Silybum marianum
milk thistle; variegated thistle
Asteraceae

Silybum marianum is an erect, annual (or biennial in California) herb growing from one to two meters tall. The root can be classified as a taproot. The leaves are large, deeply divided with undulate margins and stem-clasping. They are shiny with sparse hairs on the upper surface and more dull and hairy on the lower surface. Leaves have a variegated appearance on the upper surface because of white veins and white patches. They have sharp 1-2 cm long spines along the margin.

The large purple flower heads are 2.5-5 cm across, terminal, solitary and nodding. They are surrounded by large stiff reflexed bracts ending in sharp spines 1-2 cm long. The flowers are produced from May to July.

The seeds are black or brown, mottled, smooth, 1/4 inch long, somewhat flattened with a pappus of numerous barbed bristles 3/4 inch long.

Silybum can be distinguished from other California thistles by its distinctive white-mottled leaves. There is only one species of *Silybum* established in California. "The seed leaves (cotyledons) are large from 1/2 to 3/4 inch wide and 3/4 to 1 inch long, rather thick, succulent and light green. The first leaves are very conspicuously white-netted along the veins and have short yellowish prickles" (A.H. Lange et al., 1983).

The plant is mainly confined to high fertility soils. It frequently establishes on river flats, sheep camps, around stock yards and any other area of higher than normal soil nitrogen levels, especially if the area has been disturbed.

Silybum marianum has long been familiar to man. It commonly appears in European herbals after 1590. Formerly it was cultivated for "its oil bearing seed and as an ornamental plant in Europe and east Asia, and still finds limited use, e.g. in Italy, as a salad green or vegetable" (Goeden 1976).

The origins of *S. marianum* lie in the region of Southern Europe, the Mediterranean and Northern Africa. Its current distribution includes most temperate areas of the world. It is common in the Western U.S. as a weed afflicting pastures, wastelands and irrigation banks (Parsons 1973). It is believed to have been introduced in cattle feed.

S. marianum spread through both the southern and northern Central Valley of California during the 1940s, demonstrating a remarkable adaptation for colonizing. "The agricultural environment that was invaded had been dominated by alien weeds for 180 years. For a species without vegetative propagation to invade a community of annuals underscores the competitive advantage of its germination characteristics" Young et al. 1978). It is now common in both coastal and inland valleys.

Each terminal head of the plant produces approximately 100 seeds; 10 to 50 heads are produced per plant (Young et al. 1978). Seed weight is approximately 22 mg (Wheatley 1971). "From this we can calculate 10-50 grams of seed produced per plant. With a conservative average density of 2 plants/square meter theoretical seed production reaches 500 kg/ha" (Young et al. 1978).

Seed dispersal is the only means by which the milk thistle spreads. The seeds are equipped with a large pappus which allows effective spread by wind (Parsons 1973). Spread can also be attributed to their presence in grain and fodder (Wheatley 1971). Other means of dispersal include water, mud, agricultural produce, vehicles, machinery and animals (Parsons 1973).

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The seeds of *Silybum marianum* germinate in the fall after the first rains. "Plants develop slowly through the seedling stage, becoming flat rosettes by late autumn/early winter. Growth is rapid in late winter and early spring producing large cabbage-like plants up to 3 feet in diameter from which center stems develop in spring. Flowering commences in late spring and continues into early summer" (Parsons 1973).

The seedlings prefer disturbed soils which provide suitable bare areas for litter-free germination. Therefore, sheep camps, rabbit warrens, cultivated fire breaks, roadsides, overgrazed pastures and the like are ideal propagation sites. Seedlings do not establish in perennial pastures if the soil is well covered with vegetation during late summer and autumn. Litter seems to be a highly important inhibitive factor in the germination ecology of milk thistle seed. Because its germination is reduced by accumulations of grass litter, milk thistle is not adapted as a landscape dominant in areas where there is a continuous ground cover provided by existing vegetation. This can also hold true for annual rangelands if they are managed properly (Young et al. 1978). However, if there is an absence of pasture or litter cover in late summer and early fall, infestations of thistle may develop. This occurs especially in periods of drought which reduce the persistence of many pasture species (Michael 1968).

Silybum seed has the potential to remain viable in the soil for up to 9 years.The percentage of germination varies from year to year and can be less than 50% (Parsons 1973). In an article on germination requirements of this species, written in 1978 by Young et al., the following results were recorded.

