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SEABIRDS BETWEEN ALASKA AND HAWAII

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ABSTRACT.—Seabirds were observed between Alaska and Hawaii along 158°W longitude from 24 October to 6 November 1976. Their distributions and abundances corresponded remarkably well to oceanographic regions. Indices of seabird density dropped in a series of plateaus from 44 birds/km^2 in the Alaska Current System to less than 1 bird/km^2 in subtropic waters. Northern distribution records were found for six species. The Subarctic Boundary marked the center of the separation between subarctic and subtropic pelagic avifaunas.

Recent advances in our knowledge of the oceanography of the north Pacific Ocean (Favorite et al. 1976) indicate a system of well defined domains and currents. Studies of the relationships among seabirds and various oceanic parameters from the north Pacific (e.g., Shuntov 1972, Wahl 1978, Hunt et al. 1981) and many other regions (e.g., Bourne 1963, Ashmole and Ashmole 1967, Jehl 1974, Brown et al. 1975, Joiris 1978, Pocklington 1979, Ainley and Jacobs 1981) suggest that the dynamics of such an oceanographic system should produce distinct patterns of distribution and density among resident seabirds. The birdlife of the central part of the north Pacific Ocean is little known, yet this region encompasses the transition between distinct subtropic and subarctic pelagic avifaunas. Here I report information on the distributional limits of these avifaunas and relate these distributions to oceanographic patterns.

METHODS

Observations of seabirds were made from the 55-m research vessel Moana Wave from 24 October through 6 November 1976. Density indices for seabirds were based on data from periodic transects (strip censuses). Bird counts were taken while the ship moved along a straight path at constant speed, usually about 15–22 km/h. Each transect was based on a 10-min (temporal) cruising time. A total of 112 transects (Fig. 1) plus general observations were made throughout most daylight hours. All birds were counted forward from mid-ship to the projected end of the transect, maximum of 3,000 m at 18.5 km/h, and laterally, on one side, to 300 m. The average area of observation per transect was 0.9 km^2. Birds following the ship, recorded separately, were not used for calculating indices of density. All observations were made from the wings of the bridge, 8 m above sea level. Distances were estimated using a rangefinder developed by Heinemann (1981). Wayne Hoffman and Terence Wahl were present on this cruise and conducted seabird observations independent of mine (Wiens et al. 1978); their presence increased the probability of my detecting birds as many of their observation periods coincided with mine. Throughout the cruise, Thomas Royer (University of Alaska) recorded water temperatures, salinities, and densities to depths of 1,000 m and provided me with preliminary data. In addition, at the end of each transect I recorded surface temperature and salinity from the ship's constantly recording thermosalinograph.

STUDY AREA

Data were obtained along 158°W longitude beginning 24 October and ending 6 November 1976. The first day was spent in the Alaska Current System followed by three days in the Subarctic Current System, three days in the Transition Domain, and five days in what Svedrup et al. (1942) designated North Pacific Central Water (Fig. 1). Unfortunately, no information was obtained from the narrow Ridge Domain (Fig. 1), as we passed over this area at night.

The location of the Subarctic Boundary is identified by where the 34‰ halocline bisects the surface (Favorite et al. 1976). The ship's thermosalinograph recorded a surface salinity of 34‰ at both 39°10′N and 36°50′N latitudes, with salinities of 33.8–33.9 ppt between these latitudes. Royer, however, (pers. comm., this cruise) found the 34‰ halocline only near 37°N. I thus considered the Subarctic Boundary to have been at 37°N, but its influence on surface waters extended many kilometers to the north (Fig. 2).

The weather was fair to poor with the worst conditions occurring 27–30 October between 47°N and 41°N. High seas on 29 October forced the ship to lay-to and no observations were made on that day. Weather during transects generally included winds of 22–46 km/h, seas of 2–6 m, and visibility of 11–56 km. A subjective evaluation of observation conditions on a scale of 1 (poor) to 7 (excellent) ranged between 3 and 7 with 4 predominating.

