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POPULATION CYCLES OF WAHWEAP MILKVETCH ON THE HENRY MOUNTAINS AND SEED RESERVE IN THE SOIL

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ABSTRACT.—A population outbreak of Wahweap milkvetch (*A. lentiginosus* var. *wahweapensis* Welsh) occurred in the Henry Mountains area of southeastern Utah in 1985 and 1986, causing extensive locoweed poisoning in cattle grazing these winter ranges. Weather conditions supporting this population outbreak included above average precipitation in the fall of 1984 and 1985, which presumably allowed germination of seed lying dormant in the soil. Above average spring precipitation in the subsequent year supported the population growth. Part of the population died in the summer of 1985, and nearly all plants died in the summer of 1986. Historically, population outbreaks occurred every six to eight years: 1949, 1957, 1965, 1973, 1979, and 1985–1986. Correlation with weather records indicated that population outbreaks occurred in years of high spring and total annual precipitation. Wahweap milkvetch seed lying dormant in the soil ranged from 940 to 4,346 seed/m^2 where old stands occurred, and 20 to 40 seed/m^2 where old plants were not evident. Sufficient seed remains in the soil to cause future population outbreaks.

Locoweed poisoning of livestock is the most widespread poisonous plant problem in the western United States (Kingsbury 1964). It is a particularly difficult problem because of the cyclic nature of *Astragalus* species on desert and semidesert rangeland. When environmental conditions are favorable, populations of some species explode and dominate entire regions (James et al. 1968, Williams et al. 1979, James and Nielsen 1987), causing extensive livestock losses, i.e., poor livestock performance, reduced weight gains, impaired reproduction, and deaths. Even though the genus *Astragalus* is generally characterized by narrow endemism associated with arid microsites (Barneby 1964), population outbreaks may be associated with specifically timed periods of high precipitation (Marsh 1909).

A population outbreak of Wahweap milkvetch (*A. lentiginosus* var. *wahweapensis* Welsh) (nomenclature follows Welsh et al. 1985) occurred in the Henry Mountains area of southeastern Utah in the spring and summer of 1985 and spring of 1986. This caused great concern among stockmen because of the potential for locoweed poisoning. The desert and foothill areas surrounding the Henry Mountains are used as winter and spring range for large numbers of cattle and sheep. The green, actively growing Wahweap milkvetch generally does not cause problems because other green forage is available during the late spring. Poisoning occurs from cattle grazing the dry, senescent plants during the winter and early spring. Thus, poisoning lags the population outbreaks by one to two years.

A grazing study was conducted during the winter of 1987 to evaluate cattle grazing behavior with respect to the dry, senescent Wahweap milkvetch plants to determine when, how much, and why cattle graze locoweed (Ralphs et al. 1988). Part of the study that is reported in this paper describes the weather conditions associated with the most recent population outbreak. Outbreaks of Wahweap milkvetch during the last fifty years were also related to historical weather patterns. Seed in soil was evaluated to determine potential for future population outbreaks.

MATERIALS AND METHODS

Wahweap milkvetch is a localized variety of freckled milkvetch or spotted locoweed (*Astragalus lentiginosus* Dougl. ex Hook.). Freckled milkvetch is a large polymorphic complex comprising 36 varieties (Barneby 1964). It grows from a caudex with incurved ascending stems 1.5–6 dm high. Leaflets are small, elliptic to ovate, 4–20 mm. It has a short raceme with 11–30 pink-purple to blue colored flowers. Pods are bilocular, inflated, and oblong, 12–26 mm long and 5–20 mm

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thick, and purple to red-tinged mottled, becoming stiff, papery, or almost leathery. Welsh et al. (1987) classifies the plants in the Henry Mountains area as Wahweap milkvetch (*A. lentiginosus* var. *wahweapensis* Welsh). It is distinguished from varieties *araneosus* (Sheldon) Barneby and *diphysus* (Gray) Jones by transparent or diaphanous pods and moderately elongate racemes. It grows in the pinyon-juniper or mixed-desert shrub vegetation types from 1,860 to 2,135 m on the Henry Mountains and Four Mile Bench in Kane County (Welsh et al. 1987).

