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Did Nuttall collect his plant near the headwaters of the Platte, in June, as he says, or near the Three Buttes, called thus by the Canadians—as he also says? Future collecting may decide it.

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TWO TYPES OF BROAD-LEAF ERODIUM IN CALIFORNIA

KENNETH A. WAGNON AND HAROLD H. BISWELL¹

Shortly following the initiation of the range forage and cattle investigations at the San Joaquin Experimental Range,² O'Neals, California, in 1935, two distinct forms or types of broad-leaf *Erodium* were observed on the station lands. According to Jepson's manual (4) both types would be classified as *Erodium Botrys* (Cav.) Bertol. Growth habits of the two types differ considerably and often have a pronounced effect on the length of time green forage is available for livestock and on the total bulk of feed produced; therefore, it is economically important to be able to differentiate between them. They are easily recognized both in the cotyledon stage and after the appearance of floral parts,

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but are difficult or impossible to separate in the intermediate rosette stage. Several plantings studied in the station greenhouse and in the forage plant nursery all bred true to type, and widely distributed field observations in California have not revealed any evidence of intergradation. Chemical analyses at different comparable growth stages by Gordon and Sampson (3) revealed differences in forage values between the two types, and investigation of collections made by the authors, and as yet unpublished, showed essentially the same differences.

Because these plants differ so markedly in growth habit and have such significance in affecting the forage crop, it seemed worthwhile to check their identity by comparison with Old World species of the genus, particularly of the Mediterranean region, where most of them supposedly originated. During these times when much of the world is cut off from us we must rely on such material as is available to us in American herbaria. Specimens of the two entities were sent to several botanists for identification and were returned with determinations based upon the treatment by Knuth in "Das Pflanzenreich" (5), either as *E. Botrys* and one of its varieties or as *E. Botrys* and one of the closely related species. Fortunately, one of the finest collections of Mediterranean plant specimens to be found in North America is located in the private herbarium of Dr. Herman Knoche at San Jose, California. This herbarium is especially rich in the classical sets of the early Mediterranean collectors as well as in the personal collections of Dr. Knoche. A study was made of all of the species of *Erodium* represented and none of the specimens matched one type of the California material under consideration while the other type was definitely established as *E. Botrys*, a species richly represented in the Knoche herbarium. In the synonymy of Knuth's treatment of *E. Botrys* it was noted that Brumhard (1, 2) had published as a *nomen nudum*, and later validated with a description, the name, *E. Botrys* f. *montanum*, based upon a specimen collected by Hansen from Amador County in California. A collection from Chacabuco in Chile was also cited. Comparison of our material with a duplicate of the Hansen specimen indicates that the two are identical and substantiates the observations of Brumhard. It must be taken for granted, in the absence of evidence to the contrary, that because Brumhard, a European monographer of the group, did not cite European material for an entity which he clearly recognized, he apparently did not encounter such material in any of the herbaria where he studied.

Since the precise taxonomic rank of our material is outside the scope of this paper we will use the name given it by Brumhard and here will only direct to the attention of taxonomists our further observations as to differences between these two entities.

A simple key that has proved very useful for mature plants in the field at the San Joaquin Range follows:

- Beak (rostrum) 9.5–12.5 cm. long; fovea surrounded by two plicae; sepals with prominent brownish mucro, upper sepal red-margined; flowers large, petals about twice sepal length, stamens about sepal length *Erodium Botrys*
- Beak (rostrum) 5.5–8.5 cm. long; fovea surrounded by one plica; sepals short-mucronate; flowers small, petals about one and one-fourth sepal length, stamens about one-half sepal length *Erodium Botrys*
f. *montanum*

The two forms can be readily identified in the seedling stage by their relative size and by the shape of their cotyledons. The seedlings of *E. Botrys* f. *montanum* are smaller and the cotyledons have one small incision in the margin, while those of the species are larger and their cotyledons have several more distinct incisions (fig. 1).

