ATOLL RESEARCH BULLETIN

NO. 325

MORE BIRD BONES FROM POLYNESIAN ARCHEOLOGICAL SITES ON HENDERSON ISLAND, PITCAIRN GROUP, SOUTH PACIFIC

BY

SUSAN E. SCHUBEL AND DAVID W. STEADMAN

APPENDIX: ARTIFACTS FROM 1987 EXCAVATIONS ON HENDERSON ISLAND

BY

MELINDA S. ALLEN

ISSUED BY
NATIONAL MUSEUM OF NATURAL HISTORY
THE SMITHSONIAN INSTITUTION
WASHINGTON, D.C., U.S.A.
October 1989

Plate 1. Fractured beach rock and coarse coral rubble beach, eastern end of central north beach, Henderson Island.

Plate 2. North beach and lagoon, looking east. Small reef passage at centre, North-east Point in distance, far left. Note extensive beachrock.

MORE BIRD BONES FROM POLYNESIAN ARCHEOLOGICAL SITES ON HENDERSON ISLAND, PITCAIRN GROUP, SOUTH PACIFIC

BY

SUSAN E. SCHUBEL AND DAVID W. STEADMAN

APPENDIX: ARTIFACTS FROM 1987 EXCAVATIONS ON HENDERSON ISLAND

BY

MELINDA S. ALLEN

ABSTRACT

This study is based upon 2795 bird bones collected in 1987 from Polynesian archeological sites in limestone caves on Henderson Island. Two radiocarbon dates on charcoal from these sites are 400 ± 60 and 870 ± 70 yr B.P. 70% of the bird bones are of Pterodroma alba (Phoenix Petrel), which still nests on Henderson. A single bone of Gallicolumba sp. represents a new species for Henderson and the easternmost record for the genus. Other extirpated species of birds represented in the sites are Pterodroma externa (Juan Fernandez Petrel), a smaller unknown species of Pterodroma, and Nesofregetta fuliginosa (White-throated Storm-Petrel). These findings, combined with other extirpated species recorded in earlier archeological excavations, show that the resident avifauna of Henderson Island has lost two to five species of seabirds and three species of landbirds since the arrival of humans more than 800 years ago. We presume that hunting and habitat disturbance were primarily responsible for the loss of species on Henderson.

INTRODUCTION

In 1971, Y.H. Sinoto and A. Sinoto excavated several archeological sites on the north coast of Henderson Island, an island that had been regarded as uninhabited before the European exploration of the Pacific (Sinoto 1983). The bird bones from Sinoto's only stratified site, named HEN-1 (Figure 1), included the remains of three species that no longer occur on Henderson (the storm-petrel Nesofregetta fuliginosa and the pigeons Ducula galeata and Ducula cf. aurorae) and of two other species (the shearwater Puffinus nativitatis and the booby Sula sula) that visit Henderson but are not known to nest there (Steadman and Olson 1985). The sample of bird bones reported by Steadman and Olson was rather small (303 identifiable specimens). To increase the data base for the prehistoric avifauna of Henderson, as well as to learn more about the natural distribution of birds in Eastern Polynesia, SES excavated several bone-bearing deposits in limestone caves (different from HEN-1) on Henderson Island from 12 to 21 May 1987.

Biological Survey, New York State Museum
The State Education Department
Albany, New York 12230

MATERIAL AND METHODS

Our identifications are based upon comparisons of the fossils with modern skeletons from the National Museum of Natural History, Smithsonian Institution (USNM), the New York State Museum (NYSM), and the University of Washington Burke Museum (UWBM). The fossils from the 1987 Henderson excavations, summarized in Table 1, are catalogued in the Vertebrate Paleontology collections of USNM. Osteological nomenclature follows Baumel et al. (1979). Measurements were taken with digital calipers with 0.01 mm increments, rounded to the nearest 0.1 mm. yr B.P. = radiocarbon years before present. Unless stated otherwise, modern distributions of birds are based upon Pratt et al. (1987) for Polynesia, and Williams (1960), Bourne and David (1983), and Fosberg et al. (1983) for Henderson. Prehistoric distributions are based upon Steadman (1989).