Wahweap milkvetch grew in dense concentrations on the benches of the Henry Mountains in 1985 and 1986. Dense concentrations were limited to the semidesert, stony clay loam range site. It was especially dense on gravel and cobble outcroppings. Vegetation on this site was dominated by galleta grass [*Hilaria jamesii* (Torr.) Benth], shadscale [*Atriplex confertifolia* (Torr. & Frem.) S. Wats], and broom snakeweed [*Gutierrezia sarothrae* (Pursh) Britton & Rusby]. Minor grasses included Indian ricegrass (*Stipa hymenoides* Roem. & Schult), squirreltail [*Sitanion hystrix* (Nutt.) J. G. Smith], and blue grama [*Bouteloua gracilis* (HBK) Lag.). This range site was limited to the gravelly benches surrounding the Henry Mountains.

Wahweap milkvetch was also observed in localized areas in the semidesert, sandy loam range site along Coleman Draw. Vegetation included a sparse overstory of Utah juniper [*Juniperus osteosperma* (Torr.) Little] and understory dominated by galleta grass, rabbitbrush (*Chrysothamnus* spp.), and a variety of forbs.

The weather conditions (daily precipitation, maximum and minimum temperature, and soil moisture) relating to this most recent population outbreak were obtained from the Buck Canyon remote weather recording station, which is located in the higher elevation of the Wahweap milkvetch zone (2,130 m) about 64 km southwest of Hanksville, Utah.

Ranchers in the Henry Mountains area were interviewed in 1987 to determine when Wahweap milkvetch outbreaks had occurred in the past. Continuous weather records were collected from the Hanksville weather recording station for the past fifty years to see if weather patterns were related to Wahweap milkvetch outbreaks. Hanksville is located at a lower elevation than the bench areas where Wahweap milkvetch occurred and thus had lower precipitation and more extreme temperatures, but the weather patterns should be similar.

Soil cores were taken in the spring of 1987 to determine density of Wahweap milkvetch seed lying dormant in the soil. A 4 × 12.5-cm hand soil sampler was used to extract soil cores to 3-cm depth. Core samples were taken at 1-m intervals along transects established on two range sites at three locations. Transects were established at the King Ranch on cobble outcroppings and at the base of their slope. Another set of transects were established on the flat, gravelly bench tops of the stony clay loam site at the King Ranch and Applebush Bench. Transects were also established on the sandy loam site at the King Ranch and Coleman Draw. Old Wahweap milkvetch plants were not present on the sandy loam site at the King Ranch. Wahweap milkvetch stalks were present on one set of transects at Coleman Draw but were absent on the other set of transects.

RESULTS AND DISCUSSION

Weather Requirements

Over 40 mm of precipitation was recorded in October of 1984 and over 150 mm in the fall of 1985 at the Buck Canyon recording station (Fig. 1). We speculate that this moisture was sufficient to germinate Wahweap milkvetch seed lying dormant in the soil. Precipitation in the spring of 1985 was over 100 mm, and over 130 mm in the spring of 1986. Soil moisture recorded at 20-cm depth indicated that soil moisture was not limiting throughout the spring of 1985 or 1986 (Fig. 2). Soil moisture stress was less than 1 bar, indicating nearly saturated soil throughout the spring growing season. Mean spring temperature was above average for both years. It appears that weather conditions were suitable for germination and establishment of Wahweap milkvetch, and supported the population outbreak in 1985 and 1986.

