4100 Range

27 Native Range Clovers

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In the contiguous USA, the native clovers, *Trifolium,* are most important as range forage from the Rocky Mountains west to the shore of the Pacific Ocean. Some 65 species occur in the western states, most of them native, but some naturalized from Europe. In California alone, some 49 species are found in diverse habitats and elevations. Here 40 species are native and many are annual. The annuals are best developed in and around the Great Valley (Crampton, 1980), where they occur in some abundance, coinciding with the California Prairie and the foothill oak woodland (Küchler, 1977). Perennial clovers ordinarily occur at an elevation above 1000 m along the coast or in the interior mountains.

DESCRIPTION AND GEOGRAPHICAL RANGE OF IMPORTANT SPECIES

Ten species of clovers native to the western U.S. are described below. The author considers these to be the most important range species because of their overall local abundance and distribution over a very wide geographical area. All of the species are regarded as equivalent inasmuch as they provide a superior nutritious forage to the grazing animals.

T. longipes Nutt. in Torr. and Gray. Long-stalked Clover

Perennial by slender rhizomes, these originating from a stoutish taproot; stipules entire, lanceolate, 1 to 3 cm long; leaves grey-green, glabrous to hairy, the lowermost with ovatish leaflets, the upper leaves with much narrower and longer leaflets; peduncles up to 10 cm long and greatly extended above the leaves; inflorescence without an involucre, ovate, 1 to 2 cm long; flowers nearly sessile, whitish to light purplish; calyx teeth conspicuously hairy.

This clover is found in California in the Sierra Nevada from Tulare County north to Modoc and Shasta counties; also in the North Coast Ranges; thence north to Canada and east to the Rocky Mountains.

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T. wormskioldii Lehm. Mountain Clover; Coast Clover

Perennial by slender rhizomes; herbage glabrous; stipules toothed to laciniate up to 2.5 cm long; leaves usually green, sometimes blue-green, the leaflets ovatish to oblong, the lowermost leaves with shorter petioles and smaller leaflets; inflorescences on peduncles extending well above the leaves; involucre conspicuous, flattish, evenly jagged-toothed to lobed, the lobes with long teeth; corollas with dark red-purple wings and keel, the banner light purple to pinkish.

Southern California north to British Columbia and east to the Rocky Mountains.

T. cyathiferum Lindl. Cup Clover

Smooth annual with usually spreading stems 8 to 35 cm long; stipules mostly ovatish; leaves pale green, the leaflets obovate to narrowly elliptic; inflorescence many-flowered with a large, papery, conspicuously-veined, ciliate, toothed involucre; corollas pinkish; calyx segments (or most of them) 3-several-forked.

In California this species occurs in the Sierra Nevada and higher mountains of the Coast Ranges, thence north to British Columbia. Also in Nevada and Idaho.

T. tridentatum Lindl. Tomcat Clover

Mostly glabrous annual; stems several or solitary, erect, 10 to 50 cm tall; stipules entire, lanceolate in the lower leaves, becoming ovatish and jagged-toothed in the upper ones; leaflets ordinarily much longer than broad to sometimes linear; inflorescence dense, with a jagged-toothed, flat involucre 10 to 15 mm broad; corollas 12 to 15 mm long, red-purple to light-purple, the banner pinkish to white-tipped; calyx ordinarily with two short lateral teeth in addition to the apical point (thus tridentate).

West of the crest of the Sierra Nevada and Cascade Mountains, north into British Columbia.

T. variegatum Nutt. in Torr. and Gray. White-tip Clover

Glabrous annual; stems several to many, often sprawling but sometimes erect, 10 to 50 cm long; stipules ovatish and jagged-toothed; leaflets mostly obovate, variable in size depending upon the height of the plant and the nature of the habitat; inflorescence with a distinctly lobed involucre, each of the lobes 3 to 7-toothed; corollas 5 to 8 mm long, purple to red-violet, the petal segments pink- to white-tipped; calyx teeth subulate without lateral teeth. The size of the inflorescence and the involucre and corolla color variable over its geographic distribution.

Mostly west of the crests of the Sierra Nevada and Cascade Mountains; from southern California north to British Columbia but also east, in some areas, to the Rocky Mountains.

