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A CENSUS OF BEE POLLINATORS IN LARGE AND SMALL POPULATIONS OF THE CAMPHOR WEED (*TRICHOSTEMA LANCEOLATUM*)

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Trichostema lanceolatum Benth., commonly known as camphor weed or vinegar weed, is one of the western North American species of *Trichostema*, a genus of plants in the mint family (Lamiaceae). *T. lanceolatum* grows on dry plains and low hills from cismontane California to Washington. Its common name arises from the pungent aroma of compounds secreted by the numerous glands covering its stem and leaves.

The flowers of *T. lanceolatum* have an S-shaped floral tube with the anthers and pistil protruding above the petals as described by Howe (in press). The petals serve as a landing site for bees and other pollinators. The weight of the pollinator on these petals and the thrust of sucking mouth parts into the nectar tube cause the anther and style mechanism to flex rapidly downward and strike the back of the insect. Such an arrangement warrants a deeper understanding of the types and numbers of pollinators which visit these fascinating flowers.

T. Spira (1978) found *T. lanceolatum* to have the highest nectar production of all the insect pollinated species of *Trichostema*. Thus pollinator frequencies for this plant would likewise be of interest from the standpoint of honey production.

The rate and type of nectar production, percentage of seed set, and other floral characteristics for the western North American species of *Trichostema* were estimated by T. Spira (1978, 1980, 1981). Although he analyzed the distribution of pollen on the bodies of bees collected in *Trichostema* fields, Spira did not determine the relative

numbers of pollinator bees present in these same populations. Evidently there has been no such study of pollinator frequencies in *Trichostema lanceolatum* fields as Spira's papers are the only ones that have dealt with pollination in these plants.

In the present study I have attempted to determine the differences in pollinator frequencies between seven small populations of *T. lanceolatum* and one large one. While such study has academic importance, the behavior of domestic and wild bees in fields of wild plants has been shown to have profound influence on pollination and seed set in fields of crop plants nearby (Anonymous, 1976).

One of the small populations in this study consisted of 16 plants growing in a cluster 5 m. in diameter in a vacant lot, 30 meters west of Apple Street, Newhall, California. There were no other populations of *T. lanceolatum* near this small one but other species blooming in that same study area included *Brassica geniculata* (Desf.) J. Ball., *Eremocarpus setigerus* (Hook.) Benth., and *Stephanomeria virgata* Benth. Adjoining this field to the west was a small chaparral stand composed of *Adenostoma fasciculatum* H. & A., *Eriogonum fasciculatum* Benth., *Quercus agrifolia* Nee, *Q. dumosa* Nutt., *Q. lobata* Nee and *Sambucus* sp.

Pollinator counts in this Apple Street population were taken over 10 minute intervals either by counting bees on all 16 plants at once or by watching only one very large plant. A tally was kept of each pollinator bee that visited the plant(s) and triggered the pollen mechanism of at least one flower during that time interval. Although quite simple, such observation and counting provided direct information concerning the numbers and kinds of bees triggering the flowers of *T. lanceolatum*. The 10 minute observational periods spanned seven days from 22 July to 22 August 1983, at various times ranging from 07:20 to 16:30. There were 19 such trials, a total of 190 minutes at Apple Street. The data are summarized in Table 1.

Table 1. Total numbers of various bees observed pollinating flowers in one large and several small populations of T. lanceolatum near Newhall, California.

Pollinator	Population Location	Population Size	Number of Pollinator Visits	Total Visits[1]	Percentage of Total
Apis mellifera L.	Apple St.	Small	3	74	4
	McBean Parkway	Small	1	35	3
	Pico Canyon Rd.	Large	189	512	37
Anthophora urbana oregson	Apple St.	Small	57	74	77
	McBean Parkway	Small	7	35	20
	Pico Canyon Rd.	Large	79	512	15
Bombus sonorus say	Apple St.	Small	14	74	19
	McBean Parkway	Small	27	35	77
	Pico Canyon Rd.	Large	244	512	48

[1]Total visits by all bee pollinators in that population.

On 22 August, 1983, between 15:00 and 17:00 an additional 90 minutes were spent making similar 10 minute pollinator counts in six other small populations of *T. lanceolatum* scattered along a grassy ridge about 300 meters north of Henry Mayo Newhall Memorial Hospital, McBean Parkway, Newhall, California. Data from these six additional small populations are also reported in Table 1.

