A STUDY OF POISONOUS DRYMARIA ON SOUTHERN NEW MEXICO RANGES

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Among the harmful plants that grow on clay (adobe) soils on ranges of southern New Mexico, the most poisonous for cattle are dwarf summer annuals of the species *Drymaria holosteoides* Bentham (*D. pachyphylla* Woot. and Standl.). Of more than a dozen species of *Drymaria* occurring in Central America, Mexico, and southwestern United States, members of only the species named are known to be toxic. These plants have been found in southern New Mexico, southwestern Texas, southeastern Arizona, and Mexico.

Because of the great number of deaths of range cattle caused by eating these poisonous plants, a study of them was made by the author in 1934 and 1935, with a view to determining feasible methods of eradication and how livestock losses might be reduced. These investigations were made at the Jornada Experimental Range, U. S. Forest Service, near Las Cruces, N. Mex.

Discovery of these plants as poisonous is recent. In 1922 a cooperative study of them was begun by the New Mexico Agricultural Experiment Station and the Bureau of Plant Industry, U. S. Department of Agriculture. Lantow ('29), of the former institution, demonstrated their extreme toxicity to cattle and sheep in feeding experiments from 1923 to 1927, and found all parts of the plants above ground to be poisonous at all stages of growth. Because of the unpalatability of the plants, forced feeding was necessary. Campbell ('31) showed poisonous drymaria to be a pioneer weed in plant succession on clay soils, and made germination tests of the seeds. Mathews ('33) conducted additional feeding experiments in southwestern Texas in 1932 and determined lethal doses. He reported that the plants caused death in a cow when they were eaten at the low rate of 0.4 per cent of body weight, in a sheep at 0.6 per cent, and in a goat at 0.97 per cent. The toxic principle has not been determined.

PLANT DESCRIPTION

Drymaria holosteoides was described by Bentham (1844) from specimens collected at Cape San Lucas, at the southern tip of Lower California, Mexico, during the voyage of the *Sulphur,* 1836–1842. The New Mexico and Texas plants of the genus *Drymaria* were considered distinct by Wooton and Stand-

[1] Maintained at Tucson, Ariz., by the Forest Service, U. S. Department of Agriculture, in cooperation with the University of Arizona.

ley ('13), who proposed the species name *D. pachyphylla,* which is here regarded as a synonym. The genus *Drymaria* is classed in the tribe Polycarpeae of the Caryophyllaceae.

Poisonous drymaria plants are small, whitish-green or glaucous, tender, glabrous, summer annuals (figs. 1 and 2). They grow only 1 to 3 inches high, and spread out in round clumps from 4 to 5 inches, sometimes to 10 inches, in diameter. Ranchmen identify these plants by an anthocyanin pigment in the immature seeds, which pigment gives the juice of green capsules a purple color. Superficially, the plants resemble the common chickweeds, *Stellaria media.*

The primary root of a drymaria seedling remains as the tap root of the mature plant. Usually the root system is shallow, only 2 to 4 inches in depth, and the tap root below 1 inch has many shorter, fibrous branches. There is no main, erect stem; but from a very short stem at the top of the tap root, from 10 to 20 or more procumbent or partly erect stems spread out in all directions and give the plant a round shape. At a distance of 1 to 2 inches or more, each branch ends in a node, with usually 4 ovate leaves, a cluster of axillary, white flowers one-eighth of an inch broad, and several branches which continue the growth of the plant. About 15 dull black, flattened seeds one twenty-fifth of an inch long are produced in each capsule. Usually a plant 4 inches in diameter with about 250 mature capsules produces as many as 3,750 seeds. The large number of seeds produced by a single plant is obviously an advantage for a desert annual, likewise an obstacle in eradication.

The Lower California plants differ from those of New Mexico in having much narrower, acutish leaves, puberulent pedicels, and slightly smaller seeds.

The microscopic anatomy of roots and stems of poisonous drymarias presents no unusual features but the leaf blade, which is small and succulent, has several xeromorphic characteristics which make the plants somewhat resistant to dry weather and to chemical sprays. It is rather thick (one-fiftieth inch) and compact, when viewed in cross section. On the epidermis of both upper and lower surfaces there is a slight cuticle and a deposit of wax. The palisade mesophyll is composed of two (in places three) distinct layers of compact, elongated cells. The spongy mesophyll, which is as thick as the palisade mesophyll, is also compact. In places the cells of spongy mesophyll are elongated and form two layers of palisade-like cells next to the lower epidermis. The compact leaf cells probably function in water storage as well as in photosynthesis. Stomata are present on both upper and lower surfaces; somewhat more on the upper.