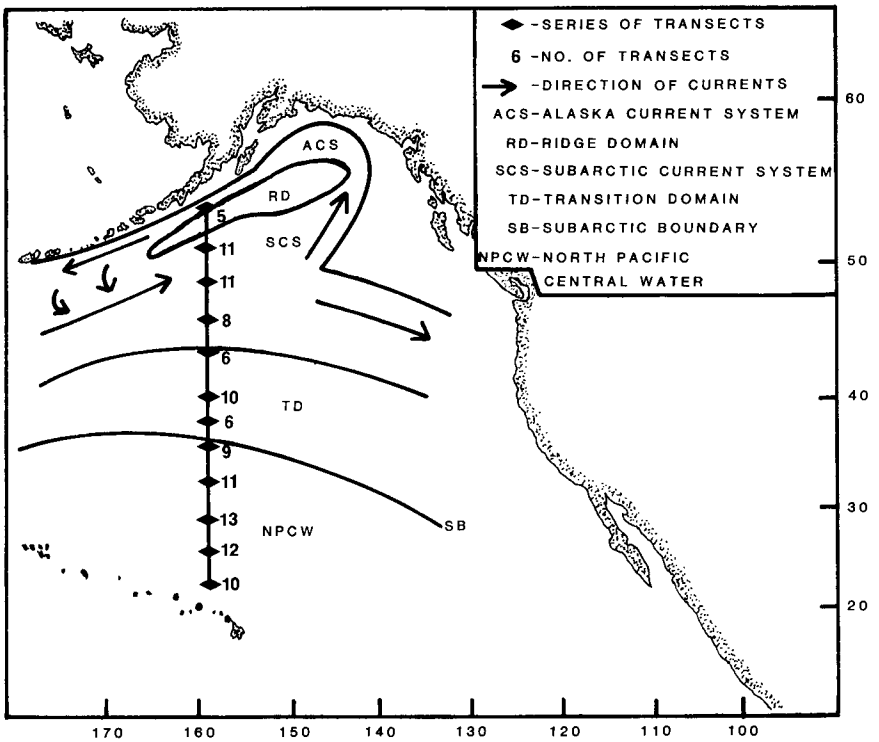

FIGURE 1. Study area showing cruise track and location of observations in relation to the surface water currents and domains.

RESULTS

Relatively level plateaus of bird density were separated by abrupt changes (Table 1, Fig. 2). Two major changes in seabird density corresponded to oceanographic regions. The first was between 54°N and 52°N where density indices dropped from 44 birds/km^2 in the Alaska Current System to 7 birds/km^2 in the Subarctic Current System. The second occurred between 41°N and 38°N where respective densities decreased from 7 birds/km^2 to 1 bird/km^2. The northernmost influence of the Subarctic Boundary occurred at about 38°N. Density indices in the subtropic North Pacific Central Water averaged less than 1 bird/km^2.

Both Black-footed and Laysan albatrosses occurred throughout the area although their relative abundance varied (Table 2, Fig. 3). Laysan Albatrosses were not seen south of 25°N, nor were Black-footed Albatrosses seen in coastal waters off Oahu. The latter were most abundant in subtropical waters whereas Laysans were most abundant at the northern edge of the Transition Domain. I was not surprised by such a separation during migration, because Robbins and Rice (1974) found the two species to normally segregate by habitat during the nonbreeding season.

Mottled Petrels, Glaucous-winged Gulls, Black-legged Kittiwakes and Northern Fulmars were most abundant in colder waters but occurred in small numbers, possibly as ship followers or migrants, southward into the transition area. A large concentration of Black-legged Kittiwakes, not shown in Figure 3, gath-

TABLE 1. Density of seabirds in relation to Favorite et al.'s (1976) surface water systems in the northcentral Pacific Ocean.

	Alaska Current System	Ridge Domain	Subarctic Current System	Transition Domain	North Pacific Central Water
No. of transects	5	0	30	22	55
No. of birds	151	—	179	106	26
No. of species	16	—	18	17	22
Birds/km^2					
Range	0–189	—	0–39	0–29	0–5
Mean	44	—	7	5	<1

