dakotensis are both represented by a single partial humeri, and both are considerably smaller than *americanus* and the Irvington humerus. Both date from mid to late Tertiary, rather than Pleistocene. *N. slaughteri*, from the late Pliocene of Idaho, is represented by only a distal tibiotarsus that is the size of the largest known *americanus* tibiotarsus, the opposite end of the spectrum from the Irvington specimen. Although the large size may indicate specific distinction of *slaughteri* from the Irvington specimen, comparable elements of these two forms are not now available. Thus, a final judgement cannot be made. Feduccia (1974) found differences between *slaughteri* and *americanus* based on the tibiotarsii alone, however. *N. vallecitoensis*, middle Pleistocene in age, is represented only by a partial tarsometatarsus and phalanges, but these are considerably larger than the same elements in *americanus* (Howard 1963). Presumably the humerus, if known, would likewise demonstrate a size increase and thus be larger than humeri of *americanus* and the Irvington form.

The Irvington specimen therefore indicates that *N. americanus* appeared no later than the middle Pleistocene in North America. At that time it was a contemporary of the larger *N. vallecitoensis*, both occurring in California. *N. americanus*, however, was the only *Neophrontops* to survive into the late Pleistocene, becoming extinct in relatively modern times, perhaps before the advent of man in North America.

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PREY OF BAT HAWKS AND AVAILABILITY OF BATS

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The Bat Hawk (*Macheiramphus alcinus*) occurs in parts of the Old World tropics and is considered to feed mainly on bats (e.g., Chapin 1932, Allen 1939, Kingdon 1974). Bat Hawks use their talons to catch flying bats or birds and to transfer prey to their mouths while in the air (Packenham 1936, Eccles et al. 1968). Studies of stomach contents show that bats comprise at least 50% of the diet of Bat Hawks, and swifts and swallows the balance (e.g. Chapin 1932, Gore 1968).

We present an anlysis of the prey represented in the pellets and compare this with available data on the relative abundances of bats in the area from which we obtained the pellets.

On 15 January 1976 we visited the nest of a pair of Bat Hawks near the Hostes Nicolle Institute of Wild Life Research in the Sengwa Wild Life Research Area (ca. 18°10′S, 28°13′E) about 110 km west of Gokwe, Rhodesia. The nest was located about 15 m above the ground in a mountain acacia (*Brachystegia glaucescens*), and has been used by a pair of Bat Hawks for the past 11 years. From under the nest and from under a roost 200 m away in a mnondo tree (*Julbernardia globiflora*), we collected 28 pellets cast by Bat Hawks. The nest was in deciduous woodland and our visit occurred in the wet season. Although we could not be certain, there appeared to have been one young in the nest.

MATERIALS AND METHODS

We dried the pellets in an oven at 90°C for three hours and then teased them apart by hand. All hair samples were washed in carbon tetrachloride to remove dirt and grease, but we did not attempt to remove all solid particles from the hair surfaces to minimize destruction of the cuticular scale patterns. The remains in the pellets were identified primarily on the basis of hairs, feathers and insect parts notwithstanding. We also relied on teeth and skull fragments to aid identification in some cases.

Hairs were examined microscopically. As diagnostic characters we used hair length and color, and details of cuticular scale patterns. The patterns were obtained from whole mounts and as impressions using clear fingernail lacquer and acetone. Hairs from the pellets were compared to reference collections of bat hairs from appropriate specimens, and to the illustrations in Tupinier (1973). Because of the difficulties associated with recognizing species of bats by hair characteristics (e.g., Nason 1948), our identifications are to the generic level; in some cases this is equivalent to the species. We have no evidence that the hairs of some bats were more prone to digestion than others, and presume our samples to be representative.

The relative abundances of bats in the vicinity of

TABLE 1. Percentages of bats in Bat Hawk pellets and mist nests from the vicinity of the Hostes Nicolle Institute of Wild Life Research.