T. microcephalum Pursh. Maiden Clover; Small-head Clover

Figure 27-1. Commonly a softly-hairy annual; stems slender, more or less spreading or sprawling to ascending, 5 to 25 cm long; inflorescence dense, many-

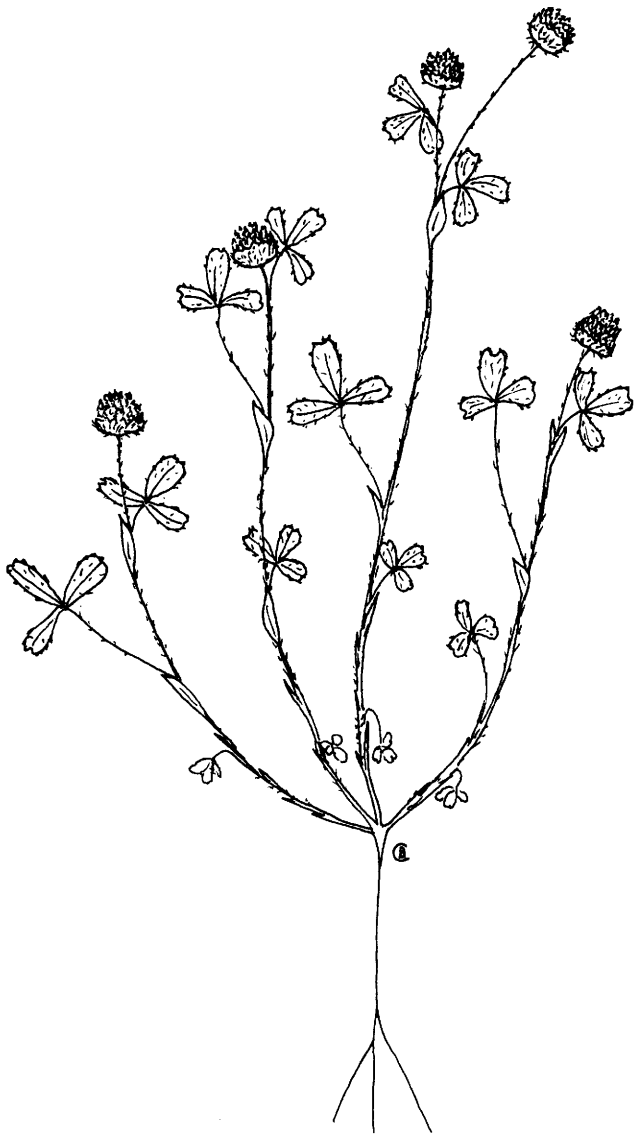

Fig. 27-1. *Trifolium microcephalum.* Collected in the open area as shown in Fig. 27-2.

flowered, with a hairy involucre that is first cup-shaped but later flattish as fruits mature; stipules narrow in the lower leaves to ovate in the upper; leaflets obovate, commonly notched at the apex; corollas 3 to 5 mm long, commonly rose-pink or sometime whitish.

Maiden Clover occurs from Baja California north to British Columbia; mostly west of the crest of the Sierra Nevada and Cascade Mountains, but occasionally east to the Rocky Mountains.

tions below 1000 m, a Mediterranean climate of cool, wet winters and hot, dry summers has molded an open grassland and oak woodland type of range where the forage consists primarily of annual species (Fig. 27-2). The area is some 7 million ha in extent (Biswell, 1956) and accommodates over 65% of all the livestock grazing in California. The maximum yield of forage (and consequently the heaviest grazing) occurs in February, March, and April. By the middle of June most of the herbaceous forage is completely dry, and seed is dispersed. Seed lies upon the soil until fall, when germination is initiated by soaking rains. During the cool winter seedling growth is rather slow. In the spring, with increasing temperature and daylength, the clovers undergo rapid vegetative development and soon flower.