A large number of the Wahweap milkvetch plants died during the summer of 1985, and very few survived the summer of 1986. There was an abundance of weathered black plants that grew in 1985 and brown senescent plants that grew in the spring of 1986. No living

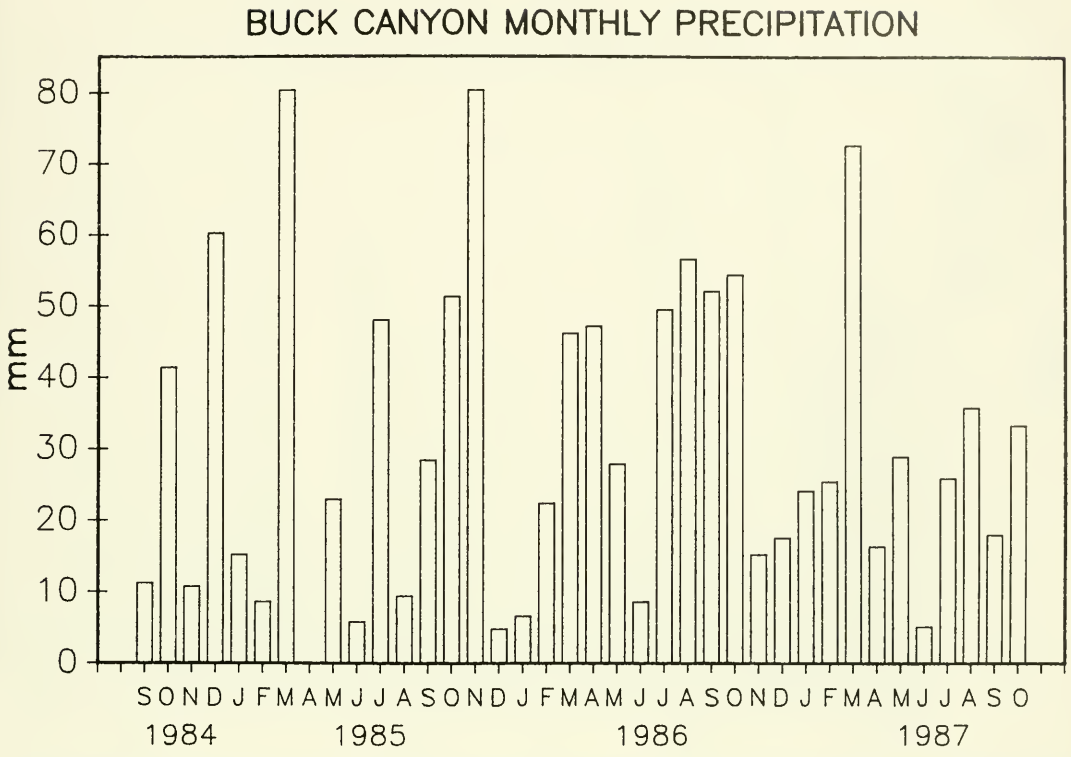

Fig. 1. Monthly precipitation at Buck Canyon remote weather recording station at 2,130-m elevation on the Henry Mountains.

plants or seedlings were observed in the fall of 1986 during the preparation and initiation of the grazing study. Very few living plants were observed on the gravelly benches in the spring of 1987, although a few plants were observed in localized areas along sandy washes. Precipitation was fairly high in the fall of 1986, but mean monthly temperatures were much lower than in the previous year. Weather conditions apparently were not suitable for germination and establishment of a new crop of Wahweap milkvetch in the fall of 1986.

The varieties of freckled milkvetch are classified as perennials (Barneby 1964, Welsh et al. 1988), but they often function as biennials. Welsh (1988) described the life cycle of potential perennials on arid or semiarid sites:

> Perennials also tend to germinate in autumn, following storms of late summer and early autumn. They persist like annuals through the winter and some will flower as annuals in the first springtime of their existence. Many do not flower in the first year, continue active growth as long as water is available, become dormant in the hot dry portions of the year, and often grow again in the autumn. In the spring of the second year they are sufficiently mature to produce flowers and fruit. If the spring of the second year is dry and moisture is inadequate, many of the potentially perennial plants die, having been functionally biennial. When conditions of moisture are adequate, however, those that have survived to flower in the second year become dormant following fruiting and persist to the spring of the third year. Seldom is precipitation adequate for continued perennation of more than a few years.