"One month after harvest, milk thistle seeds had afterripening requirements related to germination temperature that limited germination to 10-20 C degrees. The time required to satisfy afterripening requirements was dependent on germination temperature. Generally the higher the incubation temperature during germination, the longer the afterripening requirement (up to a maximum of 5 months). Once afterripening requirements were satisfied, milk thistle seeds germinated over a temperature range of from 0-30 C degrees. Optimum germination occurred with 16 hour cold periods of 2-15 C degrees alternating with 8 hour warm periods of 10-30 C degrees. Emergence of milk thistle seedlings decreased with increased burial depth, but substantial emergence occurred from a depth of 8 cm. Germination on the surface of the soil or litter was greatly reduced compared to that with slight soil or litter coverage."

Once *Silybum* has found a niche it is a competitive thistle and it tends to establish in tall dense patches that eliminate other plant species either by shading or by competition for moisture and nutrients.

In areas of continual disturbance, eradication of *Silybum* is virtually impossible until the factors which cause the disturbance are removed. *Silybum* will stay localized in these areas unless disturbance becomes more widespread. Over-grazing and fire are two factors which encourage the spread of *Silybum* in large areas.

An otherwise high quality natural area with localized infestations of *Silybum* may be suitable for acquisition or management as a preserve. Livestock and other management practices appear to contribute to high nitrogen or disturbed areas which encourage growth of this weed. *Silybum* may not represent a threat to the rest of the area's ecological quality.

Silybum marianum has been perceived as a problem for a variety of reasons. One reason control methods have been sought after is due to the toxic potential of the thistle. *Silybum marianum* has caused some of the worst cases of stock poisoning in northwest Tasmania. The poisonous principle is nitrate (Macadam 1966). Cattle and sheep eat the plant material which contains potassium nitrate and break it down by means of ruminal bacteria into the poisonous form (Knott 1971). "The nitrite ion...combines with haemoglobin to form methaeglobin ...[which is] incapable of combining with oxygen. If large amounts of methaeglobin are present in the blood stream, affected animals will begin to show respiratory distress for lack of oxygen." (Knott 1971) Poisoning threats are increased when the plants are wilting after being cut or partly turned

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under during plowing and in wet weather (or) when soil moisture is high. In dry conditions they are not considered dangerous (Parsons 1973).

As mentioned earlier *S. marianum* will establish in dense stands often competing with more desirable plants, occasionally to their complete exclusion (Goeden 1971). This is relevant to The Nature Conservancy preserve management and it also creates a problem in pasture production.

"The loss of pasture production because of thistles is difficult to evaluate in monetary terms. When thistle plants are scattered through the paddock, loss of production is minimal, as grazing is not restricted. However, when thistles are dense, stock may not be able to gain access to these areas" (Wheatley 1971).

With proper management, affected areas can be restored to more desirable vegetation. Recommended management practices are to reduce grazing or remove the source of disturbance and introduce a native replacement.

Monitoring is needed to determine the effectiveness of management practices.

Detailed observations focused on the vegetational change of the affected area over time will help to determine what method of control would be most efficient.

Qualitative observations of the changes in a thistle complex which occurs on the Marin headlands are in progress by Terri Thomas, a plant ecologist working for the Golden Gate National Recreation Area (GGNRA).

Rob Hansen, preserve manager for Kaweah Oaks in California, has been monitoring *Silybum* growth patterns in an area from which cattle have been removed. In the spring of 1984 he set out six transect lines, 100 meters each. From the data he gathered he was able to compare the radius of the existing growth to the radius of the growth from 1983. This data expressed a marked decrease in the *Silybum* population over time. The average decrease ranged from 20-80 percent. Follow up data will be gathered in the spring of 1985. Three intercept lines will be set out on original transect corridors.

The following are specific questions that need study to improve control efforts:

1.Could mowing, followed by covering the area with a thick layer of mulch, be an effective control for *S. marianum*?

2.Could burning be considered an effective method of control for this weed?

3.Is *S. marianum* germination enhanced by the disturbance created by mechanical removal to an extent that would render this method unacceptable?

4.Is grazing exclusion an acceptable method of control?

This weed does require active management once it is established in dense groves. Researched methods of control are listed below.

In Wheatley's opinion, "The ideal control (for *Silybum marianum*) is to establish a vigorous perennial grass-legume sward before an area is invaded. By providing permanent ground cover, perennial pastures can prevent thistles from becoming dominant." Where spring sowing of perennial grasses or lucerne is feasible, competition from milk thistle will be greatly reduced because they are not competitive in the fall (Parsons 1973).

Cultivation can also be a useful method of controlling seedlings as a preliminary measure to sowing competitive perennial species.

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Mowing can be effective before seeds are produced although there is a danger of poisoning if there are any grazers in the vicinity. If there is no threat to stock, it is important to mow before the flowers are fully developed because fertile seeds may still form in the heads (Parson 1973).

