the irrigated lands in Colorado and in southern Idaho indicated, however, that if allowed to spread, it will quickly take rank with your most troublesome weeds and will prove itself an evil worthy of vigorous repressive measures. In its present condition extermination seems possible and even practicable. If allowed to spread, as it is certain to do within two

years if left undisturbed, extermination will be practically impossible and a continuous war for subjugation will have to be waged against it as is now the case with this plant in the Dakotas, and with ragweed, ox-eye daisy and wild carrot in the east. Statements have been made that the Russian thistle will not thrive on well watered and well tilled farms. My own observations of this plant lead me to think that it will thrive in such situations as well and even better than in dry or sterile soil, and that if once allowed a foothold on such farms, it is likely to prove as troublesome as any of our annual weeds.

Very truly yours,

L. H. DEWEY, Assistant Botanist.

A second letter from Mr. Dewey, under date of February 23rd, adds that: "Information has been received chiefly from Mr. John Scott, Commissioner of Horticulture, Los Angeles, and from Mr. Abbu Dunning, postmaster at Lancaster. A letter just received from Mr. Scott states that he has unconfirmed reports of the Russian thistle south of Tulare City and also between Pixley and Tipton. Mr. A. H. Leckenby, of Bakersfield, writes that the Russian thistle has been reported as growing in Kern county, but as yet he has been unable to verify the report." If the thistle is indeed established south of Tulare City, it must be some distance outside of the town limits, as on April 6th the writer, together with Mr. Julius Forrer, foreman of the Experiment Station near Tulare, made a careful examination of the railroad tracks, ditches and roadsides in and around the town without discovering a single specimen of this obnoxious weed. Later in the season it will be much easier to discover any thistle plants.

While corresponding with the Department at Washington it was ascertained that Mr. W. S. Melick, proprietor of the Lancaster *Gazette*, quite an extensive land owner in Antelope Valley, was especially well posted upon the subject, and he placed himself at the service of the Experiment Station.

Under date of February 10th, Mr. Melick wrote, "You can do nothing studying the Russian thistle until later. It has not begun to grow yet. About April or May would be the time to see it here. Our altitude makes all crops late. There is no doubt but that this is the true Russian thistle. It has been here four or five years, but it has not spread much. This is a desert town surrounded by sage brush, so the thistles which grow get lodged in the sage brush and do not travel far.

"By the advice of Horticultural Commissioner Scott, under the Board of Supervisors, all last year's crop has been burned. As the land about Lancaster is not farmed much, few farmers are bothered with it as yet. I think the only way to get rid of it is by prompt, vigilant action of Boards of Supervisors or the State authorities."

VISIT TO ANTELOPE VALLEY.—In accordance with Mr. Melick's suggestion, the writer waited until some growth had been made before visiting the infected district. April 3d and 4th was spent in the town of Lancaster and its immediate vicinity. The area over which the weed to some extent prevails extends over about eleven sections of land. As noted by Mr. Melick, it first appeared in the streets of the town near the railroad track, several years ago, probably brought in by cattle cars, as there is very little immigration by wagons across that district. The weed naturally attracted little attention at first, but by last year it excited a good deal of alarm, and Mr. Melick and others began to organize public work. The County Supervisors wisely agreed to spend some money, and men have worked more or less during the last winter burning the old weeds, and are now harrowing under the young plants wherever they appear. About \$400 has been spent in this manner. It is hardly necessary to say that this work merits the approval and hearty support of every citizen and newspaper in Los Angeles county. If the expenditure of ten thousand dollars would utterly destroy the Russian thistle in the Antelope Valley, it would be a good investment.

The country which may be termed the present headquarters of the Rus-

sian thistle in California, is a level plain of rich, sandy soil in the southern portion of the famous artesian belt of Antelope Valley. Antelope Valley lies along the borders of Kern, south of the Tehachipi, and north of the La Liebre Mountains. It contains 1100 square miles of territory, and has an average elevation of 2600 feet. Although the rainfall is light, the valley contains a number of colonies irrigated from streams and reservoirs, a famous grain belt of seventy thousand acres lying along the southwestern hills, and the artesian belt to which I have already referred. A large area is undoubtedly incapable of irrigation, and receives too little rain to make it reclaimable. If the Russian thistle extends over these waste and barren sections along the middle of the valley and extending east into the Mojave and the Colorado deserts, or if it escapes into the mountain canyons, its entire destruction will become impossible. But it can certainly be conquered in all the colonies and plow-lands. It can also be choked out in every well-grown alfalfa field.

