Bromus madritensis L. (Poaceae)
Foxtail Chess

Description. Annuals, 1.5-4.5 dm tall, erect, stems erect, glabrous to short-soft-hairy. Leaves alternate; ligules 1-3 mm long, lacerate; auricles absent; sheaths glabrous to sofi-pubescent; blades linear, flat, 1.5-4 mm wide, glabrous to sofi-puberulent. Inflorescence an open to dense terminal panicle, 4-8 cm long. Spikelets 20-30 mm long, slightly compressed, composed of 3-8 florets, the glumes linear to narrowly lanceolate, the lower one 5-10 mm long, 1-nerved, the upper one 8-13 mm long, 3-nerved; lemmas 12-17 mm long, lanceolate, 3-5-nerved, the back keeled to rounded, the apex with a terminal awn 12-20 mm long and two lateral teeth 4-5 mm long. In California, flowering from March to June. (Hitchcock 1944, Holmgren and Holmgren 1977, Munz 1959, Pavlik 1995, Smith 1980, Wilken and Painter 1993).

Note: *Bromus madritensis* comprises two morphological races, *B. madritensis* ssp. *madritensis* and ssp. *rubens*. Subspecies *madritensis* has glabrous to slightly pubescent sheaths and stems, and the inflorescences are somewhat open and oblqng to ovoid. Subspecies *rubens* has pubescent sheaths and stems, and the inflorescence is dense and ovoid. Subspecies *rubens* tends to occur in drier habitats than ssp. *madritensis*. Esnault (1984) described pafferns of geographic variation in *Bromus madritensis* in Mediterranean Europe and northern Africa, providing evidence for intergradation between the two subspecies in its native range. In contrast, Pavlik (1995) treated the two races as distinct species.

Bromus madritensis is closely related to *B. tectorum* L. and *B. diandrus*, both weedy, arid-land species naturalized throughout much of western North America. *Bromus diandrus* , like *B. madritensis*, has a lower glume with 1 vein, but differs by having the lower glume 10-20 mm long and the lemma awns 30-60 mm long. The former differs from true *B. rigidus* by several traits, including longer and spreading to pendent spikelets (Gill and Carstairs 1988, Pavlik 1995, Smith 1980). *Bromus hordeaceus* is characterized by 3-veined lower glumes and lemma awns 4-9 mm long and includes plants previously referred to as *B. mollis* and *B. molliformis* (Smith 1980).

Geographic distribution. A native of southern Europe, *Bromus madritensis* has been introduced and naturalized in southern Africa and western North America from British Columbia south to Mexico, generally west of the Great Basin. (Arnold and de Wet 1993, Gibbs Russell et al. 1955, Hitchcock 1944, Holmgren and Holmgren 1977, Tselev 1984). It (only as ssp. *rubens*) has been reported as a waif in scattered localities east of the Rocky Mountains (Fernald 1950, Gleason and Cronquist 1991).

Both subspecies of *Bromus madritensis* were first reported from California in the late 19th century (i.e., ssp. *madritensis* by Watson (1880); ssp. *rubens* by Parish 1920). *Bromus madritensis* ssp. *rubens* has been reported from all northern California Islands (Junak et al. 1997). Subsp. *madritensis* is apparently restricted only to Santa Cruz Island. The species is widely distributed throughout most California counties, but ssp. *madritensis* occurrs primarily west of the Sierra Nevada (Anonymous 1998).

Bromus diandrus (previously known as *B. rigidus*), a native of Mediterranean and southwestern Europe, is widespread in western North America, South America, Australia, southern Africa, Hawaii, and Japan (Arnold and de Wet 1993, Chapman 1991, Gibbs Russell et

al. 1955, Gill and Carstairs 1988, Hitchcock 1944, Holmgren and Holmgren 1977, Kon and Blacklow 1989, 1990, Koyama 1987, Wagner et al. 1990). *Bromus diandrus* was first reported from San Francisco by Watson (1880), but it had apparently become widely established throughout California before the end of the 19th century (Parish 1920, Burtt Davy 1902, Robbins 1940).

Bromus hordeaceus (previously known in California as *B. mollis*), a native of Europe, is widespread throughout much of western North America, Hawaii, South America, and Asia (Arnow 1987, Holmgren and Holmgren 1977, Koyama 1987, Wagner et al. 1990). *Bromus hordeaceus* may have become widely established no later than the end of the 19th century (Burtt Davy 1902, Parish 1920, Robbins 1940).

