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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LITERATURE CITED

ALLEN, G. M. 1939. Bats. Harvard Univ. Press, Cambridge.

BROSSET, A. 1966. La biologie des chiroptères. Masson et Cie, Paris.

CHAPIN, J. P. 1932. The birds of the Belgian Congo, Part 1, Bull. Am. Mus. Nat. Hist. 65:1–756.

ECCLES, D. H., R. A. C. JENSEN AND M. K. JENSEN. 1969. Feeding behaviour of the Bat Hawk. Ostrich 40:26–27.

FENTON, M. B. 1975. Observations on the biology of some Rhodesian bats, including a key to the Chiroptera of Rhodesia. R. Ont. Mus. Life Sci. Contrib. 104:1–27.

FENTON, M. B., N. G. H. BOYLE, T. M. HARRISON, AND D. J. OXLEY. 1977. Activity patterns, habitat use and prey selection by some African insectivorous bats. Biotropica 9:73–85.

FOX, R., S. W. LEHMKUHLE, AND D. H. WESTENDORF. 1976. Falcon visual acuity. Science 192:263–265.

GORE, M. E. J. 1968. A checklist of the birds of Sabah, Borneo. Ibis 110:165–196.

KINGDON, J. 1974. East African mammals, an atlas of evolution in Africa. Volume IIA. Academic Press, London.

KOOPMAN, K. F. 1975. Bats of the Sudan. Bull. Am. Mus. Nat. Hist. 154:355–443.

MILLER, G. S. JR. 1898. List of bats collected by Dr. W. L. Abbott in Siam. Proc. Acad. Nat. Sci. Phila. 1898:316–325.

NASON, E. S. 1948. Morphology of hair of eastern North American bats. Am. Midl. Nat. 39:345–361.

PACKENHAM, R. H. W. 1936. Field notes on the birds of Zanzibar and Pemba. Ibis 1936:249–272.

ROSEVEAR, D. R. 1965. The bats of West Africa. Trustees of the British Museum (Nat. Hist.), London.

TUPINIER, Y. 1973. Morphologie des poils de Chiroptères d'Europe occidentale par étude au microscope électronique à balayage. Rev. Suisse Zool. 80:635–653.

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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-

TABLE 1. Analysis of variance of individual plumage character and hybrid index scores assigned to orioles collected at Big Springs, Nebraska in 1955–1956 (upper values) and Crook, Colorado (lower values).

Source of variation	Sum of squares	d.f.	Mean square	F
Individual plumage character scores				
Among plumage characters	117.22	8	14.65	9.64***
	190.78	8	23.85	20.92***
Between studies	0.44	1	0.44	.29 n.s.
	2.35	1	2.35	2.06 n.s.
Residual	478.56	314	1.52	
	316.15	278	1.14	
Hybrid index scores				
Between studies	4.69	1	4.69	.56 n.s.
	.78	1	.78	.10 n.s.
Residual	286.28	34	8.42	
	229.69	30	7.66	

n.s. = not significant at .05 level, *** $p < .001$.

braska and Crook, Colorado, that had been collected by Sibley and Short (1964). The character index scores that we assigned were compared to those of Sibley and Short (unpubl. data) using two statistical tests. First, we correlated the plumage character scores that we assigned to each specimen with scores assigned to the same specimens by Sibley and Short. All 20 correlation coefficients (nine for plumage character values and one for the hybrid index value for each of two localities) were significant at the .01 level.

Second, we compared the values assigned in the two studies by means of an analysis of variance (Table 1). The upper part of the table deals with the variation in individual plumage character scores, whereas the lower part concerns the hybrid index scores. Within the upper part, we partition the variance due to (1) inherent differences among the characters and (2) differences in the way individual character scores were assigned in the two studies. In the lower part of the table, only that variance due to differences between the assignment of scores is partitioned. For both localities the variance associated with the characters is significant ($P < .001$). That is, the among-character variation associated with the nine plumage characters contributed significantly to the overall variance. On the other hand, the variance associated with the differences in the assignment of scores is not significant. It is not possible statistically to distinguish our scores from those of Sibley and Short (1964).

These results do not bear on the question of whether the hybrid index method adequately measures the degree of intermediacy of hybrid individuals. Rather, they show that using this technique, independent studies should obtain essentially identical results.

We thank L. L. Short for providing us with copies of the original scores assigned to specimens collected at Crook, Colorado and Big Springs, Nebraska.

LITERATURE CITED

ANDERSON, B. W. 1971. Man's influence on hybridization in two avian species in South Dakota. Condor 73:342–347.

ANDERSON, E. 1936. Hybridization in American Tradescantias. Ann. Mo. Bot. Gard. 23:511–525.

ANDERSON, E. 1949. Introgressive hybridization. John Wiley and Sons, New York.

CORBIN, K. W., AND C. G. SIBLEY. 1977. Rapid evolution in orioles of the genus *Icterus*. Condor 79:335–342.

MEISE, W. 1936. Zur Systematik und Verbreitungsgeschichte der Haus- und Weidensperlinge, *Passer domesticus* (L.) und *hispaniolensis* (T.). J. Ornithol. 84:634–672.

RISING, J. D. 1970. Morphological variation and evolution in some North American orioles. Syst. Zool. 19:315–351.

RISING, J. D. 1973. Morphological variation and status of the orioles, *Icterus galbula, I. bullockii*, and *I. abeillei*, in the northern Great Plains and in Durango, Mexico. Can. J. Zool. 51:1267–1273.

SIBLEY, C. G. 1950. Species-formation in the Red-eyed Towhees of México. Univ. Calif. Publ. Zool. 50:109–194.

SIBLEY, C. G., AND L. L. SHORT, JR. 1964. Hybridization in the orioles of the Great Plains. Condor 66:130–150.

SUTTON, G. M. 1968. Oriole hybridization in Oklahoma. Bull. Okla. Ornithol. Soc. 1:1–7.

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OLFACTION IN SNOW PETRELS

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Birds were long considered to be chiefly visual animals but this idea has recently been questioned, owing to convergent findings in anatomy, ethology, and experimental physiology. Some birds seem to be much better at detecting odors than was thought formerly (Bang 1960, Cobb 1960a, Henton et al. 1966, Marshall 1960, Michelsen 1959, Stager 1964, Tucker 1965, Wenzel 1968, 1972, 1973).

Ornithologists have suggested olfactory capacities for certain procellariiformes (Murphy 1936, Miller 1942) and anatomists have demonstrated the remarkable development of the olfactory bulbs and sensory epithelium (Bang 1960, 1966, 1971, Cobb 1960b). Bang and Cobb (1968) found the highest bulb/forebrain index in this group (mean ratio of 29.4 for 11 species), second only to the Kiwi (*Apteryx australis*), which attains 34.0. The difficulty of keeping petrels in captivity doubtless explains the scarcity of experimental observations of their sense of smell.

I sought to study the olfactory capacities of the Snow Petrel (*Pagodroma nivea*), the species that is said to have the most highly developed olfactory bulbs (Bang 1965). Four non-breeding Snow Petrels were captured during the austral summer 1975–1976 at French base Pointe Géologie (Terre-Adélie) in Antarctica, but two could not be tested because they never adjusted to captivity, refusing all food. Owing to this difficulty, I had to diversify my techniques rather than repeat the same experiment.