The red margins on the upper sepal of *E. Botrys* and the difference in concentric folds about the fovea of the rostra of the two types are perhaps the characters best used for differentiation, and thus far they have proved infallible. Plants of *E. Botrys* f. *montanum* are not so robust as are those of *E. Botrys* (figs. 2, 3). In the rosette stage the stems of *E. Botrys* f. *montanum* are usually not as reddish or coarse as are those of *E. Botrys*, although it is not always possible to separate the plants accurately on this basis. Simple characters need to be found to separate the plants in the rosette stage under all conditions of habitat. Detailed descriptions of the two entities follow.

ERODIUM BOTRYS (Cav.) Bertol. Annual, 8–90 cm. high. Cotyledons oblong, incised. Stems one to many from base, decumbent to ascendent, upper surfaces usually reddish; pubescence coarsely hirsute, hairs whitish-translucent, retrocurved, often glandular. Basal leaves often numerous, petioles usually equal in length or longer than maximum of lamina, hirsute, hairs whitish-translucent, often glandular, lamina ovate, 3–4 lobate, often sublobate, lobes incised-dentate. Cauline foliage opposite; petioles of lower portion of stem often equal or greater than maximum of lamina, upper often sessile, finely hirsute, hairs whitish-translucent, often glandular, lamina ovate, 3–5 partite, mostly quadripartite, lower segments often divided, lobes acute, incised, sinuses moderate to wide. All leaves usually setose-pilose on veins and margins, glandular hairs often present on veins beneath. Stipules ovate, somewhat acute, membranous, pallid or dusky, ciliate, usually 4–5 mm. wide and long. Peduncles varying in length with the lower up to 20 cm. and the upper 2–6 cm. long, usually reddish above, glandular-pubescent. Involucre multibracteate; bracts ovate or lanceolate, acute, membranous, pallid or dusky, minutely ciliate, about 2 mm. wide and 3 mm. long. Pedicels 1–4, upper surfaces dark red, glandular-

pubescent, 15–25 mm. long, after anthesis usually retrocurved. Calyx inflated following anthesis and more or less refracted after fruit matures. Sepals ovate, midrib produced into a prominent brownish mucro, setose, glandular-pubescent, upper sepal red-margined, 13–15 mm. long and 4–5 mm. wide. Flowers large, lavender, remaining open most of day. Petals spreading, about twice calyx length, obovate and with sparsely pubescent angular base. Stamens five, alternating with five sterile, scale-like filaments, filaments of fertile stamens dilated nearly to apex and toothed, about calyx length. Prominent greenish gland with brownish apex at base of each anther-bearing stamen. Pistil densely silvery-villous. Rostrum 9.5–12.5 cm. long with densely appressed short hairs and minute glandular hairs, inner surface



FIG. 1. Young seedling stage: a, *Erodium Botrys*; b, *Erodium Botrys* f. *montanum*.

barbate; valves with short spreading stiff hairs, bearing twin glabrous foveae which are surrounded by two plicae. Seed 4–4.5 mm. long and about 1.5 mm. in diameter.

The following representative specimens, except where otherwise noted, are in the Knoche herbarium, San Jose, California. Canary Islands: Teneriffe, *Knoche* 771. Algeria: Djebel el Ouach, *Choulette* 517; *Reboud*, April, 1879. Portugal: Lisbon, *J. Daveau*, 1879. Balearica: Majorque, *Knoche* 127. Corsica: Bonifacio, *Knoche* in 1908; Bastelia, *Reverchon*, May 23, 1878. Sicily: Ficuzza, *Parlatore*, without date; (Sicula) Alcano, *Todaro* 630. Turkey: Cavalla, *Sintenis* and *Bornmüller* 190. California: O'Neals, Madera County, *Wagon* 2, 102 (Herbarium University of California).