SITE DESCRIPTIONS

Site 1, known as Lone Frigate Cave, is approximately 18 m above sea level and 350 m south of the northern edge of Henderson's Northwest Beach (Figures 1 and 2 herein; also see Figures 3 and 9 of Spencer and Paulay 1989). The entrance is 2.13 m high and the greatest interior height is approximately 3.5 m. The cave's passage extends inland for 17 m (Figure 2). The rocky terrain in front of the cave was covered with a thick growth of Pandanus, various shrubs, and tall ferns. Of the 2,795 avian fossils collected by SES on Henderson Island, 2,584 were from Lone Frigate Cave.

The floor of the main passage of Lone Frigate Cave was covered with powdery, gray calcareous sediment, with angular cobbles up to 10 cm in diameter. A layer of green mold covered most of the rocks and wall surfaces. The elevated floor in the North Chamber consisted mostly of solid limestone, with some loose calcareous sediment.

Fresh water dripped from the top of the entrance of Lone Frigate Cave for a number of days after a rain. This is one of the few sources of fresh water on Henderson, and may have been a factor in the habitation of the cave.

A 0.5 m by 0.5 m test pit just inside the entrance revealed the following stratigraphy.

Layer I (0-6 cm) is a fairly loose calcareous sediment made up of coarse sand with some brown soil, many angular to subangular pebbles and boulders, and a large number of bones. The surface, which is uneven and disturbed, appears to be a frequently and perhaps recently used site for cooking and eating.

Layer II (6-17 cm) is composed mainly of dark, moist soil mixed with medium sand and occasional angular fragments of white, chalky carbonates. This layer also has a large number of bones.

Layer III (17-30+ cm) is a gray sandy mix that yielded very few bones. In Pit 1, this layer is replaced by an indurated layer of white carbonates.

A 1 m by 1 m pit (Pit 1) was expanded from the test pit, following the stratigraphy described above. Bird bones were abundant in Layers I and II. Throughout the cave, additional collections of bones were made from the surface and by sorting carefully through piles of rubble. The rubble might have been derived from clearing the front living quarters of the cave.

The floor of the North Chamber of Lone Frigate Cave was littered with many small piles containing bones, bits of charcoal and crab claws. The bones and claws in these features were well preserved within a thin layer of calcium carbonate. Charcoal from three of these small surface piles was combined for a radiocarbon date of 870 ± 70 yr B.P., the oldest date yet determined for cultural remains on Henderson Island (see CHRONOLOGY). The piles may have resulted from the actions of crabs that scavenged food (especially cooked birds) from the fires at the cave entrance. A land crab was observed dragging the body of a hermit crab (Coenobita sp.) back into the depths of the cave as we worked there.

A second site (West End Cave) was worked at the far west end of the north beach (Figure 1). This cave is 17.3 m above sea level (Spencer and Paulay 1989, Figures 4 and 10) and has a large entrance approximately 2.7 m by 2.7 m. The main body of the cave is small (5 m by 3 m) with a maximum height of approximately 3.5 m. Three small chambers (2 m deep, 0.75 m wide) extend from the rear of the cave. 179 bird bones were collected from surface piles in Chambers 1-3 and from 0-10 cm deep in the main room. The floor of the main room is of brown soil with a disturbed surface.

A limited number of bird bones were collected from small caves and shelters behind the central coconut grove on the north beach (Figure 1). This area is heavily used by Pitcairners and other visitors, with campsites and woodpiles throughout the grove.

The few artifacts recovered during the 1987 excavations are described by M.S. Allen in Appendix 1.