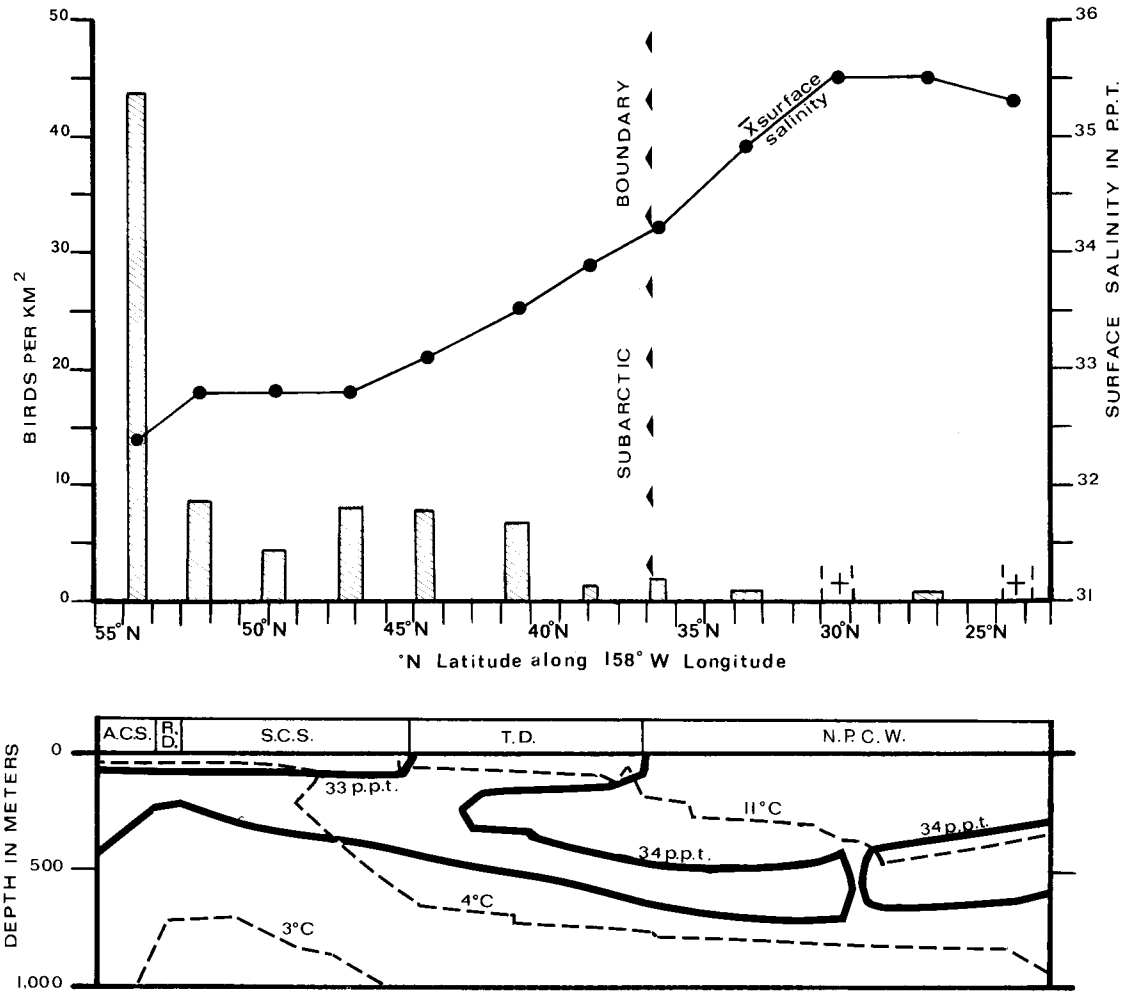

FIGURE 2. Relationship among mean seabird density indices, mean surface salinities, and oceanographic regimes in the north Pacific Ocean. Width of density columns indicates period of observations. Sample sizes for seabird density indices are equal to the number of transects shown in Figure 1. Oceanographic regimes are abbreviated as in Figure 1.

ered about the ship during each of two oceanographic stations in subarctic waters; one of about 350 birds was at 47°N and another of about 200 at 45°N. Fork-tailed Storm-Petrels, Red-legged Kittiwakes, and Herring Gulls were all confined to subarctic waters.

Horned Puffins, Tufted Puffins, Pomarine Jaegers, and Parasitic Jaegers were observed only in subarctic waters north of the southern edge of the Subarctic Current System. The jaegers, however, migrate much farther south through the central Pacific.