ERODIUM BOTRYS (Cav.) Bertol f. **MONTANUM** Brumhard. Annual, 5–55 cm. high. Cotyledons oblong, usually with one small incision. Stems one to many from base, ascendent to erect; hirsute, hairs whitish-translucent, retrocurved, usually glandular. Basal leaves often numerous, petioles usually equal or greater



FIG. 2. *Erodium Botrys f. montanum* in different stages of growth.

than maximum length of lamina, finely hirsute, often glandular-haired, lamina ovate, 3-4 lobate and often sublobate, lobes incised-dentate. Cauline leaves opposite; petioles of lower portion



FIG. 3. *Erodium Botrys* in different stages of growth.

of stem often equal in length to maximum of lamina, upper sometimes sessile, finely hirsute, often sparsely glandular-haired, lamina ovate, 3-5 partite, mostly quadripartite, lower segment often divided, lobes acute, incised, sinuses narrow to moderate. All leaves setose-pilose especially on veins and margins, glandular hairs sometimes present. Stipules ovate, somewhat acute, membranous, pallid or dusky, ciliate, usually 3-4 mm. long and

3–5 mm. wide. Peduncles vary in length with the lower up to 10 cm. and the upper 1–4 cm. long, glandular-pubescent. Involucre multibracteate; bracts ovate or lanceolate, membranous, pallid or dusky, minutely ciliate, about 1 mm. wide and 1.5 mm. long. Pedicels 1–5, usually dark red, glandular-pubescent, 5–15 mm. long, after anthesis usually retrocurved. Calyx inflated following anthesis and more or less refracted after fruit matures. Sepals ovate, short mucronate, setose, glandular-pubescent, 7–9 mm. long and 2–3 mm. wide. Flowers small, lavender, tending to close early in day. Petals often not spreading, about one and one-fourth times as long as the calyx, obovate with finely pubescent angular base. Stamens ten, the five with anthers alternating with five sterile, scale-like filaments, filaments of fertile stamens dilated nearly to apex and toothed, about one-half calyx length. Small greenish gland at base of each anther-bearing stamen. Pistil densely silvery-villous. Rostrum 5.5–8.5 cm. long with densely appressed short hairs and minute glandular hairs, inner surface barbate, outer surface reddish before ripening; valves with short spreading stiff hairs, bearing twin glabrous foveae which are surrounded by one plica. Seed 3–3.5 mm. long and less than 1 mm. in diameter.

Representative specimens. California: New York Falls, Amador County, *Hansen 502* (Dudley Herbarium, Stanford University); O'Neals, Madera County, *Wagnon 1, 101* (Herbarium University of California).

Erodium Botrys f. *montanum* appears to be more common and widespread in California than the species. The latter, however, has been found in almost pure stands on the northeastern edge of North Sacramento, abundant along the state highway from there to Auburn, and scattered along the Bodega road on the outskirts of Sebastopol. Both types are common in the Sierra foothill section and adjacent valley floor of the San Joaquin Valley. During a five-year period at the San Joaquin Experimental Range, the two types combined comprised from 15 to 42 per cent of the plant cover (6, pp. 13–49). On this area they are important components of the cattle diet.

Perhaps the most significant things from a forage standpoint are the big differences in growth habit in the rate of development and time of maturity. This affects the length of the green feed period and, frequently, the amount of forage produced. Plants of *E. Botrys* f. *montanum* normally begin upright growth about two weeks earlier than those of *E. Botrys*, and also mature about two weeks earlier; thus, when they occur together, the season of green forage availability is usually lengthened by about four weeks. This difference in growth and maturity varies from year to year, depending largely on the amount and distribution of rainfall and

in part on temperature. In the winter of 1938-39, for example, the rainfall was light and its distribution unfavorable to the best development of both types; as a result, the vegetative development of both types was retarded and the season of available green feed was shortened. On the other hand, in the winter of 1941-42 cold weather and dry spells so restricted the early-growing f. *montanum* that it matured about April 1; favorable weather after this date resulted in the later-growing *E. Botrys* maturing about mid-May. This lengthened the green forage season by about six weeks. Besides greatly expanding the green feed season the combination greatly increased total forage production.

Just where *Erodium Botrys* f. *montanum* originated is a matter of great scientific interest. Are we to assume that it is an emigrant from some source as yet undisclosed to us? Or, is it a California ecotype selected by the environment out of a diverse genetic population which developed from the original importation of *E. Botrys*? Is the Chilean material cited by Brumhard the same as the California material or is it another ecotype? These questions must of necessity be answered before a proper taxonomic evaluation of *E. Botrys* f. *montanum* can be undertaken.

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San Joaquin Experimental Range,
O'Neals, California,
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