Distribution and Habitat

Poisonous drymaria has been found in Reeves and Brewster Counties in the Trans-Pecos area of southwestern Texas, in at least nine counties in southern New Mexico, and in Cochise County of southeastern Arizona.

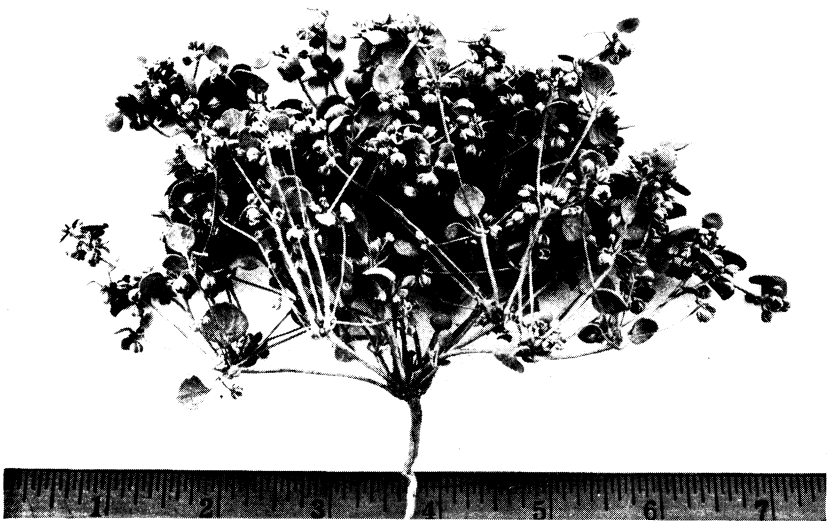

FIG. 1. A plant of the poisonous drymaria.

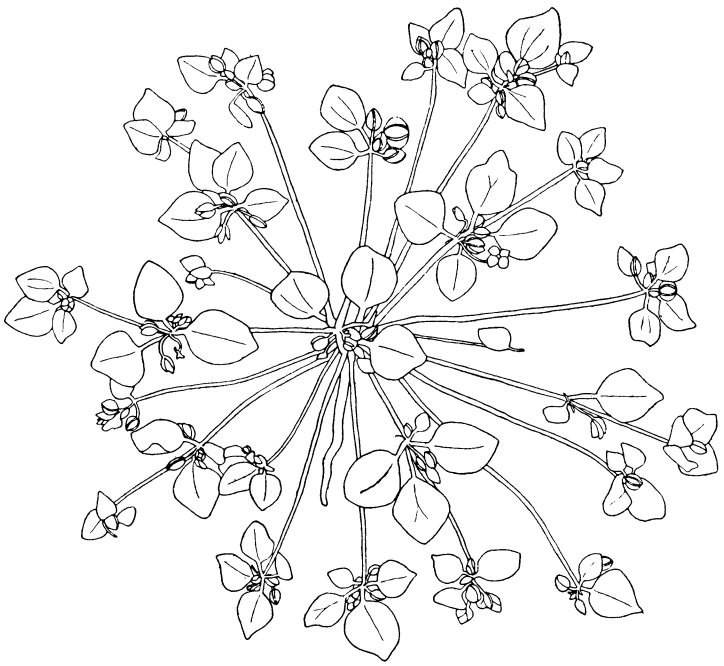

FIG. 2. The branching system of drymaria.

Livestock losses in New Mexico have been principally in: (1) Tularosa basin, which has no outside drainage, in Otero and Lincoln Counties, and (2) Jornada del Muerto plain east of Rio Grande in Dona Ana, Sierra, and Socorro Counties. They have been reported also from Lea, Eddy, Luna, and Hidalgo Counties, New Mexico.

Before it became known and conspicuous as harmful, poisonous drymaria was collected by botanists at only two places in the United States. The first, according to Robinson (Gray, 1897), was by V. Havard in August 1883, at Terlingua Creek, Brewster County, Texas. In New Mexico, E. O. Wooton collected specimens in 1897, 1899, and 1905, all in the same general locality south of White Sands and near Parkers Well, Dona Ana County. Wooton and Standley ('15) mentioned no additional records in their Flora of New Mexico. The absence of specimens in other early collections indicates that these native plants probably have increased in number and range during recent years. On the Jornada Experimental Range, where a Forest Service herbarium was started in 1915, the first record is a collection on an adjacent ranch, made in 1925.

