Tarweed, an Unloved Annual-Type Range Plant

Gregory K. Perrier, William A. Williams, and John W. Menke

Tarweed is one of a few native range plants in California that thrived after the change from a perennial dominant range to range dominated by exotic annuals resulting from European settlement. Yellow tarweed, *Holocarpha virgata* Keck, is well adapted to the hot dry summers in the Central Valley of California and the surrounding foothills. Ranchers dislike tarweed on their ranges because its tall, sticky, aromatic summer growth is not palatable to livestock, hides forage needed by livestock, and coats the faces and legs of livestock with a tarry resin.

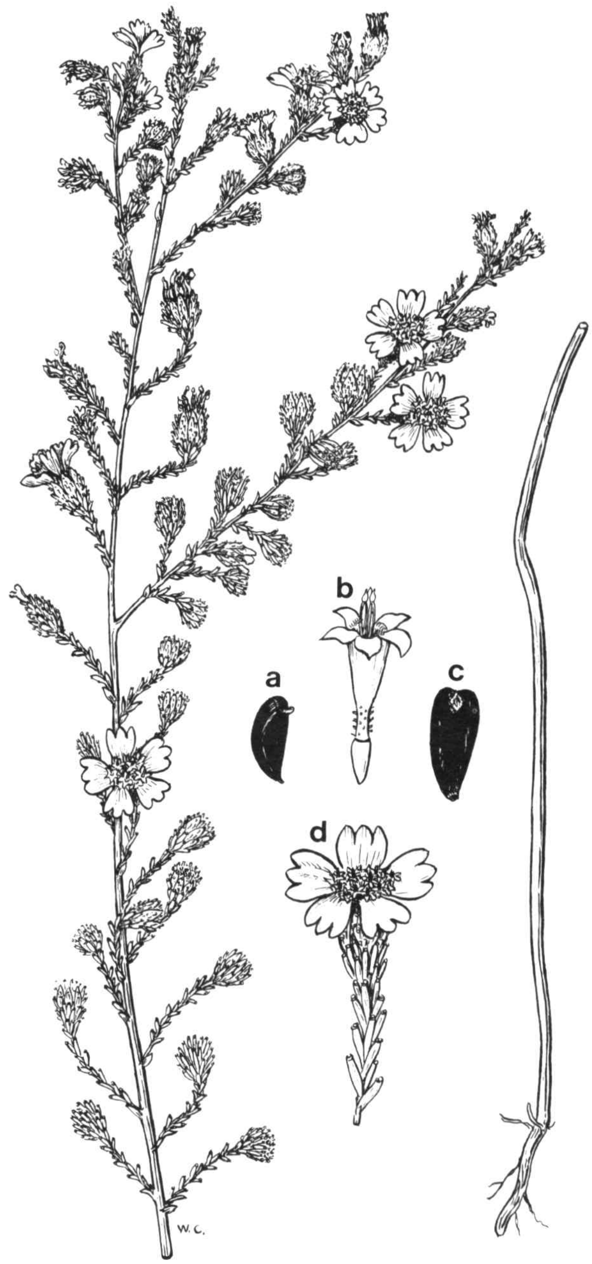
The California prairie began to change drastically after Europeans arrived. Annual grasses and forbs from the Mediterranean area were introduced both accidentally and intentionally. These species were shorter-lived and shallower-rooted than the perennial grass that they replaced. Growing numbers of domestic livestock greatly increased the grazing pressure on the range resulting in less soil moisture use by plants. Also, the summer fires that had swept through the perennial grasslands were controlled. These changes undoubtedly favored the spread of tarweed. Tarweed is in the family Compositae, tribe Heliantheae, and subtribe Madinae. It was first described by Gray (1859), who classified it as *Hemizonia virgata*. Recent studies indicate that tarweed consists of many separate populations that do not reproduce when crossed because of chromosome pairing problems.

Phenology, Growth, and Reproduction

Field observations show that germination starts in the fall at the same time that the winter annuals are germinating and it continues into April (Perrier 1980). Other summer annuals such as *Lotus purshianus* and *Hemizonia fitchii* also germinate in the fall. Still others such as turkey mullein *(Eremocarpus setigens)* and vinegar weed *(Trichostema lanceolatum)* germinate in the spring and appear to be restricted to open areas with low vegetative cover, thus avoiding competition with the winter annuals.

By the end of winter, the tarweed plant has developed about a dozen broad leaves in a rosette and a deep taproot. Roots of tarweed go deeper than most of the winter annual grasses, reducing competition with them for soil nutrients and moisture. Penetration rates in sand of over 1.5 inches per day have been observed. From late spring until early summer the shoots elongate and branch out with bract-like leaves on woody stems that stand 1 to 2 feet tall.

In August and September tarweed produces composite



Virgate or yellow tarweed (Holocarpha virgata)*:* ***a,*** *ray achene;* ***b,*** *disk flower;* ***c,*** *disk achene; and* ***d,*** *inflorescence (Robbins, Bellue and Ball. Weeds of California. 1951).*

Authors are research assistant, professor, and associate professor, Department of Agronomy and Range Science, University of California, Davis 95616. Senior author is now senior research fellow, Department of Pasture Agronomy, Ahmadu Bello University, Zaria, Nigeria.

heads that have 3 to 5 ray flowers and 3 to 12 disk flowers. The ray flower is incomplete, having only a carpel, but the disk flower also has anthers that produce abundant pollen, an important food source for honeybees. The ray and disk achenes mature by the end of September. Achene dispersal is caused by rain and wind and continues into the winter. The achenes, which have over 20% crude protein, are eaten by ground squirrels.