Ziemkiewicz and Cronin (1981) also stated that environmental factors influence germination and survival of juvenile locoweed plants and largely determine population densities. Late summer and fall precipitation and warm temperatures are apparently necessary for germination of Wahweap milkvetch. Abundant spring precipitation is necessary for continued growth and production of a population outbreak.

Population Cycles

Ranchers reported the occurrence of Wahweap milkvetch outbreaks in 1949, 1957,

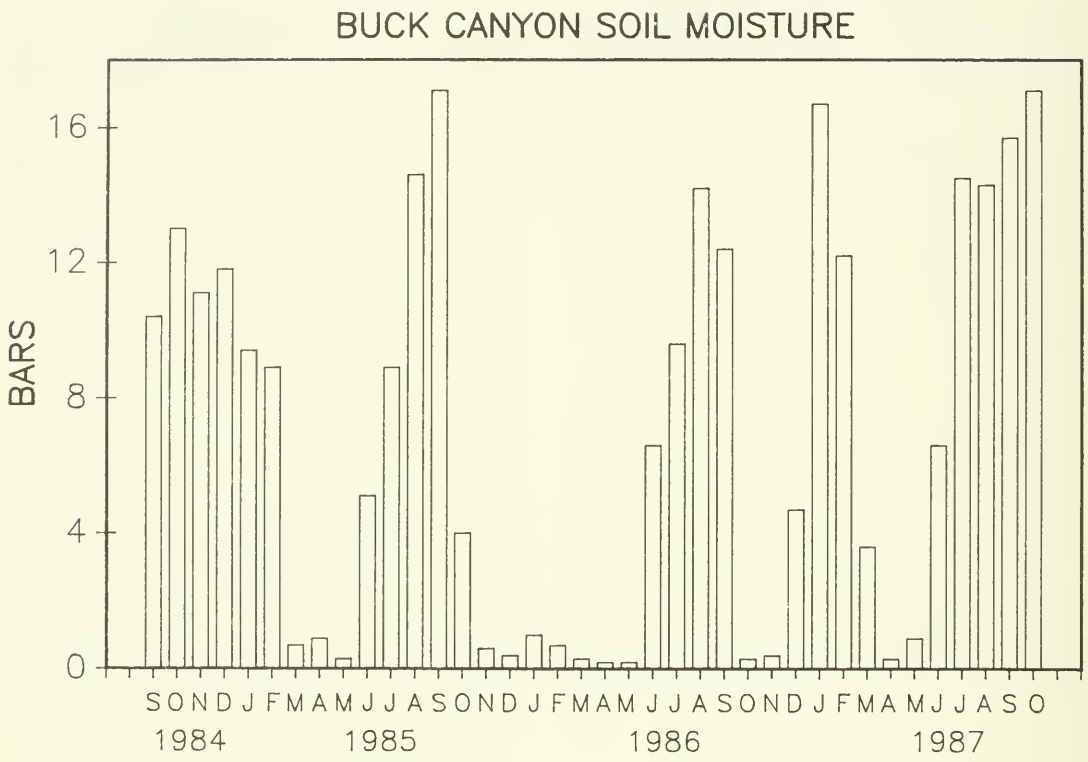

Fig. 2. Soil moisture stress at 20-m depth at the Buck Canyon remote weather station at 2,130-m elevation on the Henry Mountains.

1965, 1973, 1979, and 1985–1986 (Fig. 3). Population outbreaks occurred every six to eight years. Wahweap milkvetch grew in years of high total precipitation, except for 1973 (Fig. 3), during which it grew but not abundantly. The fall of 1972 was extremely wet, with over 130 mm of precipitation being recorded in Hanksville. The abundant fall precipitation may have carried over and supported a moderate population of Wahweap milkvetch in 1973. Spring precipitation was above average in every year Wahweap milkvetch outbreaks were reported (Fig. 4). Wahweap milkvetch grew in most years of peak spring precipitation.