Bats	Weight in g	Percent of captures in mist nets[1]	Percent of bats from Bat Hawk pellets[2]
Eptesicus capensis	5	16	33
Scotophilus (*viridis*[3] or *nigrita*)	15–25	50	31
Tadarida (*nigeriae* or *bivittata*)	15–20	6	12
Nycticeius schlieffeni	5	11	7
Pipistrellus (*nanus*, *rusticus* or *kuhlii*)	<5	5	6
Hipposideros caffer	5–10	1	4
Laephotis angolensis	5–10	1	2
Rhinolophus (*landeri*, *fumigatus* or *hildebrandti*)	5–30	1	1
Epomorphorus (*wahlbergi*, *crypturus* or *gambianus*)	>70	4	0
Myotis welwitschii	10–15	0.5	0

[1] Of a total of 264 bats taken in mist nets (Fenton 1975).
[2] Of a minimum of 65 bats represented in the pellets.
[3] *Scotophilus viridis* = *S. leucogaster* (Koopman 1975).

TABLE 2. Species or genera of bats known to have been taken by Bat Hawks.

Bats	Weight in g	Source
Hipposideros (*caffer* or *ruber*)	10±	Brosset 1966
Rhinolophus (*landeri*, *fumigatus* or *hildebrandti*)	5–30	This study
Myotis muricola	10	Miller 1898
Pipistrellus nanus	5	Chapin 1932
Pipistrellus (*nanus*, *rusticus* or *kuhlii*)	5	This study
Eptesicus ater (= *tenuipinnis*[1])	5	Chapin 1932
Eptesicus tenuipinnis	5	Kingdon 1974
Eptesicus capensis	5	This study
Mimetillus moloneyi	5	Kingdon 1974
Laephotis angolensis	5–10	This study
Nycticeius schlieffeni	5	This study
Scotophilus (*viridis* or *nigrita*)	15–25	This study
Nyctinomus ochraceus (= *Tadarida leonis*[2])	20	Chapin 1932
Allomops faradjius (= *Tadarida demonstrator*[3])	20	Chapin 1932
Tadarida pumila	10–15	Kingdon 1974
Tadarida condylura	20–30	Eccles et al. 1968
Tadarida plicata	5–10	Allen 1939
Tadarida chapini[4]	5–10	Chapin 1932
Tadarida nigeriae	15–20	This study

[1] See Rosevear 1965.
[2] Koopman, pers. comm.
[3] Koopman 1975.
[4] Type specimen of *T. chapini* recovered from stomach of Bat Hawk.

the Hostes Nicolle Institute were determined by mist netting. Since the collections made in 1976 were almost identical to those of an earlier study (Fenton 1975), we used the already published figures. For details on the sampling techniques and the biology of the bats see Fenton (1975) and Fenton et al. (1977).

RESULTS

All of the 28 pellets we examined contained the remains of bats, and 71% the remains of birds. One pellet contained 80–90% feathers, seven had traces of feathers, six were 5–10% feathers, six 10–50% feathers, and eight had no feathers at all. Insects, particularly small- to medium-sized beetles and moths, consistently constituted about 5% by volume of the pellets. The average number of vertebrate prey items per pellet was 3.5, and ranged from one to five. We found no evidence of rodents, reptiles or amphibians in the pellets we examined.

In general, the bats that were most abundant in the area occurred most frequently in the pellets (Table 1) (Spearman rank correlation 0.88; $P < 0.01$). However, chi-squared comparison of the incidences of individual genera of bats in mist nets vs. those expected in Bat Hawk pellets indicates some significant differences; specifically, the Bat Hawks appear to have taken more *Eptesicus* ($P < 0.001$), *Tadarida* ($P < 0.05$), and *Hipposideros* ($P < 0.01$) than expected as based on captures in mist nets, and fewer *Scotophilus* ($P < 0.02$). *Scotophilus* and *Eptesicus* together appeared to constitute the staple diet of the Bat Hawks we studied. The one identifiable skull we found in the pellets was from a *Tadarida nigeriae*.

