

TABLE 1. Measurements (mm) of six nests of *Piezorhina cinerea*.

Nest number	1	2	3	4	5	6
Field number	MDW #1505	PJB #2135	MDW #1514	MDW #1515	MDW #1572	MDW #1574
External width	90 × 90	90 × 90	80 × 90	90 × 95	95 × 95	85 × 90
External depth	70	60	70	70	— ^a	70
Cup width	64 × 70	66 × 70	56 × 65	59 × 69	—	54 × 61
Cup depth	40	35	40	35	—	40

^a The rim of Nest #5 was too damaged to yield complete measurements.

supported on their bottoms and sides by several branches. Nest #1 differed in that it was placed against the main stem of a tree in an upright crotch.

The markings of the seven eggs show considerable inter-clutch variation and are less diagnostic than the nests for species identification. All are ovate and have a light blue ground color; they are heavily spotted and blotched with various shades of browns and grays. One set, MDW #1515 (Fig. 1D), is more heavily marked than the other two sets; these eggs are almost as heavily marked as those of *Passer domesticus*, but they otherwise bear no real resemblance to the eggs of the latter species. The five unbroken eggs average $23.1 \pm 0.7 \times 16.9 \pm 0.1$ mm (range 22.3–24.2 × 16.7–17.1 mm); they are considerably smaller than the eight *M. bonariensis* eggs ($23.7 \pm 1.1 \times 18.5 \pm 0.7$ mm) found with them. The cowbird eggs are less heavily marked (one is immaculate) than the finch eggs.

The records presented above add another species to the list of birds parasitized by the Shiny Cowbird. The presence of cowbird eggs in four nests suggests that *Piezorhina* is a frequent host of this brood parasite. Of the other species I found nesting in this area, only the Long-tailed Mockingbird (*Mimus longicaudatus*) was as heavily parasitized; six of seven mockingbird nests contained eggs of both species. The punctured and broken eggs in the *Piezorhina* nests had probably been damaged by cowbirds. The buried egg in Nest #5 indicated that *Piezorhina* does not always accept cowbird eggs.

On 4 June I saw an adult *Piezorhina* feeding an immature finch that was already out of the nest. The juvenile bird had streaked underparts, a gray bill, and a light-colored eye-ring.

My observations were made during the transition from the rainy to the dry season. Light rain fell on the morning of 27 May but, to my knowledge, not thereafter. When I revisited the area on 27 June, I found no evidence of breeding among *Piezorhina* or any of the other 20 species of birds whose nests I had found a month earlier.

General agreement is lacking on the taxonomic relationships of *Piezorhina*. Meyer de Schauensee (1966, The species of birds of South America and their distribution, Narberth, Pennsylvania, Livingston; 1970, A guide to the birds of South America, Wynnewood, Pennsylvania, Livingston) placed *Piezorhina* near the grassquits (*Tiaris*) and seedeaters (*Sporophila*). Paynter (1970) considered *Piezorhina* more closely related to the monotypic Slender-billed Finch (*Xenospingus concolor*) and the Inca-Finches (*Incaspiza*). Unfortunately from the standpoint of making taxonomic comparisons, the nests and eggs of *Xenospingus* and *Incaspiza* remain undescribed.

I am grateful to Srs. Manuel A. Plenge and Gustavo del Solar for their assistance in Peru. P. J. Barbour collected one of the nests and helped identify some of the plants. John S. McIlhenny, Babette M. Odom, H. Irving Schweppe, and Laura R. Schweppe provided financial support for fieldwork. I thank G. R. Graves, L. F. Kiff, J. P. O'Neill, and J. V. Remsen, Jr. for commenting on earlier drafts of this paper. I benefited from a grant from the Chapman Memorial Fund to study the biology and systematics of Peruvian birds. Received 26 May 1980, accepted 7 August 1980.

The Capture Efficiency of Flickers Preying on Larval Tiger Beetles

ELIZABETH J. MURY MEYER¹

208 Mueller Laboratory, The Pennsylvania State University,
University Park, Pennsylvania 16802 USA

Although insects make up a significant proportion of the diets of many bird species, few data are available on the success rates of avian predators feeding on arthropod prey. Capture rates have been

¹ Present address: 899 C Homestead Village Lane, S.E., Rochester, Minnesota 55901 USA.

TABLE 1. Flicker attack rates on larval cicindelids.