Seed Reserve in Soil

Wahweap milkvetch seed was most abundant on the stony clay loam site (Table 1). The cobble outcroppings and base of the outcroppings had the highest seed density, 4,346 and 3,119 seed/m^2 respectively. Old dead Wahweap milkvetch plants from the recent population were very abundant on the cobble outcroppings. The flat gravel benches of the stony clay loam site had 650 and 1,300 seed/m^2 at the King Ranch and Applebush Bench, respectively. Old senescent Wahweap milkvetch plants were also present on these sites.

Wahweap milkvetch seed density was much lower on the sandy loam site (20 to 40 seed/m^2) where old plants were not present. Where old senescent plants were present, there were 940 seed/m^2. It is logical to assume that where plants were abundant during the previous two years, seed density in the soil is likely to be very high if the plants matured and produced seed. It is interesting to note that Wahweap milkvetch seed existed in soil where the plants were not present.

Seed density of other locoweed species in soil ranges from 400 to 1,500 seed/m^2 (Ralphs and Cronin 1987). Germination of spotted locoweed seed and seed of other locoweeds is very low (Ziemkiewicz and Cronin 1981, Baskin and Quarterman 1969, Green 1973,

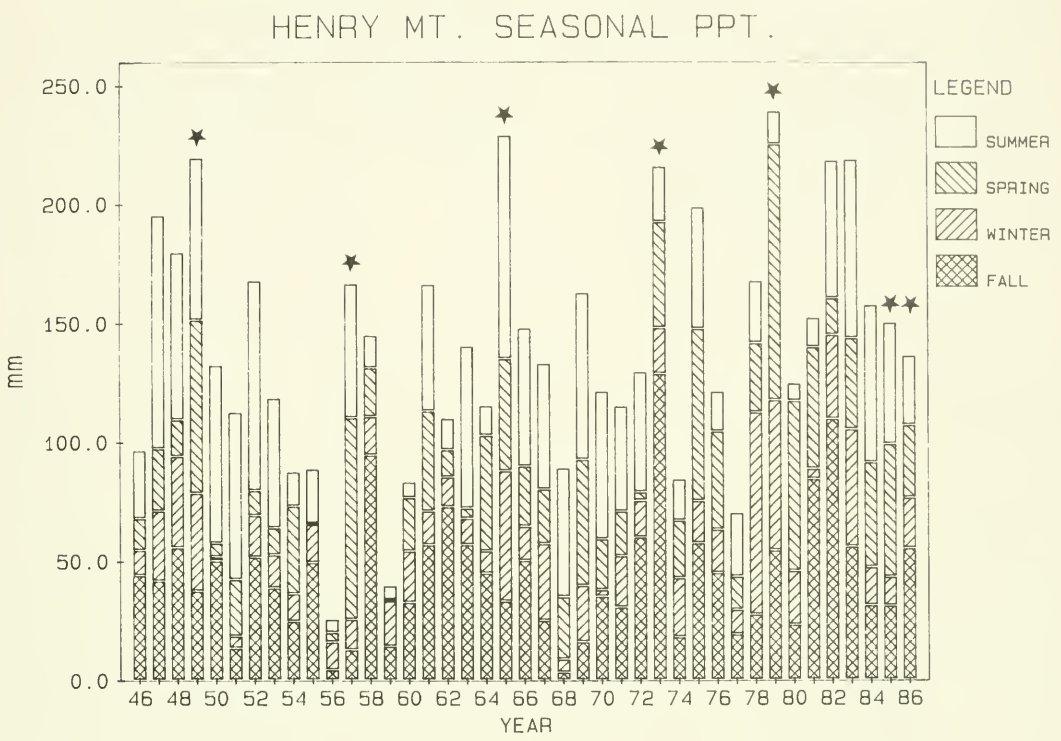

Fig. 3. Seasonal and total annual precipitation (expressed on a water year basis, October–September) recorded at Hanksville, Utah. Mean annual precipitation ($\bar{x}$) was 5.53 inches. * indicates years of Wahweap milkvetch outbreaks.

TABLE 1. Density of Wahweap milkvetch seed in soil on the Henry Mountains.