In California, a mowing regime should begin in May, and mowing should be repeated four to six times during the spring and summer to suppress seed development. This program could take two years before control is visible (pers. comm., R. Lesco, Resource Management Specialist, Pt. Reyes National Seashore, 1985). This method has not been proven successful for erradication unless forbe seed is introduced to the affected area.

Physical removal of thistle in troublesome spots has had limited success in Pt. Reyes National Seashore (pers. comm., R. Lesco, Resource Management Specialist, Pt. Reyes National Seashore, 1985). However, Lanny Waggoner, Chief Ranger at Marin Area Headquarters, California State Parks, suggested that digging the individuals out by hand was creating ideal conditions for germination (pers. comm., L. Waggoner, Chief Ranger at Marin Area Headquarters, California State Parks, 1985).

Opinions about burning as a form of controlling milk thistle differ. Mr. Waggoner mentioned that he observed a remarkable percentage of mortality in a thistle complex that was burned in an "accidental fire" in January 1980. Other individuals have explained that seed germination may be enhanced by the disturbance created by burning, thereby encouraging *Silybum* establishment (pers. comm., R. Lesco, Resource Management Specialist, Pt. Reyes National Seashore, and N. Havlick, Resource Analyst, East Bay Regional Park District, 1985).

Silybum marianum is most readily killed in the seedling androsette stages of growth. The more mature the plant, the more resistent it becomes to treatment. One method of herbicide application is spot spraying with ester 2,4-D (80% a.i.) at the dilution of one part in 1,600 parts water, increasing to one part in 400 as the plants near maturity. For boom spraying Parsons recommends 1/2 pint per acre increasing to 1 1/2 pints per acre. Because germination occurs over a period of several months in the fall, autumn spraying will have to be followed up in the winter to deal with plants germinating later.

In an experiment of herbicide use on *Silybum marianum* in wheat, authors R. Meissner and C. Mulder found that when sprayed selectively at the two to three leaf stage, the thistle was controlled 100% by picloram and methabenzthiazuron in combination with phenoxyacetic acid compound, "at rates normally recommended." After forming a rosette of three whorls or so, they discovered that *S. marianum* was not adequately controlled by methabenzthiazuron alone. They mention that spot treatment with decamba may prove successful at later stages.

The seed weevil, *Rhinocyllus conicus* may attain densities sufficient to destroy the seeds of thistles in amounts necessary for effective biological control. In June 1971, 316 weevils were collected near Rome, Italy and experimentally colonized on *S. marianum* at a site near Santa Barbara. In September of the same year 9% of 154 dissected mature flower heads had been attacked (Goeden 1971). By 1973 94% of 208 flower heads examined were infested.

The eggs of *R. conicus* are found on the lower surface of the bracts of the newly formed flower heads (Hawkes et al. 1972). When the larvae hatch they bore directly through the bracts and into the flower where they feed upon and destroy the immature seeds and pupate in cells constructed among seed fragments. Adults emerge from these cells after the mature flowerheads open to shed their seeds (Goeden and Ricker l974).

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Recently, the introduced seed weevil has been discovered on a variety of native Cirsium species (Turner 1985). The United States Department of Agricultures (USDA) Biocontrol Station in Albany, California, is now advising against its release because of the potential harmful effects of its spread. Research concerning this information is now in progress.

Goeden reports that the list of biological control agents effective on *S. marianum* has the potential to expand given further understanding and research on the effects of introducing new insect species.

Ms. Thomas of the GGNRA is conducting informal management-related research on a milk thistle complex in the Marin Headlands. To test the effect of mowing on thistle inhibition, a three acre thistle-infested stand was mowed during the winter of 1983. The following spring the mowed area had recovered, with the thistle growing back in what appeared to be an even greater density than the adjacent areas that had not been mowed the previous winter. Although the three acre thistle stand seemed to recuperate quickly and even benefit from mowing in 1983, in the spring of 1984 seedling establishment in the mowed area was poor and large patches of bare ground were visible. At this time Ms. Thomas prepared two 10' X 20' plots within the three acre area to test and monitor thistle regrowth. In one plot, the remaining few young thistles were pulled by hand and *Festuca* seed planted. In the other plot Ms. Thomas sowed *Festuca* on the bare patches among thistle seedlings. By winter 1985, the two experimental plots appeared quite different. Both supported much denser grass than the surrounding thistle-covered areas, and the occurrence of *Festuca* on the cleared quadrat was much greater than on the uncleared plot. The percentage of thistle occurring on the uncleared site was twice that of the cleared plot. Although the evidence is still inconclusive, it appears that thistle mowing reduces thistle seedling establishment and that *Festuca* introduced over areas, both cleared and uncleared of thistle, helps maintain lower thistle regeneration (pers. comm., T. Thomas, Plant Ecologist, GGNRA, 1985). Contact: Terri Thomas, Plant Ecologist National Park Service, Fort Mason, Building 201 San Francisco, CA 94123 (415) 556-1838