The annual clovers must compete with the more abundant annual grasses such as *Bromus mollis* L., *B. diandrus* Roth., *B. rubens* L., *Avena fatua* L., *A. barbata* Pott. ex Link, *Vulpia myuros* (L.) C.C. Gmel. (*Festuca myuros* L., which also includes *F. megalura* Nutt.), and *Hordeum murinum* L. ssp. *leporinum* (Link.) Arcangeli. Grasses in years of above average rainfall readily overtop the developing clover seedlings and rapidly exhaust the soil moisture later in the spring.

Perennial clovers are found principally in the mountains at elevations above 1200 m. The North Coast ranges and Sierra Nevada Mountains of California, the Cascade Mountains, the higher intermountain ranges, and the Rocky Mountains are primary areas. Most species are found in meadows, but some develop in open coniferous forests or on rocky alpine slopes and flats. Two species, *T. macrocephalum* (Pursh.) Poir. and *T.*

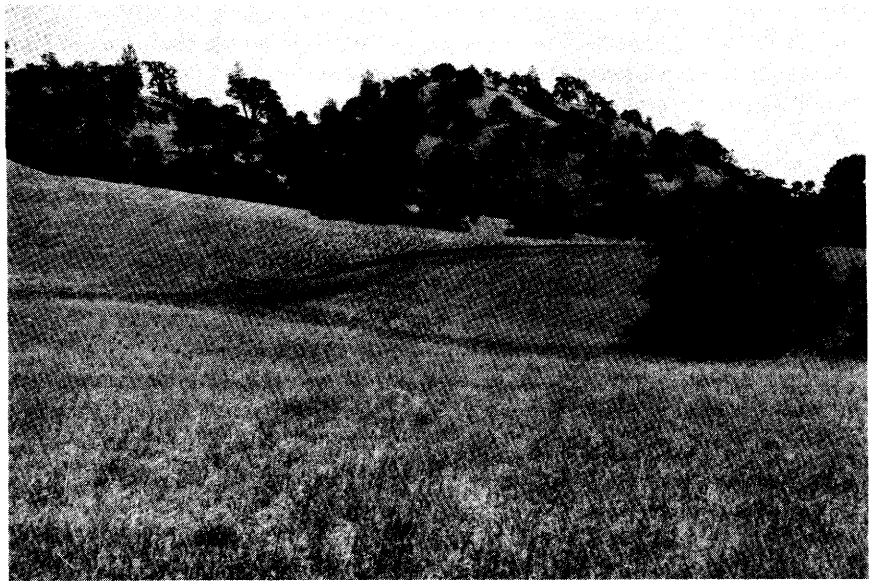

Fig. 27-2. A foothill habitat, typical of that surrounding the Great Valley of California. The trees are *Quercus douglasii, Q. wislizenii* and *Pinus sabiniana.* At the center are numerous tufts (dark) of *Stipa pulchra* A. S. Hitchc., a bunchgrass. The open areas are covered with annual grasses, annual clovers and other annual forbs.

andersonii, grow in association with sagebrush (*Artemisia tridentata* Nutt.) on dry, well-drained soils.

The mountain clovers are covered by snow, or are dormant during the winter. They renew growth in the spring and flower during summer. The cool summer temperatures of the mountains, along with an adequacy of soil moisture, favor a perenniality of these plants. Besides their mountain environment, some species such as *T. wormskioldii* occur on the immediate coast, inhabiting beaches, marshes, and meadows among dunes. Good stands sometimes are found on wet slopes and in niches of the sea cliffs. Here the species is known as "Coast Clover."

The Great Valley of California

Adobe clay flats occur throughout the Great Valley and are also found in valleys in the foothills. Some of these flats are quite extensive while others have been reduced to small areas. Regardless of size, they become flooded during the winter. As the rainwater evaporates, a meadow vegetation develops and by the end of May the soil and plants are dry. On such flats the sac clovers (so called because of corolla inflation) are prominent. The most important species is *T. stenophyllum* Nutt. (Crampton, 1980). Associated species include *T. amplectens* T. & G., *T. flavulum* Greene, and *T. fucatum* Lindl. The most spectacular of these is *T. fucatum.* Plants of this species grow to as much as 50 cm high with broad leaflets 1 to 2.5 cm long and produce large flowers 1 to 2 cm long. The corollas are at first cream-colored; they inflate and become reddish in age.