Reproductive and vegetative biology. Like most grasses, *Bromus* species are wind-pollinated wind (Proctor et al. 1996). The reproductive biology of *Bromus diandrus*, *B. hordeaceus*, and *B. madritensis* apparently has not been studied in detail. However, both *Bromus diandrus* and *B. madritensis* are self-compatible and have a mixed mating system that is skewed toward self-pollination (Brown and Allard 1981, Kon and Blacklow 1990). Seeds of both *B. diandrus* and *B. madritensis* germinate readily, but their recruitment and local distribution differ slightly in relation to soil microtopography (Harper et al. 1965).

In California, seed production in both *B. diandrus* and *B. hordeaceus* is inversely related to soil moisture and cool growing conditions, but reproductive capacity and seed production under drought conditions remains relatively high (Ewing and Menke 1983, Gleichsner and Appleby l996, Gordon and Rice 1992). A certain proportion of *Bromus diandrus* seeds remain dormant under cultivated conditions, especially with shallow tillage and can persist for several years (Cheam 1986, Harradine 1986). *Bromus diandrus* had higher densities in sunny rather than shaded conditions, and persisted under shade, relative to *Bromus hordeaceus*, in *Quercus agrifolia* woodland (Maranon and Bartolome 1993). In these oak savannas, *Bromus hordeaceus* was almost entirely restricted to open, sunny sites between tree canopies.

Ecological distribution. Introduced species of bromes tend to occur in disturbed sites, roadsides, fallow fields, and grazed pastures (Arnow, 1987, Munz 1959, Wilken and Painter 1993), and (with *Avena* spp.) have become an important component of the annual grasslands and savannas in California (Heady 1956, 1990). *Bromus madritensis* tends to be a lesser component of the California annual grassland relative to *B. hordeaceus* and *B. diandrus* (Bentley and Talbot 1948, Heady 1956, 1958, 1990, Talbot et al. 1939). Both *Bromus diandrus* and *B. hordeaceus* tend to occur over a broader range of soil types and rainfall regimes than *B. madritensis* (Heady 1990, Janes 1969, McCown and Williams 1968). *Bromus diandrus* tends to occur more frequently on sites with higher annual rainfall than those supporting either *B. madritensis* or *B. hordeaceus* (Janes 1969). Bentley and Fenner (1958), Heady (1956), Parsons and Stohlgren (1989), and Talbot et al. (1939) reported that fire had little effect on species composition of annual grasslands dominated by *Bromus*, apparently because residual seed banks were unaffected by fire.

Bromus diandrus has been reported as a common understory annual in closed cone pine forests, oak woodlands, and coastal prairies, depending on precipitation and substrate (Elliott and Wehausen 1974, Holland 1974, Maranon and Bartolome 1993, Philbrick and Haller 1990, Vogl et al. 1990, Peñalosa, J. 1963). *Bromus diandrus* also negatively affects establishment of blue oak (*Q. douglasii*) seedlings, because early germination, high densities, and deep root penetration

reduce water availability (Gordon et al al. 1989, Gordon and Rice 1992, 1993). Similar mechanisms in Australian wheat fields have been reported by Gill et al. (1987). Under experimental conditions, *Bromus diandrus* became established as a result of early rains and moist winters (Robinson and Quinn 1988, Robinson et al. 1995). It may also alter soil-water conditions to favor its persistence (Holmes and Rice 1996).

Weed status. Bromus madritensis is not considered a noxious weed in agricultural or horticultural practice, at least at a global level (not listed by Holm et al. 1977) nor is it listed for the United States in Lorenzi and Jeffery (1987). However, subspecies *rubens* is considered a noxious weed in California deserts by the State Dept. of Food and Agriculture (Anonymous 1996).
Neither *Bromus diandrus* nor *B. hordeaceus* are considered noxious weeds by Holm et al. (1977), Lorenzi and Jeffery (1987) or the State Dept. of Food and Agriculture (Anonymous 1996).

Microbial and insect pathogens. No literature was found that reported either microbial or insect pathogens of *Bromus madritensis*, *B. diandrus*, or *B. hordeaceus*.

Herbicide control. Triazinone herbicides, dimethazone, and metribuzin have been used to control *B. diandrus* (Dial and Thill 1988, Garcia et al. 1994). Resistance to metribuzin in *B. diandrus* has been reported by Gill and Bowran (1990). No other literature pertinent to herbicide control was found.

Other control methods. Heenan et al. (1990) evaluated varying patterns of tillage and crop rotation in controlling *Bromus diandrus*. Rotation of wheat with lupin crops reduced infestation by *Bromus diandrus* when combined with occasional herbicide treatment, light tilling, and retention of stubble (Cheam et al. 1992).

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