The one large *T. lanceolatum* population of this study grew on the north side of Pica Canyon Rd., Newhall, California, in the stubble of oat plants that had been cut and harvested earlier. Here camphor weed plants were so numerous that pollinator counts could be made most effectively by walking into the field and recording all the pollinating bees visible within an estimated radius of seven meters while the observer was turning slowly through a complete circle in a time period of 60 seconds. After one such tally, 10 paces were taken further into this large population and the process repeated. A total of 63 such circular, one minute surveys was made on four different dates--13, 16, 21, and 22 August, 1983, between 09:00 to 10:00 or 14:00 to 16:00. These data likewise appear in Table 1.

In all eight populations of *T. lanceolatum* the following bees were present: *Anthophora urbana* Cresson, mason bees; *Apis mellifera* L., honeybees; and *Bombus sonorus* Say, bumblebees. Only one individual carpenter bee (*Xylocopa* sp.) was seen visiting flowers, whereas Spira (1980) reported *Xylocopa* individuals as being prominent pollinators during one of the two seasons he studied *T. lanceolatum* in central California.

Occasionally I observed moths such as the woodland skipper (*Ochlodes sylvanoides sylvanoides*, Boisduval) and the field skipper (*Atalopedes campestris*, Boisduval) pollinating camphor weed plants but no numerical record was kept of these moth visits.

The most frequent bee pollinator of *T. lanceolatum* in the Apple Street (small) population was *A. urbana* (77% of all visits), with *B. sonorus* second (19%), and *A. mellifera* last (4%)--see Table 1. In the six other small populations (near McBean Parkway) *B. sonorus* had the highest visitation rate (77%) followed by *A. urbana* (20%), and *A. mellifera* (3%). Thus either the mason bee or the bumblebee figured as the lead pollinator in these small populations and in each case honeybees avoided camphor weeds.

In the one large field of *T. lanceolatum* at Pico Canyon Road, however, the honeybee foragers showed widespread acceptance of camphor weed plants (37% of all visits), although here the bumblebees had the highest visitation rate (48%) and mason bees were lowest (15%). Thus in the seven populations where *T. lanceolatum* was low in numbers, honeybees avoided them in favor of other nearby plants but in one very large camphor weed population honeybees were a

significant pollination vector. Such behavior may be explained to some extent in terms of flower specialty habits of the bees and their foraging strategies.

Butler (1974, p. 190) wrote that "... as long as there is an abundance of rich syrup, or nectar, available at a given place honeybees that have found this source of food will confine their attention to it for many hours and even for days together." Minderhout (1931) also noted that honeybees in a large population of plants were constant not only to that one plant species but also to a certain small number of those plants in a foraging area that averaged only 10 m^2 within the much larger field. A pattern of constancy like Minderhout described may have prevailed at Pico Canyon Road where the honeybees were presented with a large number of *Trichostema lanceolatum* plants in close proximity and perhaps had specialized on camphor weed even though they were found to avoid the same plant at other locations.

The low level of *A. mellifera* participation in pollination of *T. lanceolatum* at all the seven small populations (Apple Street and McBean Parkway) cannot be attributed to reduced numbers of honeybees, since many of these bees were observed actively working flowers of other plant species at these same locations. At the Apple Street site, for example, honeybees showed a consistent preference for nearby *Brassica geniculata* and *Stephanomeria virgata* plants as opposed to the 16 individuals of *T. lanceolatum*. Perhaps the honeybees had already specialized on *B. geniculata* or *S. virgata* elsewhere as these species have a much wider overall spatial distribution than *T. lanceolatum* in the Newhall vicinity. The neglect of small camphor weed populations by honeybees may have thus depended on the small size and sparcity of these camphor weed populations.

Additionally, such avoidance of camphor weed by honeybees may have resulted from relatively low nectar yields. Although T. Spira showed that camphor weeds have the highest production of nectar among the western species of *Trichostema*, nectar production in *T. lanceolatum* may possibly be lower than that of *B. geniculata* or other preferred species.

The neglect of small camphor weed populations by honeybees may have further depended on color, odor, and/or floral morphology. Camphor weed secretes some highly aromatic compounds which may be mildly offensive to honeybees. Butler (1974) reported that the odor of solvents from his bee-marking procedures could disorient a treated bee for several minutes. Heinrich (1983) found that bumblebees distinguished between flowers that are difficult to handle and those that require no skill to manipulate. Perhaps honeybees specialize more readily on simpler flowers like mustard or *Stephanomeria* than on the more complex flowers of *Trichostema*. At any rate, it was obvious

that honeybees made more frequent visits to mustard flowers than to *Trichostema lanceolatum*. Linsley and MacSwain (1947) also found a distinct preference for mustard among honeybees such that the percentage of honeybees working alfalfa for pollen was increased when nearby mustard fields were cut.

