Manitoba, Winnipeg, Manitoba, R3T 2N2; present address RWJ: *105 S. Oak, Teutopolis, Illinois 62467*). *Received 15 Aug. 1996, accepted 10 Feb. 1997.*

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Diet and hunting behavior of the Plumbeous Kite.—The Plumbeous Kite (*Ictinia plumbea*) forms a superspecies or is conspecific with the Mississippi Kite (*I. mississippiensis*), (AOU 1983, Parker 1988). It inhabits humid lowlands from eastern Mexico south to Bolivia, Argentina, and Paraguay, while the Mississippi Kite breeds widely across the southern United States and winters in South America (Brown and Amadon 1968). The Plumbeous Kite is migratory at the southern and northern limits of its range. Although the diet and hunting behavior of the Mississippi Kite have been relatively well studied (Skinner 1962, Parker 1974, 1988, Evans 1981, Glinski and Ohmart 1983), information about the Plumbeous Kite has been based on observations at one nest in Ecuador by Skutch (1947) and a handful of casual observations (Haverschmidt 1962, Ferrari 1990). Here we present data collected over a four-year period on the diet and hunting behavior of Plumbeous Kites at a Central American lowland site.

Study site and methods.—We studied Plumbeous Kites in Tikal National Park, Petén, Guatemala, from 1991–1994 as part of The Peregrine Fund's "Maya Project." Tikal National Park covers 576 km^2 in NE Guatemala (17°13′N, 89°38′W). Elevation is 200–250 m amsl, topography gently rolling, and the climate tropical, with an annual rainfall of about 1350 mm. The rainy season begins from mid-May to late June, with highest rainfall in September, and a pronounced dry season occurs from February until May or June. The semideciduous tropical forest varies along a subtle topographic continuum. In well-drained sites it is 25–30 m tall with closed canopy, open understory, and diverse tree species, while in low-lying areas, it is lower (10–15 m) with more open canopy, dense understory, and partly different tree species composition. Forest vegetation, climate, and land-use patterns of the Tikal area were described by Schulze (1992) and Whitacre et al. (1993, 1995). Tikal National Park is covered mostly by unbroken primary forest, with some areas of light selective logging prior to 1969. Study nests were located near clearings around Maya ruins and park facilities.

Plumbeous Kites arrived at Tikal in late February, began nesting in March, fledged young in June and July, and departed in August (Vásquez et al. 1992; D. Whitacre, unpubl. data). Observations of prey deliveries were conducted at six nests—two each in 1991, 1992, and 1994. In 1991 and 1992, most nest observations were full day, while in 1994 most were from two to six hours. Prey deliveries were observed using a 30-power spotting scope and binoculars at a distance of 20–30 m. Prey items were delivered to nestlings in the manner described by Skutch (1947): they were carried to the tree either in the bill or feet but always transferred to the bill before landing in the nest tree, and retained there as the bird walked to the nest, allowing sufficient time for identification. In 1994, we studied hunting behavior concurrently with nest observations, focusing on adults at two nests. We watched whichever pair member was hunting at the time, and when it joined flocks of foraging kites, we still observed one individual throughout, though not necessarily the same individual observed previously. We described all hunts, identity and position of quarry, and outcome. For success calculations, a hunt was defined as a completed attempt to seize an individual quarry. Rarely did kites make multiple attempts to seize the same quarry, but when they did, these were regarded as separate hunts. For statistical analyses, we used multiple random permutation procedure (MRPP) Chi-square tests (Berry and Mielke 1986).

Results.—We observed delivery of 702 prey items, 655 of which we identified to some level (Table 1). Because the bulk of the 47 unidentified prey items was likely insects, the diet is most accurately described as percent of identified prey rather than total prey. Considering the six nests individually, insects averaged 92.5% of prey (N = 6, SD = 8.1), lizards 6.0% (SD = 6.6), snakes 1.1% (SD = 2.0), birds 0.3% (SD = 0.7), bats 0.2% (SD = 0.5), and frogs 0.1% (SD = 0.2). Use of biomass estimates would slightly increase the importance of vertebrates but would not alter basic patterns.

Cicadas and beetles were the most commonly captured insects, although dragonflies, orthopterans, lepidopterans, and hymenopterans were also taken (Table 1). The relative importance of these orders varied between years. At 1991 and 1994 nests, cicadas and beetles dominated the diet, while in 1992, dragonflies, orthopterans, and lepidopterans figured more prominently. Especially striking was the large proportion of lizards at 1992 nests, where few cicadas were taken (Table 1). Overall, 34.4% of insect prey was unidentified; these may have included additional orders and may have systematically included smaller insects.