The first offshoot from the original thistle colony has already appeared about ten miles west, in sections 25 and 25, township 7, range 14. This is in the edge of the grain belt, and unless destroyed the thistle will soon appear along the whole line of the foothills. The wheat grown here is of the finest quality, and much of it is hauled out through the Tejon Pass. It is also shipped to Los Angeles and other points along the railroad. If every farmer takes pains to plant only clean seed, and if the rolling weeds are destroyed, this small colony will soon disappear under close cultivation. But directly west lie the pastured foothills and the mountains that surround Elizabeth Lake. There is, therefore, extreme danger that the weed may soon become naturalized in this thinly settled mountain region, which extends all the way to Ventura. Immediate action is therefore necessary.

Returning to the original thistle colony, at Lancaster, the artesian belt covers about eighty-eight square miles, and already contains eighty-three flowing wells. But these are scattered, the region being still thinly settled, and one often finds a few acres of alfalfa, grain or orchard surrounded by native desert. The sagebrush, and other shrubby growths standing up on little mounds of sand and the belts of tree yuccas, have served the excellent purpose of preventing the thistle-heads from moving far or rapidly, even under the wildest gales. Perhaps from this reason the thistle seems very thickly sown in some portions of the infected district. There are places in the streets of the town where the slender, reddish leaves of the plant, much resembling a young pine, almost cover the ground. It is very easily destroyed, however, with harrow or cultivator. The well-grown alfalfa fields seem to be little troubled, but where there is a poor stand the thistle is coming up. Excellent work has been done by the employees of the county supervisors, and it is now difficult to find a single specimen of last year's weeds. In the town itself all the young plants can easily be reached and destroyed. On the uncultivated territory the case is much more difficult.

Another letter received from Mr. Melick early in May encloses samples of the thistle after about six weeks' growth. They have begun to branch strongly, are about six inches high, and becoming too hard for even sheep to nibble. Mr. Melick says the young plants are extremely abundant, but can be very destroyed between now and the first of August. He thinks six hundred dollars spent now would ensure the destruction of every plant in the valley, but he says there ought to be no delay, for it is spreading. The weed has now been found along the Armagosa Creek wash, which extends from Lancaster south along the railroad for about five miles, and then stretches off in a southwesterly direction to the Leonis Valley in township 5 N., range 13 W. The late rains have caused unusual growth, and there is no time to lose if Los Angeles county is going to protect the colony dis-

tricts. As Mr. Melick aptly says, "A public sentiment will have to be created."

DISTRIBUTION FROM ANTELOPE VALLEY.—At first thought Antelope Valley appears to be some distance from main lines of travel, and a point from which distribution will be slow and difficult. On the contrary, few points in the State are more immediately dangerous. There is a strong probability that the thistle has already been carried southward along the line of the railroad into San Fernando Valley, and the branch railread from that point affords easy access to Ventura and Santa Barbara. In a very short time, unless controlled, the weed will move eastward to the line of the Atlantic and Pacific, and northward into the San Joaquin. In fact, it has already crossed the Tehachipi range, and has made its appearance in Kern county. A letter received from Mr. G. F. Weeks, editor of the *Daily Californian* of Bakersfield, says: "It is growing here, from seed evidently scattered from cars that have come through Nebraska or some other infected section, as at present it is only found along the railroad tracks." As previously explained, however, the thistle may have reached Kern county by way of the Tejon Pass, through which there is a great deal of travel to and from the Antelope Valley, but it is evident that the same cause which once brought the weed to California is likely to continue in force, and we may expect it to appear in many parts of the State. Judging from the experience of South Dakota, it is probably already growing unsuspected by many a roadside and in many a pasture.

