

kunthii blossoms by *Bombus* queens occurred and workers were unable to secure nectar while positioned within the floral tube, probably as much as 10–20 per cent more nectar was available to *Bombus pulcher* and *Bombus trinominatus* populations during this period due to the feeding activity of *Diglossa*.

DISCUSSION AND CONCLUSIONS

Grant and Grant (1968) have proposed an explanation for the reciprocal evolution of hummingbirds and the plants upon which they feed. According to this interpretation most hummingbird-pollinated flowers, especially temperate species, have evolved from bee flowers (Grant 1961; Grant and Grant 1965). The process involves an incipient stage during which a primitive hummingbird or progenitor already "preadapted" to feed on a particular bee flower (in the sense of securing insects within the corolla, or nectar, or both), causes at first occasional but then increasingly frequent pollinations. This stage is followed by a resultant eventual elongation (and presumably a decrease in diameter) of the floral tube and thus an increasing exclusiveness for bird pollination. The following discussion assumes that the evolutionary history of *P. kunthii* follows the model, i.e., that this Mexican highland species has evolved from a relatively unspecialized bee-pollinated form to its present condition as a hummingbird-pollinated species with a high degree of exclusiveness.

More specifically, the *Diglossa-Bombus* exploitation could aid in the selection of *P. kunthii* as a bird flower, as indicated in the following chronological schema.

1. Initial increase in nectar production is favored by hummingbird visitation concomitant with beginnings of corolla tube elongation due to increasing pollination by hummingbirds compared with bees (i.e., birds visit those plants with the greatest nectar supply).
2. Nectar production becomes sufficient to encourage exploitation by *Diglossa*.
3. Perforations attract *Bombus* spp., diminishing bee pollination and thus decreasing or removing bees as a selective force.
4. More rapid evolution of tube elongation and nectar production occurs, caused by a self-reinforcing feedback system in which greater nectar production encourages an increasing exploitation by *Diglossa*, which further discourages bee pollination relative to bird pollination, enhancing further increase in exclusiveness and nectar production.

The stage in the evolution of *P. kunthii* at which *Diglossa* exploitation began is unknown and would

depend on many factors. That hummingbirds and the ancestor of *P. kunthii* co-existed may be assumed; otherwise its adaptation to hummingbird pollination would make little sense. Thus it is possible that *P. kunthii* could have undergone much of its development under selective pressure from hummingbirds; still, it is clear that *Diglossa baritula* has co-existed with hummingbirds throughout New World montane habitats for some time and therefore an earlier and more important role in the evolution of *P. kunthii* would not be unexpected. This is not to suggest that exploitation late in the evolutionary development of *P. kunthii* would be insignificant. Even at present, given the potential counter-selection pressures on *P. kunthii* from bees, the presence of *Diglossa* perforations undoubtedly precludes a certain amount of bee pollination which would probably otherwise occur, helping to maintain the selection pressures on *P. kunthii* which favor continued floral specialization for hummingbird pollination.

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AN EARLY PLEISTOCENE EAGLE FROM NEBRASKA

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In the collections of the University of Nebraska State Museum (U.N.S.M.) are a number of fossil birds from the Early Pleistocene Broadwater and Lisco Local Faunas. Included with this collection is a new species of eagle from U.N.S.M. Coll. Loc. Gd-12. Other animals from this locality are *Megalonyx*, *Geomys*, *Procastoroides*, *Canis*, *Borophagus*, *Ischyrosmilus*, *Mammut (Pliomastodon)*, *Plesippus*, and

Gigantocamelus fricki Barbour and Schultz (holotype). An account of the stratigraphy and fauna of the Broadwater and Lisco localities is given by Schultz and Stout (1948).

The eagle is represented by the distal end of a tarsometatarsus and most of the shaft. The proximal end of a femur and the badly crushed distal end of a tibiotarsus was found associated with the tarsometatarsus and may belong to the same bird. The tarsometatarsus is too large and massive to be satisfactorily compared with any of the North American Buteoninae, which also have the tarsometatarsus tapering more abruptly distally. It resembles the tarsometatarsus of *Aquila chrysaetos* very closely, but differs from that form in being more elongate and in having the papilla for the tibialis anticus more proximally situated. It