Good stands of sac clovers are yet to be found on the undisturbed flats but much of the adobe areas are in crop agriculture. Sac clovers were major components of pristine meadows in the Sacramento Valley (Crampton, 1980).

Above the basins and towards the edges of the valley, large and extensive but remarkably gently sloping alluvial fans occur. Some of them coalesce and form terraces. These well-drained soils support a dense grass cover as well as many kinds of herbaceous broadleaved plants.

Several species of annual clovers are of considerable importance here as: *T. tridentatum, T. gracilentum, T. bifidum, T. ciliolatum* and *T. microcephalum. Trifolium variegatum* is common in this area but is restricted to wet or moist soils along streams, at edges of vernal pools, or in small depressions where rainwater has stoo. *Trifolium depauperatum* Desv. is rather common but occurs on soils of high clay content.

The Foothills

The foothills surrounding the Great Valley may be without trees or wooded (Fig. 27-2), the significant trees being *Quercus douglasii* H. & A. (blue oak), *Q. wislizenii* A. DC. (interior live oak) and *Pinus sabiniana*

Dougl. (digger pine). The soils of the Coast Range foothills are largely derived from sedimentary bedrock. Fairly large areas of intrusive serpentine occur, ordinarily above about 300 m. In the Sierra Nevada foothills soil is formed from metamorphosed sedimentary or volcanic rock, lavas, serpentine, or gabbro, and usually at higher elevations, granite. Foothill soils support good to excellent stands of *T. microcephalum, T. microdon, T. tridentatum, T. ciliolatum, T. bifidum,* and *T. gracilentum.* These are the principal forage clovers in the foothill rangeland. A few native clovers such as *T. fucatum, T. dichotomum* H. & A. and *T. albopurpureum* T. & G., are found on serpentine soils, but often in sparse stand.

Singly, the most important native annual range clover is *T. microcephalum* (Fig. 27–1). It occurs consistently in good stands on valley plains, foothill slopes, and flats, and even ascends into the mountains to about 2500 m. The species is widespread over the Pacific Coast states and is heavily grazed in all areas.

The Mountains

Meadows are characteristic habitats for clover development. *T. wormskioldii* and *T. longipes* are major species in the western states. In the Rocky Mountains several other species also occur (e.g., *T. dasyphyllum* T. & G., *T. gymnocarpon* Nutt., *T. haydenii* Porter, *T. nanum* Torr. and *T. parryi* A. Gray). They are valuable range plants at high elevations (Hamilton, 1961). Some of them, such as *T. nanum* and *T. haydenii,* are of considerable value on rocky alpine slopes and flats. *T. mucronatum* Willd. ex Spreng., closely allied to *T. wormskioldii,* also occurs in the Rocky Mountains but extends its range much further south through the Sierra Madre of Mexico. *Trifolium breweri* S. Wats. is one of the few perennial species adapted to dry soils of the open coniferous forest. It occurs in the Sierra Nevada and into Oregon.

DENSITY AND COMPETITION

Native annual clovers hold their own in regard to density (percentage of the vegetation), competition with other plants, and response to grazing regimes. Four of the most common clovers in the southern Sierra Nevada (Madera County) are *T. microcephalum, T. ciliolatum, T. tridentatum,* and *T. variegatum.* In a 5-year period their density varied from less than 1% to almost 11% of the available forage (Talbot and Biswell, 1942). The amount and time of rainfall as well as the moisture content of the soil was responsible for the wide yearly fluctuation. These clovers make most of their growth in April or early May and are greedily taken by cattle wherever they occur (Bentley and Talbot, 1951). In good clover years these plants furnish a large part of the spring forage.

In the foothills of the North Coast Range (Mendocino County) *T. microcephalum, T. microdon,* and *T. oliganthum* average 7.6% of the ungrazed herbaceous vegetation (Crampton, unpublished data). The similar densities to clover species in these widely separated range areas are still subject to the amount and distribution of rainfall in any given year. The ultimate survival of clover seedlings in this climate depends upon the nature of the rainfall (Rossiter, 1966).