Date	Larval burrow diameter ^a			
	1–1.5 mm	2–2.5 mm	3.0 mm	4–5.0 mm
16 September	4 (166)	54 (730)	0 (9)	1 (33)
18 September	0 (150)	17 (765)	2 (20)	1 (32)
20 September	0 (138)	5 (754)	0 (15)	0 (32)
23 September	0 (137)	0 (796)	1 (76)	0 (28)
25 September	1 (139)	18 (803)	0 (100)	1 (25)
27 September	2 (138)	11 (779)	2 (110)	3 (27)
30 September	0 (145)	5 (799)	0 (124)	1 (24)
Total attacks (\bar{x})	7 (145)	110 (775)	5 (65)	7 (29)
Capture success (%)	100	60.9	100	0
\bar{x} burrow depth	2.86 cm	5.50 cm	11.70 cm	11.08 cm

^a Numbers in parentheses are numbers of larvae active on the transect at the time the attacks were made.

calculated for Cattle Egrets (*Bubulcus ibis*) (Dinsmore 1973) and Spotted Flycatchers (*Muscicapa striata*) (Davies 1977) feeding on large food items, including dragonflies, beetles, and grasshoppers. In most cases, however, information on avian selectivity and foraging patterns has come from the analysis of stomach samples (Beal 1895, 1911; Hespenheide 1971; and others), regurgitated pellets (Willis 1967), or fecal material (Davies 1977).

During the fall of 1979 I obtained data on the attack patterns and capture efficiencies of Common Flickers (*Colaptes auratus*) feeding on ground-dwelling larvae of three species of tiger beetles (Coleoptera: Cicindelidae). Observations were made from 16 to 30 September 1979 on a 30 × 6-m transect of mixed sand/clay, 6.3 km west of State College, Centre County, Pennsylvania. The area supported a meager flora, consisting predominantly of the moss *Ditrichum pallidum*, whorled loosestrife (*Lysimachia quadrifolia*), and wild indigo (*Baptisia tinctoria*). Trees bordered the northern end of the transect. Approximately 1,100 tiger beetle immatures were active on the site.

Tiger beetle larvae are predaceous and live in vertical burrows opening at the soil surface. A newly hatched larva digs its first burrow by enlarging the egg chamber made by the female during oviposition. The larva will normally remain in this location throughout its life—increasing the tunnel's dimensions following each ecdysis—unless it is subjected to severe physical stress (e.g. flooding) (Shelford 1908) or is attacked by certain hymenopteran parasitoids (Wilson and Farish 1973). When searching for prey, a larva positions itself at the top of its tunnel with its head flush to the ground and completely filling the burrow entrance. Immatures can be conveniently placed into four categories based on the diameter of this opening (Table 1). Average body lengths of the insects ranged from 0.6 cm (1–1.5-mm diameter group) to 1.9 cm (4–5-mm diameter group).

All cicindelid burrows on the transect were individually marked at the beginning of the study period. The condition of each marked larva was recorded at 2–3-day intervals. Predation was assessed by counting the number of previously undisturbed burrows bearing signs of flicker damage—typically in the form of deep conical impressions left by the birds' bill. As the larvae were actively feeding throughout the observation period, the birds were credited with a successful capture if a larva did not reopen its hole following an attack. Renewed activity at a damaged burrow indicated that the larva had been missed by the predator. Surviving immatures normally resumed feeding within a week after an avian encounter. Only one exception to this assumption was noted during the study. Although most censuses were conducted after the birds had finished feeding, two flickers were observed foraging near the wooded end of the transect on the morning of 25 September.

For the most part, larvae were attacked in proportion to their relative abundance on the transect (Table 1). On 16 and 20 September, the flickers biased their strikes in favor of 2-mm burrows containing second instar *Cicindela punctulata* (Kolmogorov-Smirnov Goodness of Fit Test, $P = 0.02$). Although overall larval densities on the transect varied from 0 to 21 larvae/m², there was no significant correlation between burrow density and the frequency of avian attack (Kolmogorov-Smirnov, $P > 0.2$). It is possible that the incidence of predation was related to the density of larvae visible to the bird. Beetle immatures are sensitive to vibrations and drop from ground surfaces to the base of their burrows when alarmed. Assuming that the flickers' foraging behavior consisted of a combination of taps and probes, as described by Rathbun (*in* Bent 1939) for the Northwest Flicker (*Colaptes auratus cafer*), the number of available larvae in the bird's immediate area would be expected to decline rapidly following a foraging bout. It would thus be to the bird's advantage to move to a neighboring location after a strike was made.

