

A Hummingbird-Pollinated Species of Boraginaceae in the Arizona Flora

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Abstract. *Macromeria viridiflora* (Boraginaceae) is pollinated by broad-tailed and rufous hummingbirds in the White Mountains of Arizona. This is the first hummingbird-pollinated member of the family Boraginaceae to be recorded in western North America. It provides one more example of a predominantly bee-pollinated plant group that has given rise to one or a few exceptional species of hummingbird flowers in western North America.

Hummingbird pollination is one of the most distinctive pollination systems in the western North American flora. Hummingbird flowers in this area possess the following character combination: they are generally trumpet-shaped, red and/or yellow, pendant on flexible pedicels, odorless, diurnal, and nectariferous. Such flowers have hitherto been found in 18 plant families in western North America.^{1,2}

Hummingbird flowers were not, however, suspected in the family Boraginaceae in western North America. The purpose of this paper is to report hummingbird pollination in *Macromeria viridiflora* in Arizona. This is the first bird-pollinated member of the Boraginaceae to be recorded in the western American flora.

Observations. *Macromeria viridiflora* is a tall perennial herb that occurs in the high mountains of northern Mexico, Arizona, and New Mexico. Its numerous yellow tubular flowers are borne in loose scorpioid cymes (Fig. 1). Johnston distinguishes two geographical races on the basis of flower size.³ *Macromeria viridiflora viridiflora*, ranging from Mexico to southern Arizona, has slender elongate corollas 6- to 8-cm long; whereas *M. v. thurberi* in central Arizona and New Mexico has trumpet-shaped corollas 3.5-5 cm long. Our observations are concerned with the latter race.

The floral mechanism of *M. v. thurberi* in the White Mountains of eastern Arizona has the following features. The corollas are cream colored to light yellow and are oriented outward and downward from the arches of the scorpioid cymes (Fig. 1). The floral tube measures 4 cm long from base to orifice. This tube is expanded in its upper half, which is 2-3 mm in diameter at the orifice, and narrows down in the basal half. The five anthers and two stigmas are exerted from the corolla, and mature in protandrous order. The flowers are odorless but produce copious nectar. The nectar is secreted at the base of the ovary and accumulates in the narrow lower portion of the corolla tube. The

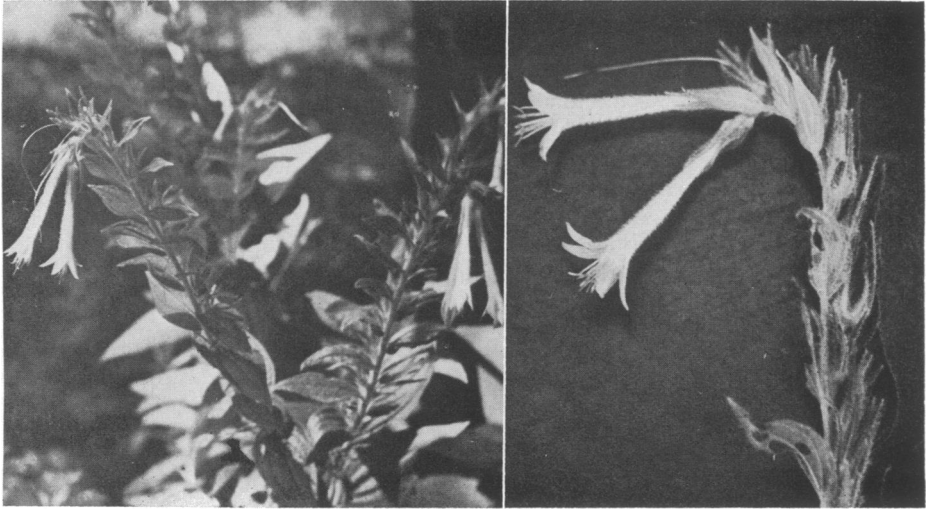


FIG. 1.—*Macromeria viridiflora thurberi* (Boraginaceae) in the White Mountains of eastern Arizona.

floral mechanism of *M. v. thurberi* is similar to that of many previously known species of hummingbird-pollinated plants in the western American flora.