Lizards taken included both the arboreal/scansorial genus *Norops* (formerly *Anolis*) and *Sceloporus*. *Sceloporus* were frequently observed on limestone Maya temples near which the kites nested and were uncommon in the forest at large. *Norops*, in contrast, were abundant on vegetation throughout the forest. All lizards brought to nests were small, estimated at <15 g. Only two bats were observed as prey items, both probably <15 g. All three birds taken were Northern Rough-winged Swallows (*Stelgidopteryx serripennis*), which nested abundantly in the ruins; it is possible these were fledglings. We witnessed one pair of kites capture a Northern Rough-winged Swallow via a cooperative hunt (Seavy, pers. obs.). The few frogs and snakes brought to nests were small, with estimated weights <10 g.

Plumbeous Kites used two foraging techniques—aerial hunts (hunts launched from flight) and perch hunts (hunts launched from a perch). Aerial hunts were launched at flying prey from extensive prospecting flights during which the kites soared anywhere from canopy level to several hundred m above. In aerial hunts, insect prey were captured in one of three ways: (1) quick grabs—when birds did not perceptibly alter their flight path and reached out to seize nearby insects, (2) short, flapping climbs to seize an insect above, and (3) diving pursuits—when kites attacked an insect below them by dropping into a long dive or shallow swoop, seizing the insect as they pulled out at the bottom. These attacks were up to 100 m but usually 10–40 m in length. In hunts launched from a perch, the birds would either drop from the perch into a stoop or make a short, flapping flight to capture prey. Unlike the aerial hunts, perch hunts sometimes culminated with the kites making contact with the forest canopy or ground in pursuit of prey. Prey was always captured with the talons.

Two hundred forty-six hunts (61%, N = 403) were successful. Sixty-nine percent (276) were initiated from soaring flight and the rest from perches. Aerial hunts were directed at flying insects and were significantly more successful (65%; 179 of 276) than hunts from perches (53%; 67 of 127) ($P = 0.002$, MRPP Chi-square test). Of hunts launched from perches, 87% were directed at insects in flight, and 13% were directed at insects or small lizards in the forest canopy or on the ground. Perch hunts at flying insects were less successful (55%, 60 of 110) than aerial hunts ($P = 0.06$, MRPP Chi-square test) but similar to perch hunts for quarry in the canopy or on the ground (41.2% successful; 7 of 17) ($P = 0.317$, MRPP Chi-square test). Hunts for quarry in the forest canopy or on the ground made up only 4% of all observed hunts.

Hunting activity peaked strongly during mid-morning, was lowest during early afternoon, and increased gradually thereafter to a low peak near sunset (Fig. 1). Most hunts during the peak hunting hours of 07:00 to 11:00 CST were launched from soaring flight at flying insects, while perch hunting predominated in early morning and throughout the afternoon and evening (Fig. 1). On six occasions in 1994, groups of 5–14 Plumbeous Kites and 1–5 American Swallow-tailed Kites (*Elanoides forficatus*) were observed foraging together over

TABLE 1

FREQUENCY OF PREY ITEMS DELIVERED TO SIX PLUMBEOUS KITE NESTS AT FOUR TERRITORIES (A, B, C, AND D) IN TIKAL NATIONAL PARK, GUATEMALA: PERCENTAGES BASED ON IDENTIFIED PREY ITEMS

	1994a N (%)	1994b N (%)	1992b N (%)	1992c N (%)	1991c N (%)	1991d N (%)	Total N (%)
Homoptera	41 (24.55)	57 (35.20)	1 (1.22)	7 (6.31)	29 (39.19)	12 (20.34)	147 (22.44)
Coleoptera	37 (22.16)	53 (32.70)	0 (0.00)	0 (0.00)	6 (8.11)	20 (33.90)	116 (17.71)
Odonata	2 (1.20)	2 (1.23)	19 (23.17)	33 (29.73)	3 (4.05)	4 (6.78)	63 (9.62)
Orthoptera	2 (1.20)	3 (1.85)	8 (9.76)	16 (14.41)	4 (5.41)	2 (3.39)	35 (5.34)
Lepidoptera	2 (1.20)	0 (0.00)	8 (9.76)	8 (7.21)	2 (2.70)	1 (1.69)	21 (3.21)
Hymenoptera	6 (3.59)	0 (0.00)	1 (1.22)	2 (1.80)	8 (10.81)	1 (1.69)	18 (2.75)
Unident. insects	70 (41.90)	44 (27.16)	27 (32.93)	31 (27.93)	21 (28.38)	17 (28.81)	210 (32.06)
Total insects	160 (95.80)	159 (98.15)	64 (78.05)	97 (87.39)	73 (98.65)	57 (96.61)	610 (93.13)
Lizards	2 (1.20)	2 (1.23)	14 (17.07)	12 (10.81)	1 (1.35)	2 (3.39)	33 (5.04)
Snakes	0 (0.00)	0 (0.00)	4 (4.88)	2 (1.80)	0 (0.00)	0 (0.00)	6 (0.92)
Frogs	0 (0.00)	1 (0.62)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	1 (0.15)
Birds	3 (1.80)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	3 (0.46)
Bats	2 (1.20)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	2 (0.30)
Total verts.	7 (4.20)	3 (1.85)	18 (21.95)	14 (12.61)	1 (1.35)	2 (3.39)	45 (6.87)
Unident. prey	2	8	5	19	10	3	47
Total ident. prey	167	162	82	111	74	59	655
Total prey	169	170	87	130	84	62	702