The pellets contained no traces of any of the five local bats larger than 30 g (*Rousettus aegyptiacus*, *Epomorphorus wahlbergi*, *E. crypturus*, *E. gambianus* and *Hipposideros commersoni*), nor had the Bat Hawks taken the smaller (< 30 g) *Nycteris woodi*, *Myotis welwitschii*, or *Glauconycteris variegata*, which were uncommon in the area.

DISCUSSION

Our pellet analysis indicates that Bat Hawks feed largely on bats, but also take birds and insects. The Bat Hawks appear to be opportunistic feeders in that the abundance of different bats as reflected by captures in mist nets generally correlates with the incidences of those bats in the pellets. Superimposed on the general pattern of opportunistic feeding is a marked selection for *Eptesicus*, a lower than expected incidence of *Scotophilus* (Table 1), and restriction of feeding to bats weighing less than 30 g (Table 2). The widespread complete absence of larger bats in stomachs or pellets (Table 2) may reflect problems of handling and swallowing by flying Bat Hawks.

Since light intensity strongly affects the visual acuity of falcons (Fox et al. 1976), it could affect the hunting prowess of Bat Hawks and may mean that they have to feed in a hurry. The need for feeding rapidly is compatible with their feeding technique which allows rapid exploitation of bats (7 bats in 20 min, Eccles et al. 1969). If light intensity does affect the foraging activity of Bat Hawks, this could explain the marked changes in behavior seen in foraging bats in bright moonlight (Fenton et al. 1977). Although refuging species of bats (e.g., *Scotophilus viridis*, *Hipposideros caffer* and some *Tadarida*) may be more vulnerable to predation by Bat Hawks than bats which do not aggregate in large numbers, this suggestion is not compatible with the high incidence of the non-refuging *Eptesicus capensis* (Fenton 1975) in the pellets we examined. Timing of emergence of bats could also affect the prey available to Bat Hawks, but the bats in the pellets included early (*Eptesicus, Pipistrellus, Nycticeius, Scotophilus*) and later flying (*Laephotis, Tadarida*) species (Fenton et al. 1977).

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REPRODUCIBILITY OF HYBRID INDEX SCORES

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The hybrid index procedure, developed independently by Meise (1936), E. Anderson (1936) and Sibley (1950), has been used in many studies of avian hybridization including several involving orioles of the genus *Icterus* (Sibley and Short 1964, Sutton 1968, Rising 1970, 1973, B. W. Anderson 1971, Corbin and Sibley 1977). Although the hybrid index method was labeled "crude" by Anderson (1949:88), Sibley was convinced that such results were reproducible because identical index scores were given repeatedly to specimens (pers. comm.). To measure his ability to assign character values similar to those of earlier studies, Anderson (1971) rescored a series of orioles collected by Sibley and Short (1964). He found that the "difference in mean scores [for a locality] varied by only a few hundredths of an index point, although individual scores occasionally varied as much as two index points." Such differences could be significant if a consistent bias existed. This problem is aggravated by the lack of a reference series of specimens.

We wished to compare the distributions of character index scores of orioles collected by Corbin and Sibley (1977) in 1970–1974 to those of Sibley and Short (1964), but were unable to reproduce the earlier distributions exactly. We thus questioned whether the hybrid index method gave reproducible results. However, we show here that the differences between separate analyses are not statistically significant.

Prior to assigning character values to the specimens from the earlier study, we established our own reference series of specimens based on the procedure detailed in Table 2 of Sibley and Short (1964). This reference series included specimens collected at Big Springs, Nebraska and Crook, Colorado (Sibley and Short 1964) and some of those collected in 1970–1974, along an east–west transect from Madison, Connecticut to Glenwood Springs, Colorado. The list of specimens in this reference series is available upon request.

We reanalyzed specimens from Big Springs, Ne-