Status of puncturevine weevils and their host plant in California

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Thanks to imported biological controls, 32 counties report a decline in puncturevine.

Puncturevine (*Tribulus terrestris* L.) was first reported in California in 1903 and has been considered a noxious pest since 1912. In 1965 it reportedly infested more than 900,000 acres and is now found in all California counties. Its spiny burrs cause a downgrading of alfalfa hay, wool, and land values. Ingestion of the burrs can injure grazing animals. Costs to the farmer vary seasonally with plant abundance.

Because of its widespread and serious nature, a seed weevil (*Micorlarinus lareynii*) and a stem-boring weevil (*M. lypriformis*) were introduced into the western United States from Italy in 1961 to reduce it through biological control. Releases were made only after it was demonstrated that the weevils would not reproduce on economic plants. The early releases were first reported in *California Agriculture* in 1961.

Both weevils are now widespread in California with varying impact on puncturevine. A 1973 field survey demonstrated that weevil colonies are established in southwestern and central states, from Texas north to the Nebraska border.

The annual nature of puncturevine, which appears erratically at different sites from one year to the next, has made direct quantitative assessment of the biological-control program difficult. However, a number of weed workers and county agricultural officials believe that the weed has been reduced in many localities, and we have attempted to assess the impact of the weevils with a questionnaire. The focus was on the number of infested net acres before and after the introductions, the changes (if any) in costs of control, and the status of the weed (whether it is increasing or decreasing).

A survey of county agricultural commissioners was conducted in April, 1975, and was updated when necessary, by telephone conversations in Fall, 1976. We asked for reports on pre-1961 (the year the weevils were released) and post-1961 net acreage infested and on pre- and post-release puncturevine control expenditures. As there usually were no pre-1961 acreage or cost figures available, we have used the net acreage figures given by James W. Koehler of the California Department of Food and Agriculture in his 1965 *Noxious Weed Acreage Report*. These figures, the base on which we have chosen to judge control, were compiled several years after the releases. At that time, the impact of the weevils on plant abundance was not readily apparent.

Many commissioners provided estimates of the number of net acres infested (see tables 1 and 2). Despite personnel changes in some counties, we arbitrarily assumed that the method used to estimate 1975 net acreage figures is similar to that used by Koehler. We did verify, however, that the methods were the same in Fresno and Merced counties where puncturevine abundance has dropped drastically. When an estimate of reduction or increase was provided, it was applied to the 1965 base figure to estimate the current infested net acreage shown in the tables. Where only a trend towards "increasing" (I), "decreasing" (D), or "stable" (S) was noted, it was indicated in the tables.

Our assessment of the role of the weevils in reducing puncturevine is based in part on comments by commissioners, and it is balanced by other factors known to contribute to reducing puncturevine.

Of the 58 counties surveyed, 57 reported the weed present, 32 reported that puncturevine had decreased as a direct result of the weevils, 13 reported an increase in the weed, and 12 said that the weed population remained unchanged.

Puncturevine: stable or decreasing

Forty-four counties reported that puncturevine populations were either stable or decreasing, most of them in the San Joaquin and Sacramento valleys, and in the south coastal (Monterey south) and southeast desert drainage basins. Of these 44 counties, data for actual acres infested with puncturevine in 1965 and 1975-76 were available for only 17. Judging by the data from these 17 counties (table 1), net

acreage infested with puncturevine in California decreased from nearly 492,000 (1965) to 200,000 (1975).

Several factors were cited as causes for the decrease (e.g., weevils, herbicides, urban encroachment, farming practices), but the weevils were said to be of primary importance in Fresno, Madera, Merced, Kern and Tulare counties. In the Sacramento Valley, the weevils apparently did not have as striking an effect, but they were felt to be suppressing the plant (i.e., keeping the infestation stable even where the infested net acreage had not been reduced). It was also felt that the weevils worked best in undisturbed sites, such as uncultivated soil. In south coastal areas, the weevils were generally considered very effective, but their effect was overshadowed by urbanization, heavy use of chemical soil sterilants, and reduced agricultural acreage. The weevils apparently have also been effective in the southeast desert area. Imperial County returns noted that before the weevils became established the weed was abundant; now it is seldom found.

Puncturevine: increasing

The abundance of a plant species largely depends on environmental stresses: climate, soil, competing plants, and natural enemies, and puncturevine abundance in California is directly related to these factors. Puncturevine is also favorably influenced by irrigation, fertilization, and soil disturbance, and thus for the most part it has been a pest in warmer agricultural areas.