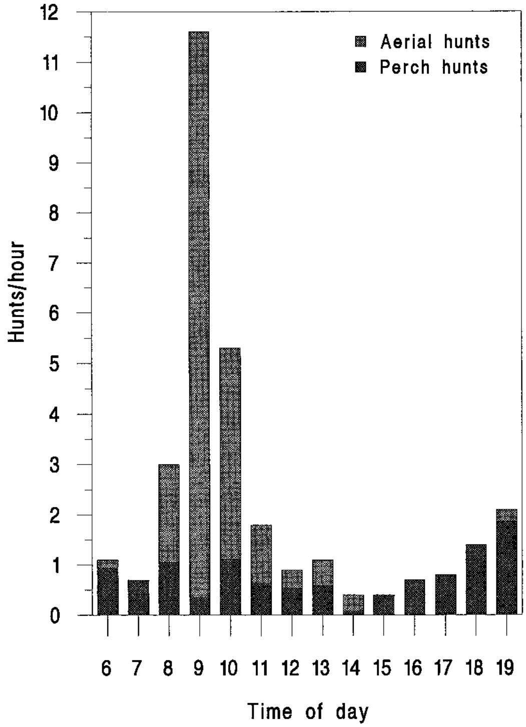

FIG. 1. Diel pattern of Plumbeous Kite hunts launched from flight and from perches at two nests at Tikal, Guatemala (nests 1994a and b, combined data).

the forest. These group foraging bouts were observed between 07:50 and 09:10, and lasted from 5–60 min. This foraging took place 50–200 m above the canopy as the kites repeatedly grabbed at small insects with their feet and fed on the wing.

Discussion.—The diet and hunting behavior of Plumbeous Kites were similar to those of the Mississippi Kite (Glinski and Ohmart 1983, Parker 1988). In both species, insects comprised the bulk of the diet, with small vertebrates providing the remainder. Cicadas were the predominant prey in both Arizona and Tikal, and Glinski (pers. comm.) emphasized those authors' conviction that cicadas are central to the Mississippi Kite's ecology in Arizona. In Brazil, Plumbeous Kites preyed on cicadas flushed from vegetation by small primates (Ferrari 1990).

Diel patterns of perch and aerial hunting, similar to those we observed in Tikal, have been noted in Mississippi Kites (Glinski and Ohmart 1983). Scarcity of atmospheric lift and insect flight activity may explain the predominance of perch hunting during the cool, early morning, but these explanations do no apply to the hot afternoon hours. Aerial hunts at dawn and dusk may have been directed at insect mating swarms, especially of ants and termites, which often occur at such hours (Whitacre 1992).

Annual variation in the composition of the nestling diet may suggest a functional complementarity between certain large insects and small vertebrates in the diet of this raptor. It is our impression that, at Tikal, populations of some large insects, including cicadas and some beetles, are generally more labile than those of small reptiles. We speculate that fluctuations of insect populations may largely dictate the degree of predation pressure at a given point in time directed at small vertebrate prey by Plumbeous Kites and other raptors with mixed insect/vertebrate diets.

Though much Plumbeous Kite hunting occurred within 200 m of the nest, much also occurred farther afield. The extent to which the prey base of Plumbeous Kites may be economically defensible is open to question. Areas of forest yielding cicadas, beetles, and lizards may be defensible, but ephemeral aggregations of dragonflies and other flying insects probably are not. It is unknown whether aggregations of foraging individuals resulted simply from gregariousness, from independent discovery of local prey concentrations, or by kites cueing in on the foraging motions of other individuals ("network foraging" or "local enhancement"; Thorpe 1956, Pulliam and Millikan 1982), a behavior that could aid these highly mobile birds to exploit rich but ephemeral food sources such as insect swarms.