Ranchmen in parts of southern New Mexico state that they found drymaria present and destructive to cattle when they came to their localities 20 or 25 years ago, but the absence of a common name indicates the unimportance of these plants in the past. According to cattlemen, poisonous drymaria is getting more abundant, is spreading to other ranches, and is causing greater losses.

Plants of the species *Drymaria holosteoides* occur in two distinct geographic divisions and in different habitats: (1) in the Chihuahua desert of southwestern Texas, southern New Mexico, southeastern Arizona, Coahuila, and Chihuahua, where they occur on bare adobe flats of plains at elevations of 3,000 to more than 5,000 feet, and (2) along the coasts of Lower California and Sonora, where they grow on subtropical sea beaches, but sometime at higher elevations. These widely separated environments are similar, in that ocean beaches and clay flats are bare, subject to flooding, and contain large quantities of salts. The southern New Mexico portion of the range is in the Lower Sonoran life-zone with semidesert shrub and grass vegetation.

In southern New Mexico poisonous drymaria is confined to areas of clay soils, including clay loams and occurs in shallow gullies and on broad flats where water collects. These soils have a reaction of pH 8 and more. As similar clay soils are common throughout the southwest, it is possible that these plants might spread over a much greater area of several states through dissemination by water, wind, and in mud on the feet of livestock. Ranchmen should be on guard to avoid introduction of seed, and to prevent establishment of these destructive plants in new localities.

Life History

The life history of poisonous drymaria is completed between the beginning of summer rains in July and the first killing frost in the autumn (Nov. 1, average for Jornada range). The annual precipitation at Jornada Experimental Range, a typical area within the range of these plants in southern New Mexico, is only 9.07 inches, of which about half falls during the summer growing season (July, August, and September) and half is fairly evenly distributed over the remaining 9 months. Being annuals and dependent on rainfall, these plants cannot avail themselves of the warm season after the last killing frost in the spring (Apr. 21, average date at Jornada range), because then the soils are dry.

Fig. 3. Seven stages in the development of drymaria seedlings, viewed from above and from the side, natural size.

Commonly, seeds of these plants germinate within a few days after the first heavy summer rain thoroughly wets the surface of clay flats and drainage channels. Rapid germination and growth are advantages in these locations, where soil moisture and humidity soon become unfavorably low. In places, seedlings become established in the cracks of clay soils, where the seeds obviously had been blown by wind. The depth at which germinating seeds are buried is usually one-fourth of an inch or less, but seeds covered as deep as one-half an inch may grow.

A series of drawings of seedlings (fig. 3) is shown to aid in recognition during early stages of growth. Floral buds appear very early, even by the time a plant has only 6 or 8 leaves and is less than half an inch high. Axillary buds develop into long prostrate branches. The plants shed mature seeds

within a month after germination, and continue to flower and produce quantities of seeds until killed by frost or drought. Seeds fall to the ground and remain around the base of the plants until blown by wind into soil cracks, or until carried by water or wind to distant places.

Length of life of poisonous drymaria in southern New Mexico varies from 1 to 5 months, depending on moisture and date of the first killing frost. A single heavy wetting or flooding of the clay flats may furnish enough water for germination, growth, storage of water in the leaves, and maturity of the seeds within a month. Plants continue to germinate and grow as more rain falls, until killing frost. Where the soils are drier, plants are smaller and growth is slower. The fact that these plants are not more widespread undoubtedly is due to the extreme dryness of their habitats during long periods annually.

During wet springs poisonous drymaria appears earlier and livestock losses start earlier than under dry conditions; but in dry summers, such as 1934, plants may be very scarce and short-lived, because of lack of water. The greatest livestock losses occur in late summer and early fall, when the plants are most abundant.

Place in Plant Succession

In connection with the possibility of eliminating poisonous drymaria through revegetation, its relation to other plants and animals and its place in plant succession were studied. No native animals were observed to use drymaria either as food or host plant. It is pollinated by insects, mainly bee-flies of the genus *Anthrax*.

Campbell ('31) has described the following four stages (fig. 4) in plant succession on clay soils on the Jornada Experimental Range: (1) pioneer lichen stage, (2) localized ruderal-weed stage, (3) burrograss (*Scleropogon brevifolius*) or first grass stage, and (4) tobosa (*Hilaria mutica*) climax. Poisonous drymaria occurs in the first two.