Flickers searched specific sections of the transect more than once during the 2-week feeding period. Attacks in these regions were focused predominantly on undisturbed holes. In five cases, however, strikes were made on damaged burrows that had shown signs of renewed larval activity.

Flicker capture rates varied from 0 to 100% among cicindelid larval classes (Table 1). The number of captures in each size category did not differ from the expected value ($\chi^2 = 4.64$, 3 df, $0.1 < P < 0.25$). Burrow depth was probably a major factor affecting the birds' foraging success. Average bill length, gape to tip, for four male and two female *Colaptes auratus* from the Pennsylvania State University collection was 3.73 cm. The flicker's range of feeding effectiveness may be increased as much as 5 cm beyond this point as a result of its extensible tongue (Short 1971). The mean depths of 1–1.5-mm and 2–2.5-mm diameter burrows placed larvae well within this attack distance (Table 1). The accuracy of the flickers on larvae in the 3-mm class is more difficult to explain but may have been related to sluggishness on the part of the insects, most of which had just reopened their holes following a period of summer diapause.

Birds have previously been noted as occasional predators on both ground-dwelling and arboreal tiger beetle larvae (Zikan 1929). The incidents described above marked the only period of woodpecker predation of cicindelid immatures at my study site from March 1977 to July 1980, although flickers were regularly seen in the area throughout the larval activity season. Perhaps increasing larval densities (two to three times as high in 1979 as in 1978) attracted the attention of the predators.

I wish to thank W. Koenig, D. L. Pearson, and A. L. Rypstra for their helpful comments during the preparation of this manuscript. This research was partially supported by a grant from the National Science Foundation, DEB 78-03172, to the Pennsylvania State University.

LITERATURE CITED

- BEAL, F. E. L. 1895. Preliminary report on food of woodpeckers. U.S. Dept. Agri. Div. Orn. and Mamm. Bull. No. 7.
- . 1911. Food of the woodpeckers of the United States. U.S. Dept. Agri. Biol. Surv. Bull. No. 37.
- BENT, A. C. 1939. Life histories of North American woodpeckers. U.S. Natl. Mus. Bull. No. 174.
- DAVIES, N. B. 1977. Prey selection and the search strategy of the Spotted Flycatcher (*Muscicapa striata*): a field study on optimal foraging. *Anim. Behav.* 25: 1016–1033.
- DINSMORE, J. J. 1973. Foraging success of cattle egrets, *Bubulcus ibis*. *Amer. Midl. Natur.* 89: 242–246.
- HESPENHEIDE, H. A., 1971. Food preference and the extent of overlap in some insectivorous birds, with special reference to the Tyrannidae. *Ibis* 113: 59–72.
- SHELFORD, V. E. 1908. Life-histories and larval habits of the tiger beetles (Cicindelidae). *J. Linnean Soc. London* 30: 157–184.
- SHORT, L. L. 1971. Woodpeckers without woods. *Nat. Hist.* 80: 66–74.
- WILLIS, H. L. 1967. Bionomics and zoogeography of tiger beetles of saline habitats in the central United States (Coleoptera: Cicindelidae). *Univ. Kansas Sci. Bull.* 47: 145–313.
- WILSON, E. O., & D. J. FARISH. 1973. Predatory behaviour in the ant-like wasp *Methocha stygia* (Say) (Hymenoptera: Tiphidae). *Anim. Behav.* 21: 292–295.
- ZIKAN, J. J. 1929. Zur biologie der Cicindeliden Brasiliens. *Zool. Anz.* 82: 269–414.

Received 22 May 1980, accepted 1 September 1980.

Nocturnal Activities of Brazilian Hummingbirds and Flycatchers at Artificial Illumination

HELMUT SICK AND DANTE MARTINS TEIXEIRA
Museu Nacional, Rio de Janeiro, Brazil

Although twilight activities are common in Trochilidae, as in the Brazilian Ruby (*Clytolaema rubricauda*) and the Swallow-tailed Hummingbird (*Eupetomena macroura*), little is known about their nocturnal activities. Decker (1936, Aspectos biológicos da flora brasileira, São Leopoldo, Rotermund) reported (probably at São Paulo, Brazil) that flowers of the trumpetlily (*Datura suaveolens*), which blossom