Arthropod abundance at Central American lowland sites typically reaches a strong annual peak soon after the onset of the rainy season, often dropping to lower, dry season levels during the latter half of the rainy season (Janzen 1973, 1980, Levings and Windsor 1982). Weekly insect sampling begun in December 1994 at Tikal showed the same pattern, with insect numbers increasing during the first weeks of the rainy season and declining thereafter (D. Whitacre, unpubl. data). Plumbeous Kites at Tikal fledged during the first few weeks of the rainy season. Such reproductive timing, with the high food demands of nestling young and the fledging event both taking place at a time of maximal insect abundance, conforms to the pattern prevalent among insectivorous birds in Central America (Skutch 1950). Likewise, the high hunting success rates and diet of mainly insects and lower vertebrates, in combination with the very small degree of sexual size dimorphism of the Plumbeous Kite (Bierregaard 1978), conform well with patterns established to date among these factors within the Falconiformes (Temeles 1985).

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Nathaniel E. Seavy, *17142 Lemolo Shr. Dr. N. E., Poulsbo, Washington 98370*; Mark D. Schulze, *Dept. of Biology, Pennsylvania State Univ., University Park, Pennsylvania 16802*;

DAVID F. WHITACRE, *The Peregrine Fund, 566 W. Flying Hawk Lane, Boise, Idaho 83709*; AND MIGUEL A. VÁSQUEZ, *Parque Nacional Tikal, Petén, Guatemala. Received 27 Feb. 1996, accepted 27 Feb. 1997.*

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European Starlings nesting in southern Baja California, Mexico.—The European Starling (*Sturnus vulgaris*) has become abundant across North America since its introduction in New York in 1890. Starlings have been recorded breeding in Baja California as far south as Cataviña (Fig. 1) (Wilbur 1987) and now occupy virtually all the suitable habitat in the northern portion of the peninsula (Short and Crossin 1967). Some incidental winter records have also been reported in southern Baja California (Wilbur 1987, Howell and Webb 1992). Until recently, Southern Baja may be one of the least disturbed areas in the world. The desert is dry and hot (average annual precipitation, 150.6 mm; mean annual temperature, 22.1°C to 23.4°C, maximum 44°C) with a dense sarcocaulescent scrub vegetation dominated by cardon cactus (*Pachycereus pringlei*), dagger cactus (*Stenocereus gummosus*), mesquite (*Prosopis articulata*), palo verde (*Cercidium microphyllum*), Adam's tree (*Fouquieria diguetii*), plum tree (*Cyrtocarpa edulis*), copal (*Bursera* spp.), lomboy (*Jatropha cinerea*), and cholla (*Opuntia cholla*) (Wiggins 1980). Cardons are giant columnar cacti with a principal trunk and generally 4–12 branches starting 3–4 m from the ground. Almost every 6–8 m cardon contains a cavity in one of the branches, cavities that generally were excavated by woodpeckers. These holes are extensively used by both primary and secondary cavity-nesting birds (Rodríguez-Estrella, unpubl. data).

Human activity in the desert of Baja California was still minimal a decade ago. In the 1950s, the Federal government strongly promoted human colonization and increased agricultural activity in the nearly uninhabitated peninsula of Baja California. Subsequently, agriculture and livestock activities have increased along the peninsula. Agriculture was only progressing slowly until the end of the 1980s (Gobierno del Estado 1992). An increase in areas dedicated to agriculture has been recently detected (RR-E pers. obs.). The increase has been concentrated mainly in the Ciudad Insurgentes-Ciudad Constitución, Centenario-Chametla, Los Planes, Santiago-La Ribera, and El Carrizal regions (Fig. 1). These changes may have benefited starlings for colonization.

In this paper, we report the first nesting records of the European Starling in the Cape region, the southernmost record in Baja California, and discuss potential effects nesting starlings might have on the native cavity-nesting bird species in the area.

From May through July 1995, while doing breeding bird censuses in Baja California Sur, we found a European Starling nest with nestlings and observed several other instances of starling breeding activity. We recorded starlings in 16% of the 117 two-hour observational points from Loreto to Cabo San Lucas (Fig. 1). Records were significantly more frequent in human-transformed areas with field crops and rural settlements (14 of 39 points) than in remote areas with natural vegetation (5 of 78 points) ($\chi^2 = 13.9$; 1 df; $P < 0.001$). The mean number of starlings counted was 2.6 ± 2.6 (range 1–10; $N = 19$ observations). Record sites are shown in Fig. 1.

The starling nest was found on 26 May at the edge of a field crop in a cultivated area containing some scattered trees (Fig. 1). Grazing pastures and corn fields were located within 100 m of the nest area, and some relictual patches of natural vegetation, including cardon and dagger cactus, mesquite, palo verde, Adam's tree, lomboy, and cholla bordered the area. The nest was in an old woodpecker hole in a 4.7 m cardon cactus. The nest cavity was 4.2