Commonly, where they occur, drymaria plants are the only ones present as pioneer annuals on bare clay flats—unkindly habitats for most other kinds of plants—where they may attain a density as high as 0.1. Associated with them in the localized ruderal-weed stage are plants that grow in shallow drainage channels, including those of the species *Hoffmanseggia densiflora, Chamaesyce albomarginata, Wedeliella incarnata, Amaranthus graecizans,* and *Cheirinia clata.*

As drymaria is a pioneer on clay soils, it would seem that it might be slowly eliminated during the next stage in succession, the burrograss or first grass stage; but no evidences of crowding and shading by other plants were observed. Burrograss is a low perennial which, in mats, may vary in density from 0.1 to 0.35, and which may spread by means of stolons and sets. Although seeds are abundant and become lodged in cracks on bare clay, seedlings of burrograss are not common. On a quadrat at the edge of a burrograss mat

on the Jornada range, this grass has advanced about 130 cm. onto bare clay in a 19-year period, which rate may not be typical, because that period includes years of drought and heavy grazing. Burrograss has some natural protection from overgrazing, in that it is palatable only a few weeks in the summer, after which the long-awned florets protect it from grazing animals. Because of the slow rate of succession on clay flats in this semiarid climate, natural revegetation will be too slow for immediate eradication of drymaria, but it may prove to be an inexpensive solution to reducing the number of these plants on badly deteriorated lands.

FIG. 4. Three stages of plant succession in the revegetation of an adobe flat: in the foreground a ruderal-weed stage of poisonous drymaria; farther out, burrograss; and in the background, tobosa grass.

Unfortunately, with the deterioration of grass cover on large areas, due to overgrazing, and the consequent accelerated erosion and deposition of clay, the bare flats apparently have increased in size, and the pioneer, unpalatable drymaria is becoming more abundant.

GERMINATION TESTS

Information on viability and longevity of seeds is needed in studying eradication of drymaria, whose only means of survival from one year to the next is in the form of seeds and whose eradication seems to hinge on prevention of seed production. Campbell ('31) tested drymaria seeds at Jornada Experi-

mental Range, and the author made additional germination tests in Petri dishes and folded blotters at ordinary room temperatures in a dark room.

The average germination of 17 tests of 100 seeds each (produced in 1933 and tested in 1934) was 30.6 per cent. Most of the seeds germinated within a week. There were delayed germination and dormancy also, which are important factors in the continuation of the plants in following years.

Germination is rather low just after the seeds mature. The results of 11 tests of 1934 seeds immediately after maturity (2.8%) agreed with Campbell's test of October 1929, which gave 3 per cent.

A test of 100 selected seeds collected January 17, 1934, from dead plants hoed in August 1933 gave 42-per cent germination. Thus, hoeing of mature plants may not necessarily prevent reproduction by seeds.

Seeds from herbarium sheets were tested to obtain information on longevity, but none from the New Mexico collections of 1897, 1899, and 1905 germinated. One test of 1925 seeds, almost 9 years old, gave 23 per cent, and another test gave no germination. Seeds of 1929 and 1931 collections had higher germination percentages. As seeds retain their viability several years, follow-up eradication seems necessary for a few years.

Because run-off floods the clay flats and is an important factor in seed dissemination, experiments were made to determine what effect the soaking of seeds in water would have on germination. Seeds in lots of 100 were soaked 7, 14, 21, and 28 days; check samples were kept dry. The results showed that soaking of seeds 7 days increased germination, but caused decay of seeds that did not germinate; and that soaking for longer periods caused decay of all seeds. Thus, under natural conditions, flooding for short periods may increase germination and at the same time may increase decay of seeds that do not germinate at once.

Eradication Studies

The principal means of preventing losses from poisonous drymaria and other poisonous range weeds are (1) proper range management, including light stocking and conservative grazing, to give the assurance of sufficient good forage; (2) judicious handling of livestock, such as herding the animals away from infested areas, and fencing such areas; and (3) actual eradication through such methods as grubbing or hoeing, cultivation, burning, and spraying with chemicals. Eradication of range weeds is similar to the controlling of farm weeds, except that the lower values involved do not justify much expense. Control of annuals, such as drymaria, concerns principally the prevention of seed production. The alternative of cure by medical treatment of poisoned animals is not likely to succeed, because cattle soon die after eating drymaria.

Fencing on the Jornada range was confined to two areas, one of 90 acres and the other of 4,500, fenced in 1930. But fencing proved to be expensive,

and did not solve the problem, because these plants became common on other parts of the range.

Eradication by hoeing was tried in 1933, 1934, and 1935. As these weeds are delicate, shallow-rooted annuals which can be killed simply by scraping with one's shoe, it is not necessary to cut off the plants more than half an inch below the ground surface. A sharp, broad-bladed hoe is the best tool. If seeds are present, the hoed plants should be put into sacks and destroyed.