The ray achenes are quite different in appearance, hardness, and the vigor of resulting seedlings, but there appears to be no morphological difference between the plants they produce. The ray achene is 3 mm long, ovate-shaped, and extremely hard. In laboratory tests no germination was achieved without scarification. The factors causing ray achenes to germinate in the field are unknown. Tarweed produces at least 5 times as many fertile ray achenes as fertile disk achenes.

The disk achene is 4 mm long and lanceolate shaped. Newly collected disk achenes with filled endosperms have 100% germination without any pretreatment, but less than one-fourth of the disk achenes are filled. Most of the germination in the fall is from disk achenes.

Achene dispersal and plant senescence starts at the end of October. By the end of spring only the woody stems and thicker branches remain, and they stand until the following rainy season.

Livestock use tarweed in winter and early spring while it is young and succulent. Use decreases rapidly as it increases in height and resin covering. It is hardly grazed at all at maturity when covered with resinous exudate, although it is still an important source of protein and moisture for ground squirrels. Summer annuals are often the only actively growing green plants, relatively high in protein, available in the summer on annual range. To discourage herbivory, summer annuals have apparently evolved mechanisms such as spines *(Hemizonia fitchii)*, aromatic compounds in vinegar weed *(Trichostema lanceolatum)*, and aromatic resins as in tarweed. Few animals are able to feed on these plants in the summer.

Competition

Tarweed competes with winter annuals by diminishing soil moisture in late spring. Because tarweed germinates in the fall and grows in close association with dense stands of winter annuals, there is probably also some competition for light and nutrients during the growing season, but the degree of competition is unknown. Major factors complicating our understanding of competition are the large diversity found in the species of plants grouped together as winter annuals, the great plasticity in growth and botanical composition of the annual grasslands due to soil and climatic variations, and the effects of grazing and human manipulations on these grasslands.

The occurrence of tarweed in the early successional stages of the annual grassland-type indicates that it is more compatible with the less productive species commonly found in these stages, thus tarweed has been designated an "invader" species. The shallow-rooted, short statured, early maturing alien annual grasses use less light and water than the late successional perennial grasses or taller annual grasses. This results in a surplus of moisture that tarweed is able to utilize.

Because tarweed relies on stored soil moisture for summer growth, it is most competitive on deep fine textured soils. Tarweed is distributed widely over the range but is more common in swales, and tarweed often dominates the better forage-producing sites.

Annual variations in climate—mainly rainfall and temperature—result in large year-to-year differences in the composition of the California annual grasslands. Annual grasses are dominant in some years, and annual forbs or annual legumes in other years. The amount of competition between tarweed and these winter annuals is less in grass-dominant years and greater in forb-dominant years. The nitrogen-fixing ability of annual legumes tends to increase soil fertility, which increases forage production and water use and therefore reduces tarweed densities.

Instead of being a highly competitive invader like some alien annual grasses, tarweed seems to have been able to invade the annual grassland by taking advantage of underused resources of moisture, nutrients, and light. Thus, its survival is due largely to niche separation from the winter annuals rather than aggressive competition.

Management

There are two ways of managing annual-type grassland to limit tarweed production: (1) increase early canopy cover and soil-moisture use by manipulating soil fertility and thereby species composition and (2) directly removing tarweed by mechanical or chemical means. A consistent set of grazing management guidelines has not been attained to date.

Fall fertilization of annual range with nitrogen has been shown to reduce tarweed density. However, it is doubtful whether the large amounts of nitrogen fertilizer required annually to reduce tarweed density effectively (100 lb/acre) would be economical at today's prices on much of the range. Increased forage production in a pasture seeded with rose clover *(Trifolium hirtum)* and fertilized with single superphosphate has been observed to reduce tarweed.

Tarweed can be suppressed directly either by mowing or by applying broadleaf herbicides such as 2,4-D (2,4-dichlorophenoxyacetic acid). These techniques can greatly reduce a population of tarweed leaving very few plants to flower and set seed. However, the timing of these activities is critical. Mowing any time prior to May reduces tarweed very little, but mowing in July reduces tarweed by about 90% and mowing in late August virtually eliminates seed production.

Perrier (1980), using 1.5 lb/acre of a low volatile ester of 2,4-D, found that tarweed was affected much more by the herbicide treatment before rapid stem growth than after. Herbicide application in winter or early spring results in the greatest reduction apparently, but this needs further study as does the impact of leaving various amounts of plant residue.

One of the major obstacles to mechanical or chemical removal of tarweed is the seed bank of hard ray achenes that exists on sites. To be successful, the use of these methods must be long-term to totally eliminate tarweed, otherwise the pasture will be reinfested once the eradication project ends. Thus, it is unlikely that these direct treatments can be economically justified on rangeland solely for the control of tarweed.

We conclude that control of tarweed in practice must depend on increasing niche overlap and competition, especially for moisture, by the more useful winter annual species. This can result from grazing management, the seeding of annual legumes, or fertilization, but it needs to be accomplished as a fringe benefit of the economically sound use of practices that increase forage production. ●