Management of *Silybum marianum* has been underway at Kaweah Oaks Preserve since 1984. In February of that year an experimental application of 2,4-D was applied to *Silybum* at its maximum rosette stage of development. The treatment has focused on dense stands under oak trees where cattle had traditionally congregated. This method of control proved to be successful. In 1985 however, herbicidal methods of control will not be employed. This year a 40 acre infested area will be mowed with a "bushwacker" before flowerheads mature. Contact: Rob Hansen, Preserve Manager, 3450 Avenue 144 Corcoran, CA 93212 (209) 992-5308

To achieve control and potential eradication of *S. marianum*, physical removal, cultivation and mowing can prove effective if complemented by sowing a perennial, or otherwise competitive grass.

The most effective herbicide used on *S. marianum* is 2,4-D. The plant is most susceptible to the chemical from the seedling to the rosette stages of growth.

The introduction of the biocontrol agent *Rhinocyllus conicus* on milk thistle populations has provided some degree of control of *S. marianum* in Southern California. However, specialists at the USDA office of biological control are advising against its release due to the fact that it has been found on at least ten species of native *Cirsium*.

There are no completely satisfactory techniques to eradicate *Silybum*. All techniques should be considered experimental and treated as such, with the use of controls and careful documentation and reporting.

BIBLIOGRAPHY

Preparer: Caitlin Bean, Sept. 1985 for The Nature Conservancy, California Field Office, 785 Market Street, 3rd Floor, San Francisco, Ca 94103 (415) 777-0487

Auld, B.A., K.M. Menz, and R.W. Medd. 1979. Bioeconomic model of weeds in pastures. AgroEcosystems 5:69-84.

Edelbrock, J. 1978. Thistle Management in Marin Headlands, Golden Gate National Recreation Area. Unpublished Manuscript.

Goeden, R.D. 1976. The paleartic insect fauna of milk thistle, *Silybum marianum* as a source of biological control agents for California. Journal of Environmental Entomology 5(2):345-353.

Goeden, R.D. 1971. The phytophagous insect fauna of milk thistle in southern California. Journal of Environmental Entomology 64(5):1101-1104.

Goeden, R.D., L.A. Andres, T.E. Freeman, P. Harris, R.L. Pienkowski and C.R. Walker. 1974. Present status of projects on the biological control of weeds with insects and plant pathogens in the United States and Canada. Weed Science 22(5):490-495.

Goeden, R.D. and D.W. Ricker. 1980. Mortality of *Rhinocyllus conicus* in milk thistle flowerheads in southern California. Protection Ecology 2:47-56.

Goeden, R.D. and D.W. Ricker. 1977. Establishment of *Rhinocyllus conicus* on milk thistle in southern California. Weed Science 25(3):288-292.

Goeden R.D. and D.W. Ricker. 1974. Imported seed weevil attack on Italian and milk thistle in southern California. California Agriculture January, p.8-9.

Hawkes, R.B., C.A. Andres, and P.H. Dunn. 1972. Seed weevil released to control milk thistle. CaliforniaAgriculture, December, p.14.

Knott, S.G. 1971. Nitrite poisoning in livestock. Queensland Agricultural Journal, 97(9):485-489.

Lange, A.H, B.B. Fischer and J. McCaskill. 1983. Milk thistle - *Silybum marianum* (L.) Gaertn., thistle Family.In Index to the Growers Weed Identification Handbook (Sheets WI-1 through WI-215), Cooperative Extension, University of California, Berkeley, CA.

Macadam, J.F. 1966. Some poisonous plants in the northwest. Agricultural Gazette of New South Wales, 77(2):73-78.

Meissner, R. and C. Mulder. 1974. Research note, herbicidal control of volunteer *Silybum marianum* in wheat. Agroplantae 6:87-88.

Michael, P.W. 1968. Perennial and annual pasture species in the control of *Silybum marianum*. Australian Journal of Experimental Agriculture and Animal Husbandry, 8(30):101-105.

Parsons, W.T. 1973. Noxious Weeds of Victoria. Inkata Press, Melbourne, 300p.

Turner, C. 1985. Botanist, USDA Biocontrol, Albany, California. Personal Communication.

Wheatley, W.M. 1971. Thistles - Prickly problem of pasture improvement. The Agricultural Gazette of New South Wales 82(5):258-261.

Young, J.A., R.A. Evans, and R.B. Hawkes. 1978. Milk thistle (*Silybum marianum*) seed germination. Weed Science 26(4):395-398.

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