Several ranchmen have tried eradication by cultivation methods, using drags and other kinds of harrows. It is possible that making soils more open through harrowing might favor the growth of drymaria the next year. Where these plants are scattered, mixed with other plants, or occur in gullies or other areas that are not level, drags or harrows cannot be used.

The use of kerosene and gasoline burners was successful. The burners tested included one made for destroying weeds and also a "pear" burner used by ranchmen in removing spines from prickly-pear cacti in their preparation for forage. Burning was slightly faster than hoeing; but the flame seemed to blow the seeds already on the ground into clay cracks instead of destroying them.

Of five chemicals tried in spraying tests with a hand-spray tank, 10 per cent sulphuric acid proved to be satisfactory. This acid, which is superior to most chemicals under conditions of low humidity, caused drymaria leaves to begin to wilt and turn yellow and brown within a few minutes.

As an indirect way of combating poisonous drymaria, as well as aiding nature and increasing forage production, revegetation of clay flats by transplanting and seeding of six native grasses was tried. But the experiments of 1934 were failures, because of drought; and attempts to hasten plant succession by applying sand on clay flats were also unsuccessful. Artificial revegetation, even if successful, would be too expensive and too slow a measure.

Of the several methods tested, hoeing is to be preferred in most cases, because it is least expensive, it allows convenient and time-saving travel on horseback, and it enables better use of labor or helps to reduce unemployment by providing more temporary work. Dragging or harrowing, if shown by further tests to be successful, might prove to be the quickest and cheapest way of ridding large patches on level areas.

Recommendations for Control

Measures for control of poisonous drymaria on southern New Mexico ranges may be classed as permanent and temporary. Permanent measures involve revegetation, which is slow in semiarid regions. Before natural revegetation can occur, overgrazing must be stopped. Even if natural conditions can be restored through protection from grazing or by conservative use, there probably will always be a few small bare areas of clay where poisonous drymaria will grow.

During natural restoration of the ranges, there are several temporary methods that may be effective in reducing livestock losses from drymaria. The first is reduction in number of cattle, in order to assure more forage per animal. Experience has shown that where plenty of forage is available, cattle losses from unpalatable poisonous weeds, such as drymaria, are light. Other methods that may be applied would differ on each range according to such factors as losses, abundance and distribution of drymaria and clay flats, and cost of eradication.

Action should be taken as soon as drymaria seedlings (fig. 3) first appear after summer rains begin. If there are livestock losses, all cattle should be removed immediately from suspected areas, otherwise the losses might mount overnight.

Where drymaria is restricted to small areas, fencing of these patches may be the best solution. But the possibility that these weeds may spread from a fenced area to other parts of a range should be considered. On ranges where there are areas of soils other than clay, those parts or areas overrun with drymaria may be isolated by fencing. Herding or riding to keep cattle away from infested areas is also suggested.

On ranges where poisonous drymaria is widely distributed, annual hoeing, or hoeing combined with dragging or harrowing of large patches on level areas, is probably the best solution. Eradication work should begin as soon as possible after these plants start growth in July or earlier, in order to prevent or reduce seed production. Mature plants bearing seeds should be put into sacks and destroyed. In wet years it may be necessary to hoe more than once, because seedlings may continue to appear after rains during the summer.

The possibility of eradicating drymaria permanently is not encouraging, because of the difficulty of locating all rapidly growing, scattered plants before some have borne seeds. Although hoeing will have to be done each year, it is possible that these poisonous weeds can be greatly reduced after a few years of thorough eradication before seeds form.

If the cost of application of these methods is greater than the value of the forage and profits from the range lands involved or greater than the value of the cattle killed, the only other immediate solution seems to be deferred grazing or removal of cattle from infested ranges during the wet summer months while drymaria is growing. Deferred grazing will result in a loss of forage, because the principal grasses of clay flats (burrograss and tobosa) are palatable only in summer. However, the grasses will benefit thereby.

SUMMARY

The characteristics and life cycle of poisonous drymaria (*Drymaria holosteoides* Bentham or *D. pachyphylla* Woot. and Standl.), which occurs on ranges of southern New Mexico, were studied with a view to control and

mitigation of livestock losses. These harmful annuals have increased during recent years as the result of overgrazing.

To meet these problems, reduction of cattle in order to assure adequate forage is suggested. Also, eradication on small areas through hoeing, and in large level areas through dragging or harrowing seems cheapest and most satisfactory.

Permanent control seems to be through natural revegetation, although this process takes time.

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