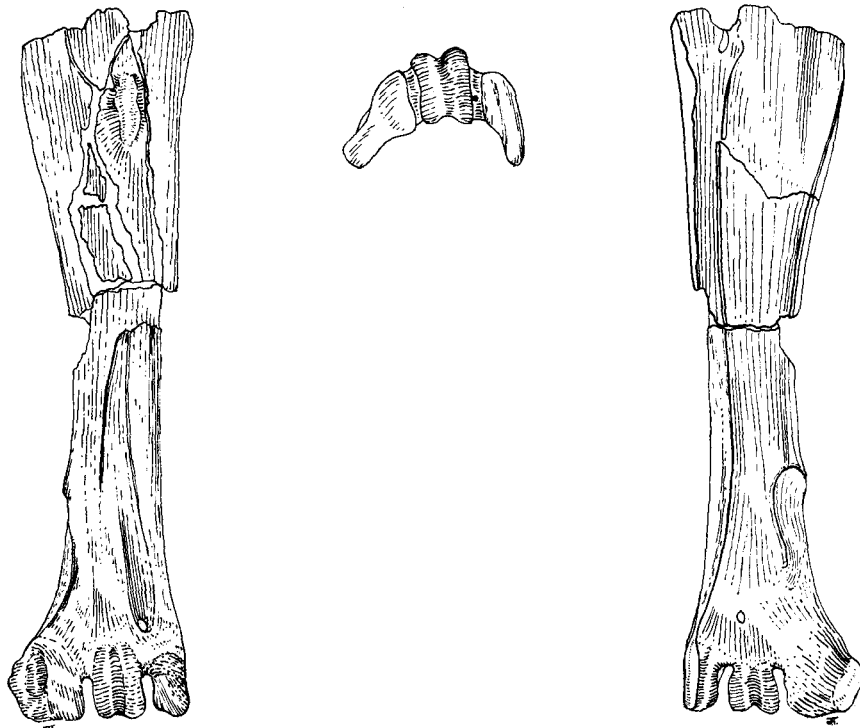


FIGURE 1. Tarsometatarsus of *Spizaetus tanneri*, U.N.S.M. 20038, anterior, distal, and posterior views of type specimen, $\times 1$.

does resemble *Spizaetus grinnelli* (Miller) and *S. willetti* Howard in these and other characters, and is referred to *Spizaetus*. *Haliaeetus leucocephalus* has a much shorter, heavier tarsometatarsus, with the papilla for the tibialis anticus more distally placed and the trochlae for digit 2 extending further distally than do the other trochleae.

Comparisons were made with tarsometatarsi of *Haliaeetus leucocephalus* (5), *Buteo regalis* (2), *B. (Geranoaetus) melanoleucus* (2), *Aquila chrysaetos* (15), and *Spizaetus tyrannus* (1). In addition, femora were examined of *Aquila chrysaetos* (5), *Spizaetus tyrannus* (1), and *S. nipalensis* (1). Published descriptions and illustrations were relied upon for the characters of *Spizaetus grinnelli* (Howard 1932) and *S. willetti* (Howard 1935).

Spizaetus tanneri, new species

Figure 1

Holotype. Distal end and most of the shaft of the left tarsometatarsus, U.N.S.M. 20038.

Type locality and horizon. U.N.S.M. Coll. Loc. Gd-12, near center of E $\frac{1}{2}$ SE $\frac{1}{4}$ sec. 13, T. 18 N, R. 46 W, 3 mi. E, 2 mi. N of Lisco, Garden County, Nebraska. From the Broadwater Formation, Early Pleistocene.

Referred material. Proximal end of femur U.N.S.M. 20039 and the distal end of a tibiotarsus U.N.S.M. 20040. This material was found associated with the holotype and is probably part of the same individual.

Diagnosis. Tarsometatarsus slightly smaller than in *Spizaetus willetti* Howard from which it also differs in having the facet for metatarsal I not so large or so lateral and the trochleae much more arched. It is larger and much more massive than *S. grinnelli* (Miller) and has a wider shaft of the tarsometatarsus.

When viewed anteriorly the trochlea for digit 2 appears large and extends further proximally than in the extinct species or in most specimens of *Aquila*. However, when viewed posteriorly the trochlea for digit 2 appears weak as in other species of *Spizaetus*.

Measurements. Dimensions of the holotype of *S. tanneri* U.N.S.M. 20038: width of distal end, 24.3 mm; width of shaft at the proximal end of the facet for metatarsal I, 13 mm; distance from the distal end of the trochlea for digit 3 to the middle of tubercle for tibialis anticus, 89.5 mm. (This measurement is approximate because of the crushed condition of the proximal end of the bone.)

Etymology. The species is named in honor of Lloyd Tanner who supervised many of the excavations at the Broadwater and Lisco Localities and who has contributed much to our understanding of the Pleistocene of the Central Great Plains.