Both Sooty and Short-tailed shearwaters were seen throughout most of the cruise. Most of those seen south of 44°N, however, appeared to be actively migrating southward. Leach's Storm-Petrels occurred erratically throughout the trip and individuals south of subarctic waters were probably moving between their subarctic breeding grounds and their equatorial wintering quarters. Except for the occasional individual, Red Phalaropes were seen in numbers only at 41°N. Whether these birds were migrating or wintering in the area is not known, but their nondirectional patterns of flight and frequent contact with the water indicate the latter. Woodward (unpubl. field report) found many Red Phalaropes between 40°N and 45°N and 158°W and 164°W in late August 1966. Many of those he saw were in partial breeding plumage and none were flying south as would be expected of migrating birds.

The remaining species were all typical of equatorial Pacific waters. The following were noteworthy distribution records: Kermadec Petrel north to 39°12′N; Herald Petrel north to 38°48′N; two Cook's Petrels flying southeast at about 34°N and one at 36°N; Phoenix Island Petrel at 24°30′N; Bonin Petrel at 30°N; and Band-rumped Storm-Petrel at 30°20′N.

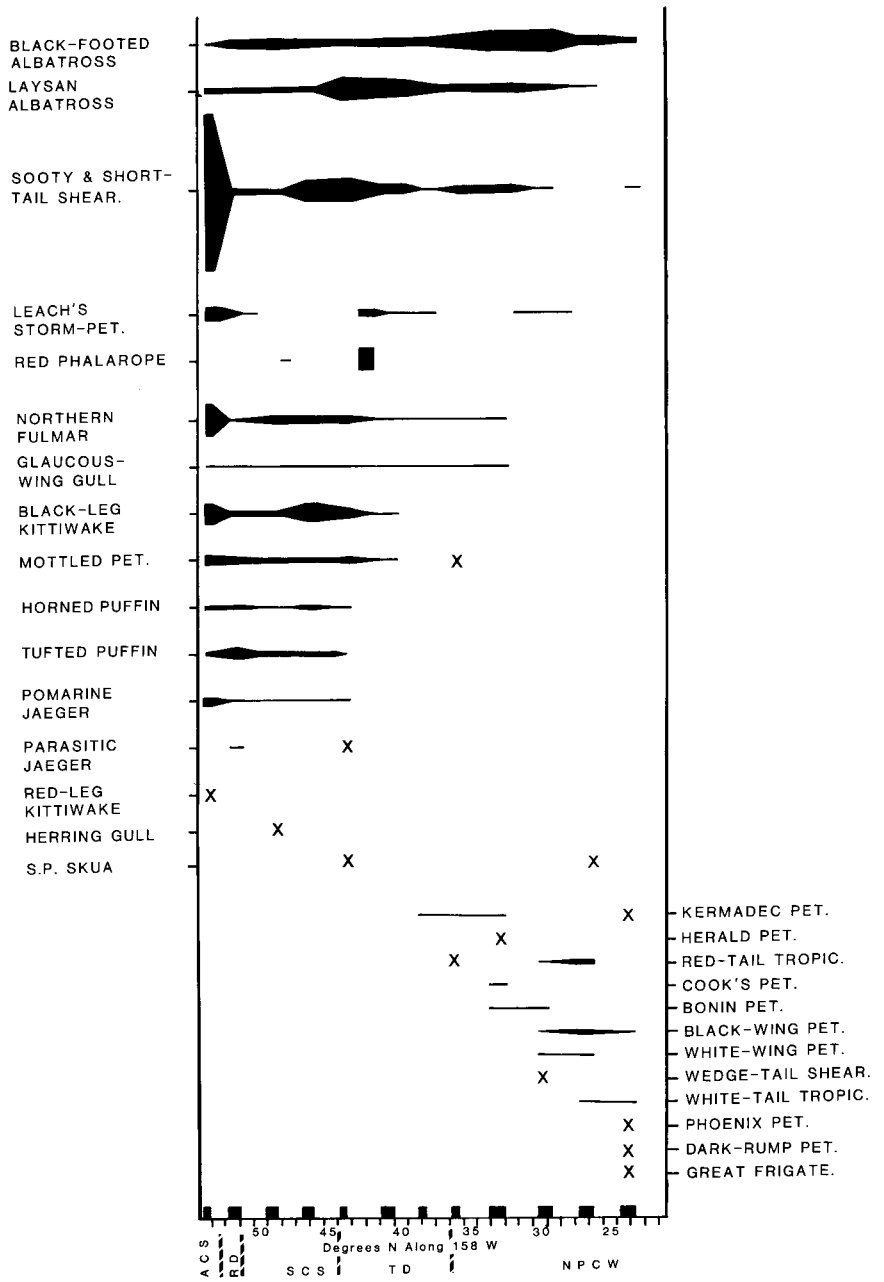

FIGURE 3. Relative abundances of seabirds interpreted from mean densities recorded at intervals between Alaska and Hawaii. Black bars along axis indicate periods of observations from which abundances are derived. Oceanographic regimes as in Figures 1 and 2.