During the present season every effort should be made to locate the various points of affection in both northern and southern California, and determine their areas. The only dependence in the determined warfare that must now be made must be upon thorough local organization. If farmers will destroy the weed upon cultivated land, and if the county authorities will destroy it by the roadsides and over uncultivated places, the railroads and other corporations will probably be willing to do their share. The railroad companies, irrigation companies and similar corporations have a large interest in the matter, but the whole community must be aroused, or the work will not be done.

SUGGESTED REMEDIES.—Since the plant is an annual it is easily killed during the growing season. For three months from the time it sprouts no good farmer need be afraid of it, but, according to Dakota experience, concerted action is necessary. The fundamental principle of the conflict must be: *No Russian thistle should be allowed to produce seed.*

The vitality of the seed, as compared with other annuals, appears to be low. The conditions affecting seed vitality are moisture and heat. The seeds of this plant crack, and the germ is destroyed by a low degree of dry heat, hence when stubble and pasture fields are burned over in the autumn the larger part of the thistle seed will be kept from germinating.

The tap-root will not sprout again when cut at the surface, and if the plants are plowed under they perish as easily as mallows. In orchards, vineyards, beet-fields, and all lands devoted to hoed crops, there should be no trouble, with respectable cultivation. But if a farmer stops at the limits of his cultivated land, he must do the same work every year. Fence-corners, creek-borders, and waste places of every description, must receive the same attention, or the Russian thistle will again seed the fields. The slipshod cultivation so often seen even in the most fertile parts of California, and perhaps endurable with less aggressive weeds, though never advisable, or profitable, becomes entirely impracticable after the Russian thistle once obtains foothold.

The Minnesota Experiment Station bulletin lays great stress on upon

the use of what is called the "green-manure fallow" in cultivated lands. Modified to suit California conditions, this means to plow shallow with the first rains, and sow bur-clover or some similar crop, to plow under, with the young thistles, for a green crop fertilizer. After the last plowing one must go over the field and hoe out any stray plant.

If the thistle is found in grain fields it would be better to cut for hay as early as possible and plow the stubble under, without waiting for the aftermath. A second plowing may also be necessary. In most sections this system will clear the grain fields in two seasons, if no seeds are allowed to blow into the fields.

As soon as the grain crop is harvested the stubble and weeds should be burned in every case where the thistle has appeared. In our dry climate this is always easy, and it has been suggested that the use of a header, as leaving a greater amount of stubble, furnishes the material for more thorough burning. Especial attention should be paid to any patches in the grain fields where a poor stand of grain has allowed the thistle to develop into large "tumblers."

Well-graded highways are easily kept clean by dressings with a reversible road machine, and by vigorous use of the hoe on the narrow borders. Wide, unutilized road-spaces are difficult to deal with, and often will have to be plowed and cultivated. Attention should be paid to the road ditches, whose sides should be so sloping that they can easily be cleaned from top to bottom. Along infested highways the cultivation should extend to the wheel-tracks. The scythe seldom cuts low enough, as the thistle branches so close to the ground that many seeds will be left. Burning is preferable, or the hoe. Professor Bolley says: "A small force of workmen is sufficient to destroy all the weeds upon road margins of the worst infested townships. A foreman on horseback constantly inspecting the work of a dozen men can rapidly get over the country."

In order to prevent the large weeds from rolling, the Russians plant belts of sunflowers which stop the plants, collecting them in high banks, and they are then burned. Belts of trees, or any other windbreaks, answer the same purpose, as do fences, excepting that the weeds must be raked back so as not to injure trees or fence when fire is set. This, of course, is expensive, on a large scale, and there is no doubt that the time to fight the thistle is when it can still be plowed under. In Dakota the farmers harness ten or twelve horses by long ropes to immense bars of wood, and drag very large piles of the weeds into heaps to burn. Any work of this kind should be followed by burning the stubble, and by two plowings before another crop. Our system of managing orchards gives us every advantage.