Individual bumblebees (*Bombus sonorus*) moved between flowers of different species. Clements and Long (1923) found that only 49% of pollen loads carried by *Bombus* individuals were pure, 51% mixed, whereas Grant (1950, p. 380) reported that "... species of bumblebees are relatively inconstant..."

Henrich (1983) concluded that bumblebees routinely major on one species of flower while minoring on others. Thus the apparent "inconstancy" of bumblebees in this present study evidently stemmed from their majoring on one of the species present while minoring on two or three others. Heinrich (1983) further indicates that since bunblebees have neither scouts nor hive communication systems, the bees are best served by a pattern of sampling among their major and minor species. He reported that the bumblebees can change a minor to a major on one foraging trip and can thus more readily maximize foraging efficiency.

Concerning the mason bee, Spira (1980, p. 279) had noted that *A. urbana* was an important pollinating agent in *T. lanceolatum* populations during both years of his study in central California, although census data were not provided.

Reports on the degree of specialization or flower constancy of several species of mason bees are varied. Linsley and MacSwain (1942) found a rigid specialization of *A. linsleyi* in collecting pollen from *Salvia carducea* Benth. in the Mohave Desert where the bees by-passed other plants to obtain sage pollen even though this necessitated flying more than a mile from their nest. Bennett (1874) found that in a mixed field of *Lamium album* and *L. purpureum*, *Anthophora retusa* bees visited only the *L. album*. By way of concontrast, however, Grant (1950) reprinted data from studies in Colorado to show that only 20% of the pollen loads carried by *Anthophora* bees were pure loads.

In this present study, mason bees were the major species pollinating camphor weeds at the Apple Street site and they played a significant role at all of the other locations as well. I found *A. urbana* to have a high degree of specialization in that individual mason bees were not observed to visit several species in succession.

In this locality, camphor weed plants grow and flower from late May through August or September. Since this is well after the harvest of grains such as oats, it might prove feasible to sow *T. lanceolatum* seed along with the oats. After oat harvest, the camphor weeds would grow and provide valuable nectar forage for honeybees, as

occurred here in the Pica Canyon Road oat field. There may be other species of native California plants which could be raised in conjunction with grain production for their nectar yield. Camphor weed seems especially suited since its entire growing season follows grain harvest and it does not persist as a pernicious weed like mustard.

In conclusion, I found the solitary mason bee, *Anthophora urbana*, and the social bumblebee, *Bombus sonorus*, to be of major importance in the pollination of *T. lanceolatum* plants in both large and small plant populations. Honeybees, however, played an active part in camphor weed pollination only in the one large population studied. While some aspects of this behavior are understandable, more information is necessary to account for honeybees avoiding the camphor weeds in the small populations while visiting them in large populations.

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WHALE-WATCHING EXPEDITION TO SAN IGNACIO LAGOON, BAJA CALIFORNIA SUR, MEXICO

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January 30, 1985, Dr. Kenneth Stager, Emeritus Curator of Ornithology and Mammology at the Los Angeles Museum of Natural History, and I, Curator of the Herbarium at the Rancho Santa Ana Botanic Garden, left Fisherman's Landing at San Diego on the large fishing cruiser, Qualifier 105, as the two naturalists on an eight-day, whale-watching cruise along the Pacific Coast of Baja California to the Laguna San Ignacio in Baja California Sur, Mexico, south of the Laguna Ojo de Liebre (Scammon's Lagoon). The crew of six hoped to show the 30 Coloradoans on tour with Ports o' Call, based in Denver, numerous gray whales, elephant seals, California sea-lions, dolphins, and other sea mammals, many aquatic birds and numerous flowering plants at the Laguna and also en route on the Islas San Benito del Oeste, Cedros, and San Martin.

After a day and night of cruising, we arrived on the morning of January 31 west of Isla Cedros at Isla San Benito del Oeste, a dry, rocky island about one square mile in area (2.5 for all three San Benito islands) and rising in the center to a height of about 600 feet. Aside from the island plants, the main attractions of the West Island are the harems of elephant seals, carefully guarded by the huge, battle-scarred beachmasters ready to challenge all male comers, the small Cassin's awklets then nesting in their burrows, the friendly feral burros, and perhaps ten pairs of ospreys nesting along the shores. The three skiffs from the Qualifier were quickly launched and used to transport the 32 tourists and naturalists to the presently all-but-deserted fishing village at the east end of the island. The flora of the three San Benito islands is sparse, some 40 natives, including 15 ephermerals, and 5 introduced weeds, presenting an open cover of maritime desert scrub, well supplied with cacti and agaves.



Howe, George F. 1985. "A Census 0f Bee Pollinators in Large nd Small Populations of the Camphor Weed (Trichostema lanceolatum)." *Crossosoma* 11(2), 1–7.

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