SUMMARY AND DISCUSSION

The density and distribution of seabirds corresponded remarkably well with oceanographic features such as the domain and current systems proposed by Favorite et al. (1976). Eleven species were recorded only in the colder and less saline subarctic waters of the Ridge Domain and Alaska and Subarctic current systems. Three additional species (Northern Fulmar, Glaucous-winged Gull, and Black-legged Kittiwake) were basically restricted to these waters, but a few, probably ship-following individuals, were recorded a short way into the Transition Domain. Fourteen species were restricted to the warmer, more saline waters of the Transition Domain and North Pacific Central Water mass. The eight species not restricted to the above areas are all known to be trans-Pacific migrants. Highest densities for all birds occurred in the cold, nutrient-rich waters of the Alaska Current System near its border with

TABLE 2. Occurrence of species in relation to environmental parameters along 158°W longitude in the north Pacific. Species are listed by north to south distribution patterns. Nomenclature follows the A.O.U. Check-list Committee (1982).

Species	Surface salinity (‰)	Surface temperature (°C)	Latitude range (°N)	Number of transects
SUBARCTIC WATERS				
Red-legged Kittiwake (*Rissa brevirostris*)	32.5	8.2–8.3	54.5–54.3	2
Fork-tailed Storm-Petrel (*Oceanodroma furcata*)	32.0–32.8	7.3–8.3	54.7–50.2	9
Pomarine Jaeger (*Stercorarius pomarinus*)	32.5–33.1	7.4–11.2	54.5–44.7	9
Parakeet Auklet (*Cyclorrhynchus psittacula*)	32.4–32.8	7.2–8.2	54.7–52.2	3
Horned Puffin (*Fratercula corniculata*)	32.4–33.0	7.1–10.6	54.7–44.8	9
Tufted Puffin (*F. cirrhata*)	32.4–33.0	7.2–10.6	54.7–44.8	15
Loon (*Gavia* sp.)	32.8	7.4–8.0	52.5–49.5	4
Parasitic Jaeger (*Stercorarius parasiticus*)	32.8–33.0	7.2–10.6	52.2–44.8	4
Herring Gull (*Larus argentatus*)	32.8	7.7–8.1	49.8–49.3	3
Northern Fulmar (*Fulmarus glacialis*)	32.0–34.8	7.1–28.2	54.7–34.2	43
Glaucous-winged Gull (*Larus glaucescens*)	32.0–34.9	7.2–20.7	54.7–33.7	14
Black-legged Kittiwake (*Rissa tridactyla*)	32.0–33.6	7.1–13.6	54.7–41.2	37
SUBTROPIC WATERS				
Herald Petrel (*Pterodroma arminjoniana*)	33.9–34.8	16.1–20.4	38.8–33.2	2
Cook's Petrel (*P. cookii*)	34.8	20.5	34.0	1
Wedge-tailed Shearwater (*Puffinus pacificus*)	35.5	23.1	30.3	1
Kermadec Petrel (*Pterodroma neglecta*)	33.8–35.3	15.6–24.7	39.2–24.0	6
White-necked Petrel (*P. externa*)	35.6	23.2–24.1	29.8–27.3	2
Phoenix Island Petrel (*P. alba*)	35.3	24.7	24.5–24.0	2
Dark-rumped Petrel (*P. phaeopygia*)	35.3	24.7	24.0	1
Bonin Petrel (*P. hypoleuca*)	34.7–35.6	20.3–23.2	33.0–29.8	2
Black-winged Petrel (*P. nigripennis*)	35.3–35.4	22.4–24.7	30.7–24.0	2
Band-rumped Storm-Petrel (*Oceanodroma castro*)	35.3–35.5	23.1–24.9	30.3–24.3	3
Red-tailed Tropicbird (*Phaethon rubricauda*)	34.3–35.6	18.4–24.0	36.3–27.5	5
White-tailed Tropicbird (*P. lepturus*)	35.4–35.6	23.8–24.9	27.7–24.0	5
Great Frigatebird (*Fregata minor*)	35.3	24.7	24.5	1
ALL WATERS				
Mottled Petrel (*Pterodroma inexpectata*)	32.5–34.3	7.1–18.3	54.5–41.8	22
Black-footed Albatross (*Diomedea nigripes*)	32.0–35.6	7.1–24.9	54.7–23.9	96
Laysan Albatross (*D. immutabilis*)	32.4–35.6	7.1–24.3	54.7–26.8	74
Sooty Shearwater (*Puffinus griseus*)	32.8–34.8	7.2–20.2	52.8–34.2	7
Short-tailed Shearwater (*P. tenuirostris*)	32.0–35.0	8.1–20.6	54.7–33.2	25
Shearwater (*Puffinus* sp.)	32.0–35.5	7.2–23.1	54.7–30.3	20
Leach's Storm-Petrel (*Oceanodroma leucorhoa*)	32.9–35.4	7.4–24.2	52.5–26.7	14
Red Phalarope (*Phalaropus fulicaria*)	32.8–35.5	9.4–22.7	47.2–30.8	10
South Polar Skua (*Catharacta maccormicki*)	33.0–35.3	10.6–24.9	44.8–24.3	3