Table 2 lists 13 counties in which puncturevine is estimated to have increased since 1965. Paradoxically, many are in northern California, especially on the north coast and in the northeast interior where cooler temperatures and harsh winters are generally less conducive to plant development. In 1965 puncturevine infested only 100 net acres or less in each county; in 1975 about 15,000 acres were infested. However, it is not surprising that the weed is increasing in some areas, such as Napa, Lake, and El Dorado counties, where increased soil disturbance associated with increasing human populations and cultivation, increasing vehicular traffic, and transport of soil from one area to another favor weed growth. In the more northern counties, climatic factors inimical to the natural spread of puncturevine also greatly deter the establishment and buildup of the weevils. Although it may be relatively easy to establish the weevils in these areas during the summer, cold winter temperatures (as in Siskiyou and Modoc counties) that kill off the plant also reduce the overwintering weevil populations, but do not kill the seeds, which germinate the following season.

The stem-boring weevil, *Micrelarinus lypriformis*, feeds on the stems of puncturevine. Note the feeding scars on the stems. This weevil, along with the seed weevil, *M. lareynii*, pictured on the cover, have helped reduce the incidence of this noxious weed.

Cost versus benefits of biological control

Development of biological control of a weed may be divided into three phases: (1) foreign exploration and food plant testing, (2) introduction and release of the approved control agent, and (3) evaluation of its effectiveness against the weed in the new locale(s). After foreign exploration for natural enemies of puncturevine by USDA entomologists, the food plant testing of the puncturevine weevils was carried out jointly by USDA and University of California entomologists in 1959-1960. The University of California released the weevils in California; the USDA made releases in other states.

Investment in the initial release of the weevils is estimated at 4.50 scientist years (SY). The cost of one SY—that is, the time of one scientist working one year, plus supporting staff and facilities—is estimated by USDA to be $80,000. Overall project cost is estimated at $360,000.

Do the project's benefits equal its costs? In the 17 counties that reported reduced puncturevine infestation between 1965 and 1975, there has been a net reduction of 292,000 acres. It is conceded that the weevils are not responsible for this entire reduction, but if they accounted for only 5.1 percent of the decrease (14,892 acres), savings in control costs alone ($24 per acre, according to Dr. W. B. McHenry, U.C., Davis) would almost equal the project's estimated cost. If, however, the weevils are credited with 25 percent of the overall reduction (a conservative estimate based on statements by agricultural commissioners), the control provided by the weevils could mean a savings of up to $1.7 million in spray costs annually. At this rate the weevils, which continue to pressure the plants year after year, provide a highly favorable cost:benefit ratio. In addition, the so-called hidden benefits (reduced use of herbicides and reduced energy needs) are not included in this calculation. They certainly weight the ratio still more in favor of biological control. Although the specific role of the weevils in reducing puncturevine is not always clear, they do provide a continual stress on the plant and, in combination with other environmental stresses, are contributing to a significant lessening of the puncturevine problem.

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TABLE 1. Counties Reporting Decreasing or Stable Puncturevine Acreage Since 1965.

Drainage Basin and County	Puncturevine Acreage or Population Trends* 1965	1975
San Joaquin:		
Amador	1,400	S
Calaveras	551	300
Fresno	66,648	1,333
Kern	48,000	1,440
Kings	92,530	70,000
Madera	2,200	D
Mariposa	— —	D
Merced	75,000	7,500
San Joaquin	22,995	D
Stanislaus	260,000	D
Tulare	400	D
Sacramento:		
Butte	35,500	28,400
Colusa	30,000	S
Glenn	15,720	5,345
Modoc	100	S
Nevada	— —	D
Placer	2,900	290
Plumas	1	S
Sacramento	275	S
Sierra	— —	D
Sutter	800	125
Tehama	13,025	6,512
Yolo	600	S
Yuba	40,768	24,461
South Coastal:		
Los Angeles	70,000	D
Orange	775	D
San Diego	6,250	D
Santa Barbara	4,673	D
Ventura	2,900	405
Southeast Desert:		
Imperial	10,000	200
Inyo	— —	D
Riverside	85,000	52,250
San Bernardino	1,600	400
Central Coast:		
Contra Costa	50,000	D
Monterey	3,600	D
San Benito	300	D
San Francisco	— —	D
San Luis Obispo	997	498
San Mateo	6	S
North Coast:		
Del Norte	— —	D
Humboldt	2	0.5
Mendocino	1,550	D
Trinity	— —	D
Northeast Interior:		
Alpine	— —	D
Mono	— —	D

*D = acreage decreasing; S = acreage stable

TABLE 2. Counties Reporting Increasing Puncturevine Acreage Since 1965.

Drainage Basin and County	Puncturevine Acreage* 1965	1975
San Joaquin:		
Tuolumne	55	110
Sacramento:		
El Dorado	240	600
Lake	80	165
Napa	910	1,001
Shasta	16	1,800
Solano	52	I
Central Coast:		
Alameda	25	I
Santa Clara	100	I
Santa Cruz	27	38
North Coast:		
Marin	2	I
Siskiyou	5	105
Sonoma	1,100	11,000
Northeast Interior:		
Lassen	13	26

*I = acreage increasing.