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RECORDS OF HUMMINGBIRD POLLINATION IN THE WESTERN AMERICAN FLORA

III. ARIZONA RECORDS¹

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On several field trips in Arizona we have been able to make a beginning in the study of hummingbird pollination in that interesting state, and present here the records obtained so far.

POLEMONIACEAE

1. IPOMOPSIS AGGREGATA

We have previously reported hummingbird pollination of various races of *Ipomopsis aggregata* in California and Colorado (*Flower Pollination in the Phlox Family*, New York, 1965, pp. 77-80). Here we can add observations in Arizona on the race known as var. *texana*.

The plants of this race are very common in the coniferous forest around Flagstaff and Williams, forming extensive stands over large areas. Their red trumpet-shaped flowers make a showy display visible from a long distance and afford the most abundant kind of hummingbird flower in bloom in this region in late summer. The flowers are frequented by fairly large numbers of hummingbirds, whose probings lead to head pollination.

Flagstaff, Coconino Co., August 20-21, 1965. Broadtailed hummingbirds: adult males, females, and/or immatures.

Showlow, Navajo Co., August 19, 1965. Unidentified hummingbird feeding on flowers.

LABIATAE

2. SALVIA LEMMONI

This sage of the mountains of southern Arizona and northern Mexico bears bright rose flowers in terminal spikes. The stout corolla tube is about 2 cm long. The upper lip of the corolla houses the two anthers and the stigma. The flowers are abundantly visited and pollinated by hummingbirds.

Above Rustler Park, 8800 ft elev., Chiricahua Mts., Cochise Co., August 21-22, 1961. Rufous, Black-chinned, Broad-tailed, and Rivoli hummingbirds were actively feeding on the flowers in the sunny morning. The yellow *Salvia* pollen became

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abundant on the upper side of the birds' bills after an hour of feeding visits. In this position it would be sure to contact the stigmas.

Rustler Park, 8400 ft elev., Chiricahua Mts., Cochise Co., August 16, 1965. A male Rivoli and another hummingbird, probably a female Broad-tail, were feeding on flowers. The latter bird had a heavy coating of the yellow *Salvia* pollen on the top of its bill.

3. *CASTILLEJA PATRIOTICA*

This species of openings in pine forest in the mountains of southern Arizona has light red flowers. As in the genus *Castilleja* generally, the stamens and stigma are positioned so as to transfer pollen on the top of the bird's bill or head as it probes through the slit-like orifice into the corolla tube.

Onion Saddle, 7600 ft elev., Chiricahua Mts., Cochise Co., August 18, 1965. Unidentified hummingbird feeding on flowers.

4. *PENSTEMON BARBATUS*

This species is common in the mountains of Arizona. The nodding, bright red flowers are well spaced in the upper part of the erect stems, and are borne on flexible wiry pedicels. In the population mentioned below the tubular corolla is 2.2 cm long from orifice to base, and 6 mm wide at the orifice. The four anthers stand below the lower lip and above the entrance to the corolla tube. The style extends on the upper side of the corolla and outward beyond the orifice. The probings of hummingbirds will thus usually bring about head pollination.

Below Rustler Park, Chiricahua Mts., Cochise Co., August 21-22, 1961. Rufous, Black-chinned, and Rivoli hummingbirds feeding on flowers.

Rustler Park, Chiricahua Mts., Cochise Co., August 14 and 16, 1965. Rufous hummingbirds, male and probably females; Broad-tailed hummingbirds, probably females and immatures; and Calliope hummingbird, male; all feeding on flowers.

ACANTHACEAE

5. *ANISACANTHUS THURBERI*

This southwestern shrub has long tubular brick-red flowers which are visited and pollinated by hummingbirds.

Molino basin, Santa Catalina Mts., Pima Co., May 3, 1967. Costa hummingbirds and Broad-billed hummingbirds (*Cyananthus latirostris*) were regularly feeding on the flowers. The Costa carries pollen on its breast feathers, and the Broad-bill, which has a longer bill, contacts anthers and stigma with its chin.

Chiricahua Mts., Cochise Co., Spring 1966. Miss Betty Hackner of the University of Pennsylvania informs us that Black-chinned hummingbirds were feeding regularly on *Anisacanthus* in this area.

RUBIACEAE

6. *BOUVARDIA GLABERRIMA*

The low woody-based plants are scattered in the semi-shade of oak and conifer woods in the mountains of southern Arizona and northern Mexico. The bright red, tubular flowers are borne in clusters. The corolla was found to vary in length from 2.5 to 4.5 cm long in the Chiricahua Mts. The orifice is 2 mm wide. The anthers lie within the tube and the style projects above the corolla limb. The flowers are visited and pollinated by hummingbirds.

Near Southwestern Research Station, and on road to Rustler Park, Chiricahua Mts., Cochise Co., August 14-17, 1965. Unidentified female hummingbirds were feeding

on the flowers and probably transferring pollen on the bill top or head top. Hawkmoths (*Phlegethontius*) were also visiting the flowers at dusk, and probably bring about pollination of the longer-tubed form especially.

CAMPANULACEAE

7. *LOBELIA CARDINALIS*

The erect herbs grow along streams and in boggy places over a wide area in North America; they occur throughout the non-desert parts of Arizona. The brilliant red flowers are borne in terminal racemes. The flowers are inverted at maturity by the twisting growth movement of the pedicel.