Compatibility of clover species with each other is of considerable interest. In some locations five or six species of native annual clovers grow together (Crampton, 1980). In most areas three or four species are commonly associated. Little research has been done on the interaction of the several clovers growing in any given range area. More evident are investigations relative to nitrogen fixation of the species (Holland et al., 1969; Vaughn and Jones, 1976). Uniform distribution of clover plants such as *T. microcephalum, T. microdon, T. ciliolatum* and *T. gracilentum* over the grazing terrain suggests uniform inoculation by and effectiveness of *Rhizobium.* Colonialization of *T. tridentatum* may indicate colonies of effective bacteria, but it does not explain a scattering of plants of this species in other areas. Competition among native *Rhizobium* strains is suggested as a common occurrence in annual type rangelands (Holland et al., 1969).

What effects the levels of phosphorus and sulfur have upon the density or distribution of clover species is not known. These two elements are necessary to increase the yields of seeded range clovers as well as to increase the quantity of protein (Williams et al., 1957).

Competition for nutrients and light is afforded by the abundant grasses. The first soaking rains of fall initiates massive germination of grass seed. Should the temperature remain warm after the rains, grass seedlings would grow rapidly and shade out clover seedlings. Various species of *Erodium* (the filarees), especially *E. botrys* (Cav.) Bertol. and *E. brachycarpum* (Godr.) Thell., are serious competitors for clover seedlings. Following the rains, leaf rosettes of the filarees develop rapidly and soon cover areas where clover seeds are present. Despite competition from other kinds of plants, however, the clovers develop good stands. Annual clovers have an excellent seed production and the seeds have hard coats. In severe drought years, clover seed remain dormant and do not germinate until a time of sufficient rain.

In the perennial mountain clovers, density becomes a matter of seed-producing ability and grazing pressure. Cross pollination is probably the norm in perennial species. Owing to the usual sparse stand of these clovers, the colonies may be too far apart for successful insect pollination, with resulting poor seed set. Any decline in the pollinator insect population would be further deleterious. The normally slow seedling development and vegetative growth becomes a problem in the maintenance of clover populations. Those forming rhizomes or stolons may be restricted in lateral spread by competition from associated plants and by the effects of too-close grazing. Taprooted species are particularly vulnerable to close grazing.

The annual clover *T. cyathiferum,* which inhabits meadows, fares much better than the perennials. Its excellent seed production, ability to rapidly colonize any disturbed site, and effective spread by animals make it a valuable forage in the mountains.

In the Rocky Mountains *T. parryi, T. nanum, T. haydenii,* and *T. dasyphyllum* are adapted to rough rocky areas and grow under extremely adverse conditions (Hamilton, 1961). These species are of sufficient density to furnish valuable forage.

Meadows vary from large valley flats to small patches along streams. Density of the clovers depends upon the water relations in the meadow and competition from other plants. Any adversity such as accelerated drainage, soil disturbance, or overgrazing affects the whole meadow ecosystem. In this habitat the biology of the native clovers is little known.

Grazing

The native range clovers are sought after as forage by most animals as plant or seed or both. Sheep, deer, and cattle in their grazing produce the most dramatic effect on clovers. Sheep are perhaps the most selective grazers since they literally "camp" on clover patches and move on only after most of the plants are consumed. This type of grazing is a disaster for the mountain clovers. *Trifolium wormskioldii* and *T. longipes* resist fairly close grazing and recover fairly well by means of new shoots that arise from rhizomes. In the taprooted species as *T. parryi*, however, prolonged grazing quickly eliminates the parent plants.

The critical factor in the maintenance of perennial species is establishment of seedlings. The grazing animal may remove many seedlings. In California, 130 years of intense grazing and depredation of seedlings in the mountain meadows has seriously affected the spread of clover plants by greatly reducing the density of the populations.