We observed two populations of *M. v. thurberi* in the White Mountains in the summer of 1969, one at McNary Junction and the other on the North Fork of Paradise River. Both *Macromeria* populations were in full bloom in mid-July. Hummingbirds were actively feeding on the flowers in both populations. Numerous hummingbirds, both broad-tailed and rufous hummingbirds (*Selasphorus platycercus* and *S. rufus*), were feeding on the *Macromeria* flowers in the McNary Junction population; while a single hummingbird, probably a female broad-tail, was making flower visitations in the Paradise River population.

The hummingbirds probe the floral tubes while hovering on the wing in their usual manner. Their bills fit down into the broad upper part of the floral tube, and their extensile tongues presumably reach the nectar in the narrow lower part of the tube. In the probing position pollen becomes dusted on the bills. The process of cross-pollination is completed as the birds fly systematically from plant to plant and visit flowers with receptive stigmas.

Discussion. Previous field studies have yielded records of hummingbird pollination in 41 species in western North America.^{1,2} Flowers with a similar character combination, suggesting a similar mode of pollination, were found to occur in 88 additional species in the same area.² The 129 species of previously known or predicted hummingbird flowers are distributed among 18 plant families.² The observations reported here of hummingbird pollination in *Macromeria viridiflora* (Boraginaceae) add a new family as well as a new species to this list.

The systematic distribution of western American hummingbird flowers by plant families is interesting in itself and significant in relation to the question of the evolutionary development of the bird pollination system in this area.

Only one family (Scrophulariaceae) contains a large number (74) of bird-

pollinated species in western North America. Three other families have 8–10 bird-flowered species each (Ranunculaceae, Polemoniaceae, Labiatae). The 15 remaining families all have few bird-flowered species each, mostly 1–2 but up to 5 such species.² The families with single species of bird flowers in western North America are: Cactaceae (*Echinocereus triglochidiatus*), Saxifragaceae (*Ribes speciosum*), Nyctaginaceae (*Allionia coccinea*), Rubiaceae (*Bowardia glaberrima*), Convolvulaceae (*Ipomaea coccinea*), Fouquieriaceae (*Fouquieria splendens*), and now the Boraginaceae with *Macromeria viridiflora*.

The 15 families with few species of hummingbird flowers are mostly large families in the western flora; and their bird-flowered species are therefore not only few in number but also represent an exceptional condition in their respective families. The well-developed plant families with one or a few exceptional species of hummingbird flowers in the western America flora are the: Convolvulaceae, Rubiaceae, Onagraceae, Nyctaginaceae, Caryophyllaceae, Saxifragaceae, Papilionaceae, Cactaceae, and Liliaceae.² We can now add the Boraginaceae to this subgroup.

In most of these same well-developed families the prevailing pollination system is bee pollination, and the close relatives of the exceptional hummingbird flowers are bee-pollinated species or genera. This is the case *inter alia* in the Onagraceae, Cactaceae, Papilionaceae, and Convolvulaceae. This relationship taken together with other correlations described elsewhere suggests strongly that the hummingbird flowers have evolved from bee-pollinated ancestral stocks in a number of independent lineages.² With certain qualifications the Boraginaceae also conforms to this pattern. The small genus *Macromeria*, containing at least one hummingbird-pollinated member and probably others, is related to the predominantly bee-flowered and more widespread genera *Lithospermum* and *Mertensia*.³ The observed systematic pattern and the inferred evolutionary pathway gain support from the addition of this new example in the Boraginaceae.

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¹ Grant, V., and K. A. Grant, *Aliso*, 6, 51 (1966); 103 (1967).

² Grant, K. A., and V. Grant, *Hummingbirds and Their Flowers* (New York: Columbia University Press, 1968).

³ Johnston, I. M., *J. Arnold Arboretum*, 35, 1 (1954).