the Ridge Domain. The Subarctic Boundary marks the separation between subtropical and subarctic pelagic avifaunas although some overlap occurs on both sides.

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RECENT PUBLICATIONS

A Birder's Guide to Eastern Colorado (East of the Continental Divide).—James A. Lane and Harold R. Holt. 1979. L & P Press, Box 21604, Denver, CO 80221. 125 p. Paper cover. $5.00. Source: publisher. Detailed guides to bird-finding for eight regions of North America (guide to Florida noticed in Condor 83:191) have now been produced by Lane (in some cases with collaborators). This is a second revised edition of one that was previously revised in 1975. Following now-familiar format, it describes good birding areas, tells where to look for the avian specialties of eastern Colorado, tabulates the status and migration data for all birds of the region, and lists other vertebrates to be found. Maps, photographs, chart, references, index. A practical and invaluable aid to birders, especially those from out-of-state.

A Birder's Guide to Churchill.—James A. Lane and Bonnie Chartier. 1983. L & P Press, Denver, CO. 62 p. Paper cover. $5.50. Source: as above. Situated on the west side of Hudson Bay above latitude 58°N, Churchill is the most accessible and most famous locality for low-Arctic birds in North America. This booklet, similar in plan to the above, gives directions to birding sites and much other useful information. Notable is a full list of plants of the region. Maps, photographs, chart, references, index. To be fully equipped, visiting birders should also have Jehl and Smith's *Birds of the Churchill Region, Manitoba* (1970. Spec. Publ. No. 1, Manitoba Museum of Man and Nature, Winnipeg).

The Birds of Africa, Volume 1.—Leslie H. Brown, Emil K. Urban, and Kenneth Newman. 1982. Academic Press, London. 536 p. $99.00. This is the first of four volumes in a comprehensive, definitive handbook on the birds of the African continent and its offshore islands; a fifth volume on the Malagasy region is under active discussion. The series will give the essential information for every species in the region (some 1,850), whether resident, migrant, or vagrant. In so doing, it will assemble data that hitherto have been dispersed through many books, journals, and unpublished sources, as well as gathered through the authors' considerable field experience. This volume opens with a valuable introduction on the main features of African bird faunas, some possibilities for research, the scope, content, and layout of the text, and a list of references. Following are the species accounts, from the Ostrich through the falcons. Varying in length from one-half to five pages, they are organized into the usual topics, concisely written, and crammed with information where known; each is furnished with a continental range map. It is intended that the series will illustrate nearly every species in color; this volume contains 32 plates and many line drawings by Martin Woodcock and Peter Hayman. Bibliography, indexes. This authoritative work becomes the primary reference for information and entry into the literature on African birds. One must applaud Urban for having assumed leadership of the project after Brown's death, and encourage him toward its completion.