The corolla consists of a tube 2 cm long containing nectar, and a bilabiate limb with three large red lower lobes (lower in the flower's actual position at maturity) and two slender upper lobes. The corolla tube is not joined along its upper seam and so can easily be expanded from the normal diameter of 2-3 mm at rest to 4 mm by insertion of a bill. The stamens and style stand 1 cm out from the orifice. The disc-shaped stigma points downward as a result of a bend in the style.

We looked unsuccessfully for hummingbird visits in Sycamore Canyon, Santa Cruz Co. However, Mr. Lloyd Martin of the Los Angeles County Museum (oral comm.) has seen hummingbirds feeding abundantly on the flowers in Madera Canyon, Pima Co. The floral mechanism is such as to ensure head pollination as the birds probe into the corolla tube.

COMPOSITAE

8. *CIRSIUM NEOMEXICANUM*

This common southwestern thistle has lavender heads composed of densely packed, slender florets with long exerted sex organs. The heads are visited and pollinated to some extent by hummingbirds, but the floral mechanism is not well fitted for bird pollination. The situation is worth describing here as an example of a mutual relationship between flowers and hummingbirds which is relatively ineffectual yet workable as regards nectar-feeding and pollination.

The corolla of this thistle consists of three main divisions from base to apex: a thin colorless tube which fills up with nectar; a lavender bulbous chamber in which some of the nectar accumulates; and the free lobes. The style is well exerted above the free corolla lobes, the lavender styles of a head standing up like pins in a pin-cushion. As usual in thistles, the style presents the pollen of its own floret on its lower part and is receptive to foreign pollen at its tip.

Access to the nectar is through a narrow orifice between the free corolla lobes. The route to this orifice of course passes by the pollen and stigma. The distance from style tip to base of bulbous chamber is 2.5 cm, and the length of the thin colorless corolla tube is 1.2 cm, making the overall length of the floret 3.7 cm (in the population studied and listed below).

Butterflies and skippers perch on the heads and probe with their long slender proboscis into the floral tubes for nectar. Their feeding posture brings their tongue base and face into contact with pollen and stigma. Pollen grains were found adhering to the face of a butterfly visitor (*Battus philenor*). Butterflies and skippers are probably the primary pollinators of these thistles.

In the Chiricahua Mts. in the fall of 1961 we also observed hummingbirds going briefly but repeatedly to the thistle heads, while feeding mainly on other neighboring species of flowers better adapted for their visits. The hummingbirds

quickly inserted their bills into the heads while hovering momentarily in flight. As the thistle heads contained melyrid beetles and other insects between the florets, as well as nectar, it was of interest to determine which types of food the birds were seeking.

This question could not be settled satisfactorily with bird glasses in the field. Therefore we brought a bouquet of thistles from the natural population into the hummingbird feeding area of the Southwestern Research Station a few miles away. Here, with the aid of Dr. Paul Ehrlich, we made an artificial set-up favorable for close observation of hummingbird action on thistle heads. Observations were carried out through a quetzar telescope, and also, as the birds later became tame enough to feed on a thistle held by hand, by naked eye at very close range.

Four species of hummingbirds visited the thistle bouquet in the feeding station: Black-chinned, Rufous, Rivoli, and Blue-throated hummingbirds.

The birds consistently ignored the melyrid beetles on the flowers, which are probably too hard-shelled for them. Furthermore, they showed no interest in small dipterans and other small soft-bodied insects which came to the flowers at the feeding station. This was true in both a morning and an afternoon period of observation. The birds' visits to the thistles were not motivated, in this situation at least, by a search for small flower-inhabiting insects.

The birds sometimes inserted their bill between the florets, probing to the base of the head where there was no food — either nectar or insects — for them. In other cases they probed into the bulbous corolla chamber between the free lobes with bill and tongue where they could obtain nectar. No doubt they have to learn from practice, and do learn, how to get nectar from a thistle head. Their bill is too big for the slender corollas, however, so that they can tap only the upper layer of nectar.

The bird's bill contacts the essential organs and picks up pollen on some floral visits but not on others. The hummingbirds therefore seem to be relatively ineffectual pollinators — but nevertheless real accessory pollinators — of this *Cirsium*.

Chiricahua Mts., Cochise Co., August 19, 22, 24, September 4, 1961. (1) Unidentified hummingbird as a casual visitor and pollinator. (2) Melyrid beetles common in flowering heads and probably bringing about some incidental pollination. (3) Butterfly, *Battus philenor*, as a well adapted thistle feeder and pollinator. (4) Skipper, *Apyrrothrix araxes*, likewise feeding and pollinating successfully.

CACTACEAE

9. ECHINOCEREUS TRIGLOCHIDIATUS

This hedgehog cactus grows among rocks in desert mountains near or in the juniper zone. The flowers are tubular in shape due to an elongation of the hypanthium as compared with other cup-shaped cactus flowers. The floral tube is about 3 cm long and the entire flower from base to petal tips about 6.5 cm long. The petals are brilliant red and the flowers point upward and outward. Abundant nectar is present at the base of the floral tube. A hummingbird can reach this nectar by probing with its bill through the central mass of stamens. Such probings will bring the bird's face and throat into contact with anthers and stigma. Hummingbird visitations have been observed.

Near Hackberry, Mohave Co., May 12, 1967. An unidentified female hummingbird was nesting in the area and was feeding on the cactus flowers.