Location	Site	N	Seed/m^2 ± SE	% frequency of samples containing seed
King Ranch	semidesert stony clay loam			
	cobble outcropping	20	4346 ± 24	100
	base of slope	20	3119 ± 12	85
	bench	20	650 ± 240	65
	semidesert sandy loam	20	20 ± 14	20
Applebush	semidesert stony clay loam	20	1300 ± 347	60
Coleman Draw	semidesert sandy loam			
	old plants present	10	940 ± 308	80
	old plants not present	10	40 ± 27	20

Payne 1957, Ralphs and Cronin 1987). However, almost all seed are viable and will remain in soil and lie dormant for many years (Ralphs and Cronin 1987, Barneby 1964). There is probably sufficient seed of Wahweap milkvetch in the soil of the stony clay loam range site on the benches of the Henry Mountains to germinate and establish populations when weather conditions are favorable and create future population outbreaks.

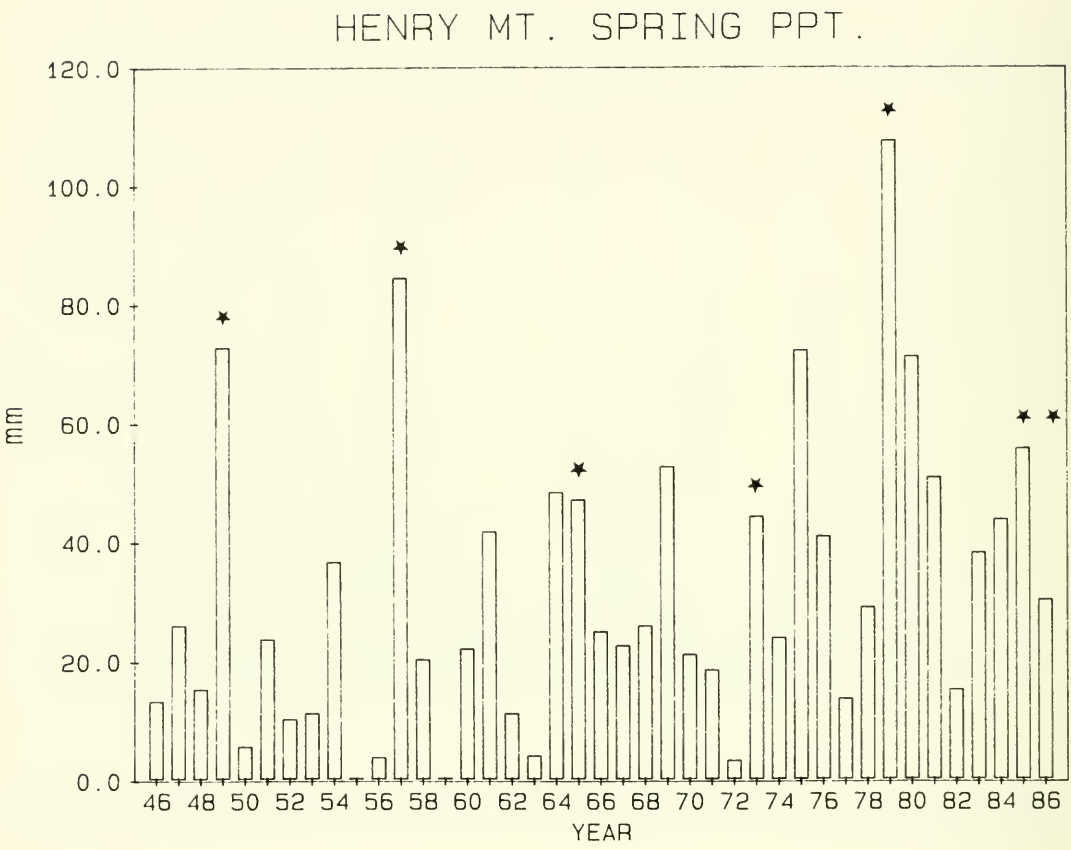

Fig. 4. Spring precipitation (April–June) recorded at Hanksville, Utah. Mean spring precipitation ($\bar{x}$) was 1.25 inches. * indicates years of Wahweap milkvetch outbreaks.

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