In cities, towns and villages special care is needed, not only on the streets and sidewalks, but upon all the unoccupied lots. In California, as in the Northwest, the points of infection usually begin at or near the railroad station, and the townspeople and merchants should make stringent regulations to suppress the thistle at its first appearance, and not allow it to escape into the farming country to lessen the value of town property. The owners of lots should combine and break up every neglected piece of ground, sowing it to alfalfa, or, where water cannot be obtained, to such a plant as the Australian salt bush (*Atriplex semibaccatum*.) It is needless to say that this would make our towns and villages look much neater. A town ordinance could tax non-residents for such necessary improvements, and town trustees have the power to pass such an ordinance.

When the Department of Agriculture sent out circular letters for information, one question read "In what manner was the Russian thistle introduced?" The bulk of the answers were "By the wind," and "In impure seed." Considering the second cause, it may be said that many small

threshers do not thoroughly clean the grain, and thistle seeds, or pieces of stem containing seeds, may easily find their way into the sacks and be sowed again the following season. Poor (or careless) farmers who buy cheap grades of seed grain, or flax, or clover, or millet, may obtain a liberal stand of thistles without extra charge. The papery flower-parts of a thistle seed often adhere even after passing through a threshing machine, so the mass varies considerably, from naked seeds as large as a clover and about half as heavy, to pieces the size of a melon seed. If the fans are properly adjusted, thistle seeds can be blown out even from flax or clover, but it is much more difficult to separate them from grains of millet. Fortunately, the California farmers do not grow millet extensively, but we raise a good deal of flax for oil, and the coast districts devoted to that crop should pay special attention to the subject of sowing only clean seed.

SOME GENERAL CONSIDERATIONS.—From the preceding pages, the reader will conclude that while the Russian thistle is dangerous, it can be conquered by persistent work. Many other weeds when well established furnish more trying problems to the individual farmer. The small morning glory, or wild convolvulus, of our rich bottom-lands is infinitely harder to destroy.

We may classify all weeds from the cultural standpoint as either annuals, biennials, perennials with underground, creeping root-stocks, and perennials without creeping rootstocks (rootstocks are underground stems with buds). In order to know how to fight a dangerous weed it is first necessary to study its root system and method of propagation, and then the proper measures to exterminate the weed can readily be ascertained. To some extent these classes intermingle; a weed which is an annual in one country, owing to climatic conditions, may be a biennial or a perennial in another country; but the root system offers a more stable basis of comparison. The annuals can be again divided into those which ordinarily live and die in the same place, and those "tumble-weeds," such as the subject of this bulletin, which traverse a considerable region before their power for mischief has come to an end.

Decidedly the most troublesome class of ordinary weeds are those perennials with permanent roots, whether creeping or not. The ordinary species of *Rumex* (the common docks of our fields), the plantains, the ox-eye daisy (*Leucanthemum vulgare*), and the golden-rods, are illustrations of one type, while the wild morning-glory, the wild licorice (*Glycyrrhiza lepidota*), the Canada thistle and the ordinary mint have the horizontal rootstocks, which, as previously stated, are really creeping underground stems, every joint of which will make a new plant.

LINES OF FURTHER WORK.—Now that we know of the presence of the Russian thistle in California, and have the experience of other States to guide us, it should be our first duty to map out the areas of distribution, no matter how small. The Experiment Station invites farmers, land-owners, road overseers, supervisors, and all persons interested in the agricultural welfare of California, to send samples of weeds suspected to be the Russian thistle to the director, Professor E. W. Hilgard, for determination. We invite further correspondence on the subject, and in all cases where it seems advisable a representative of this department will go to any part of the State, either to identify and map out suspected infection centers, or to deliver a lecture to the people. By the close of this summer we ought to know fairly well whether the thistle has entered the State by way of Nevada and Oregon, in which case it is already in the Sierra foothills and in the Sacramento Valley. If the only colonies we now have are those extending from

Lancaster an energetic campaign ought to conquer the enemy. While devoting attention to the great interior valleys, however, we should not neglect to study the smaller coast valleys, where the use of impure seed may have already established unsuspected plantations. In short, it behooves us to examine every portion of the State, and there is no county whose supervisors should not be prepared to take active measures of self-defense.