In the foothill oak woodland and grassland area the annual clovers have fared much better under intense grazing. The foothill rangelands had been exposed to year long grazing since about 1790 and by 1890 were saturated with sheep and cattle. Periodic and severe droughts did not appreciably affect native clovers but did reduce the density of perennial grasses. In particular these were *Bromus carinatus* H. & A., *Elymus glaucus* Buckl., *Melica californica* Boland. and *Stipa pulchra* A. S. Hitchc. Under grazing pressure and severe droughts the California grassland become one of essentially annual forage plants. The clovers resisted grazing and droughts by means of an excellent seed production and hard-coated seed. Hard seed coats are impermeable to water, frequently requiring a year or more for the coat to become permeable and permit germination. Thus viability of seed is achieved over unfavorable periods.

Some clover seed is consumed by the grazing animal and, unless ground up during chewing, passes through the digestive system to be deposited upon the ground in the feces. Some of the seed germinate in the

decomposing dung after the fall rains begin. Clover is readily dispersed in this manner. Most of the clover seed falls to the ground about the parent plants. Annual clover density is maintained by a large seed production, hard seed, and amount and distribution of rainfall. Grazing intensity and duration seem to have little effect upon clover density (Pitt and Heady, 1979).

In the annual clovers there are wide differences in growth habit and leaf production. Under optimum conditions two major types of stem structure are apparent. In *T. tridentatum, T. bifidum,* and *T. ciliolatum,* stems are stout and erect with ascending branches. *Trifolium microcephalum, T. microdon* and *T. cyathiferum* have a structure with widely divergent, sprawling, slender stems. In some species such as *T. variegatum* and *T gracilentum,* stems may be erect or sprawling and either condition is related to available moisture, soil fertility, and degree of competition from other plants. Larger leaflets are produced on erect stems, while smaller leaflets occur on clovers with slender and sprawling stems. What effect either of these growth types has upon selectivity by grazing animals is not known. Overall, the larger-leaved species may be favored.

RESPONSE TO FERTILIZER

Fertilized ranges produce more forage and forage of higher nutritive quality than unfertilized areas. Fertilization also enhances seed production. In the annual clover ranges, nitrogen, phosphorus, and sulfur are deficient. Much of the research on clover fertilization has developed around the establishment and production of introduced species such as *T. hirtum* All., *T. subterraneum* L., and *T. incarnatum* L. (Williams et al., 1957). Phosphorus significantly improves clover growth in the native annuals. In Madera County, CA, the value of sulfur application on native clover stnds is well documented (Bentley and Green, 1954; Bentley et al., 1958; Woolfolk and Duncan, 1962). Plots fertilized with a sulfur component in the application averaged 2877 kg/ha (1308 lb./acre) greater production than unfertilized plots. Nodules were larger and more abundant on fertilized plants.

In regard to nitrogen fixation, the native clovers have equal potential with that of introduced clovers such as *T. hirtum* and *T. subterraneum* (Vaughn and Jones, 1976). The usually good stands of local species greatly enhance the existing rangeland even without application of costly fertilizer.

MANAGEMENT

The native annual range clovers are considerably more important than the introduced species, since they are usually sufficiently dense and occur over a large area (7 million ha in California alone). The introduced species greatly improve the quantity and quality of forage on local ranges, but are of limited area in extent.

Little research is directed toward the production and management of native clovers. They respond to grazing regimes and fertilization as the introduced species.

The mountain clovers require an adequate moisture supply, protection from severe grazing and trampling, and minimal competition from more aggressive plants. New growth on the perennial clovers is very susceptible to grazing. Removal of too much herbage interferes with lateral expansion of the parent plants and in development of flower stalks. In meadows, heavy grazing of preferred species such as the clovers tends to increase undesirable forage plants. Without a doubt, many clover stands have been eliminated in this way.

Any change in the water relations (for example abrupt drainage or too-long inundation of meadows) could rapidly eliminate any given clover species. Creation of a meadow by means of water spreading may be of value in increasing the extent of clover populations, as clovers would come to occupy an area where they were not found before. Such a method is not without problems, however. Using seed or clones to effect establishment may also stimulate competition from weedy species, and grazing too soon would drastically limit success.

Until the biology of the native perennials becomes known, prudence in grazing practice will be beneficial in maintenance of existing stands. Livestock producers should strive to increase the carrying capacity of their ranges by seeding, soil treatment, water conservation, controlled grazing, and other practices to increase the production of both native and introduced clovers (Hamilton and Gilbert, 1971).

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