DISCUSSION

Spizaetus tanneri differs from *Aquila* in having the tarsometatarsus more elongate and the papilla for the tibialis anticus more proximally placed. However, the shaft is shorter and stouter than it is in *Morphnus woodwardi* Miller. The shaft above the trochleae does not narrow as much as in *Aquila*. *Spizaetus tyrannus* also has the shaft of the tarsometatarsus less constricted above the trochleae than it is in *Aquila*. It resembles *S. tanneri* and differs from *Aquila* in having the medial margin of the shaft relatively straight, in having the shaft less indented at the facet for metatarsal I, in having the distal foramen smaller, and in having the extensor groove leading into the distal foramen relatively deeper. The trochleae of *S. tanneri* are arched more as in *Aquila* than as in *Spizaetus willetti* or *Haliaeetus leucocephalus*. The external

flange on the trochlea for digit 4 is slender as in *Aquila* and *Spizaetus*, and is not short and stubby as in *Morphnus woodwardi* (Howard, Condor 37:208, 1935). The facet for metatarsal I is larger and higher than it is in *Aquila* of similar size. The femur indicates a proportionally small bone. The diagnostic region around the pneumatic foramen has largely been destroyed and the assignment of it and the tibiotarsus which is crushed almost beyond recognition is based entirely on their association with the holotype of *S. tanneri*.

Spizaetus tanneri is the oldest known member of the genus as the species nearest it in age, *S. pliogryps* (Shufeldt), from Fossil Lake, Lake County, Oregon, cannot be older than Middle Pleistocene. *Spizaetus pliogryps* is based on phalanges which, according to Howard (1946), have greater depth of shaft than do those of *S. grinnelli*. As no phalanges of *S. tanneri* are known it cannot be satisfactorily compared with *S. pliogryps*. *Spizaetus willetti* Howard from Smith Creek Cave, White Pine County, Nevada, and *S. grinnelli* (Miller) from Rancho la Brea, Los Angeles County, California, are both Late Pleistocene in age. Miller (1943) has also reported *S. grinnelli* from San Josecito Cave in México. *Spizaetus tanneri* is the first record of this genus from the Central Great Plains. It seems closer to *Aquila* than do other species of *Spizaetus*, and it would not be surprising if the two genera had a fairly immediate common ancestry.

NOTES ON THE BREEDING OF THE SULPHUR-BELLIED FLYCATCHER IN ARIZONA

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The breeding range of the Sulphur-bellied Flycatcher (*Myiodynastes luteiventris*), a widespread species in México and Central America, barely extends into southeastern Arizona. In Arizona these flycatchers breed only in riparian mountain canyons where sycamore (*Platanus racemosa*), oaks (*Quercus*), walnuts (*Juglans*), Arizona cypress (*Cupressus arizonica*), and two species of pines (*Pinus leiophylla* and *P. engelmanni*) are common.

I observed nesting Sulphur-bellied Flycatchers in Cave Creek Canyon of the Chiricahua Mountains, Cochise County, Arizona, during the summers of 1964 and 1966 while I was engaged in other studies.

SPRING ARRIVAL AND COURTSHIP

Sulphur-bellied Flycatchers are among the last of the summer residents to arrive in the mountain canyons of southern Arizona, typically appearing in late May or early June (Bent 1942:100; Phillips et al. 1964:80). Courtship apparently begins soon after arrival. At 18:40 on 26 May 1964 I watched a duet in which both birds shook their heads vigorously and popped their mandibles synchronously. This was repeated several times before they began flying within a small area, one behind the other, shrilly calling *she-eu she-eu*.

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Certainly it is useful to unite them in a single subfamily, Aquilinae, as was suggested by Howard (1932).

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Their calls were almost perfectly synchronized. When the lead bird perched, the follower did likewise, alighting several inches from the first. These events terminated when the lead bird flew at the other and drove it from its perch. These were my only observations of what appeared to be pair formation or courtship activities. Other authors (Gross 1950; Skutch 1960:374) have not described the bill-popping and head-shaking displays in either the Sulphur-bellied or the closely related Streaked Flycatcher (*M. maculatus*).

NEST SITES AND THE NEST

In Arizona nest sites are usually in natural cavities in living sycamores. However, one nest was located in an old flicker (*Colaptes auratus*) hole and another was in a bird box that I had placed high in a sycamore. Six Arizona nests ranged in height from 6.8 to 13.4 m (mean, 11.0 m). Skutch (1960:387) found seven nests at heights of 3.4-27.7 m above the ground.

Unlike *Myiarchus* flycatchers which also nest in cavities, Sulphur-bellied Flycatchers usually do not place their nests deep inside a hole. Instead they often fill a deep hole with large twigs almost up to the rim and then place the nest proper on this platform. However, this is not invariable (cf. Bent 1942:100; Skutch 1960:388). Five nests I located were 10 cm (woodpecker hole), 27.5 cm (natural cavity), 11.25 cm (natural cavity), 2.5 cm (natural cavity), and 25.0 cm (bird box) below the rim of the hole. The nest in the old flicker hole was situated directly on top of a nest and four unincubated eggs of the Olivaceous Flycatcher (*Myiarchus tuberculifer*), another common tyrannid of Cave Creek Canyon. Bent (1942:105) recorded a Sulphur-bellied Flycatcher nest built over the fresh eggs of a Flicker.

According to Skutch (1960:388), the female alone constructs the nest, but its mate often is present. I observed only one bird, presumably the female, carrying nest material. At two nests, the time elapsed