CHRONOLOGY OF THE 1987 EXCAVATIONS

We obtained two radiocarbon dates on materials excavated in 1987. The dated charcoal samples were collected and stored in aluminum foil and were associated with numerous bird bones. The charcoal was pretreated by examination for rootlets, followed by acid, alkali, acid series of soakings to remove carbonates and humic acids. Benzene synthesis and counting proceeded normally. As reported, both dates are adjusted for C13/C12. The first date is 870 ± 70 yr B.P. (Beta-25244), based upon approximately 6 gm of wood charcoal from the floor surface of the North Chamber, Lone Frigate Cave. This charcoal was collected from three small accumulations of bones and crab claws (see SITE DESCRIPTIONS). The second date is 400 ± 60 yr B.P. (Beta-25245), based upon approximately 7 gm of wood charcoal from Test Pit 1, Lone Frigate Cave. This sample originally comprised 3 gm of charcoal from the 20-30 cm level, but was supplemented by 4 gm of charcoal from the 10-20 cm level when the original sample was determined to be too small.

Our dates of 870 ± 70 and 400 ± 60 yr B.P. correspond remarkably well with those obtained by Sinoto (1983, and in Fosberg et al. 1983) from the cave he excavated in 1971 on the north shore of Henderson. Sinoto's dates were 790 ± 110 yr B.P. (Isotopes-6344) from the base of cultural layer III, and 495 ± 105 yr B.P. (Isotopes-6343) from the upper part of cultural layer II. Considered together, the four radiocarbon dates suggest that Polynesians first arrived on Henderson between 900 and 800 yr B.P. After about 500 years of probably increasingly stressful occupation, Henderson was abandoned (or the people died out) between 400 and 350 yr B.P. No European accounts of Henderson, which begin with the landing of Quiros in 1606 A.D., mention the existence or any evidence of people living there. Quiros, in fact, stated specifically that Henderson was uninhabited (Fosberg et al. 1983:5). Had Polynesians been living on Henderson in 1606, they almost certainly would have made themselves known to Quiros.

SPECIES ACCOUNTS

Order PROCELLARIIFORMES

Family PROCELLARIIDAE

Pterodroma alba

Phoenix Petrel

MATERIAL: NISP = 1,961, MNI = 93; 41 crania, 43 rostra, 13 pterygoids, 1 jugal, 32 quadrates, 125 mandibles, 6 vertebrae, 38 synsacra, 71 sterna, 130 furculae, 206 coracoids, 143 scapulae, 199 humeri, 221 ulnae, 185 radii, 2 ulnare, 71 carpometacarpi, 34 manus digit II, phalanx 1, 60 pelves, 24 femora, 196 tibiotarsi, 120 tarsometatarsi. Among these bones are 820 (various elements) identified as Pterodroma cf. alba, and 46 others too fragmentary for precise identification, but clearly representing Pterodroma rather than Puffinus and indistinguishable from modern specimens of Pterodroma alba. Comparisons were made with the following specimens from the USNM: Pterodroma hasitata (598524), P. rostrata (576827), P. alba (498007, 498009, 498010), P. inexpectata (556261), P. solandri (500641), P. brevirostris (561316), P. ultima (497224), P. neglecta (497176), P. arminjoniana (500318, 500324, 500316), P. phaeopygia (556262), P. externa (498357, 498358), P. cookii (497150), P. hypoleuca (497943), P. nigripennis (495648), Bulweria bulwerii (498246), B. fallax (498366).

REMARKS: Pterodroma alba breeds in the Pitcairn Group (Ducie, Oeno, Henderson), Tuamotus, Marquesas, Kiribati, Tonga, and perhaps Kermadec Islands. It has been recorded at sea near Hawaii, the Society Islands, Samoa, and perhaps the Cook Islands. The bones of P. alba make up 70% of the total bird bones collected in 1987, and 54% of the total bird bones collected in 1971 (Table 2), indicating that these petrels were a major source of food for the prehistoric people of Henderson Island.

Pterodroma externa
Juan Fernandez Petrel

MATERIAL: NISP = 2, MNI = 1; 2 tibiotarsi (388630, 426539).

REMARKS: These two adult specimens are a right and left that may represent the same individual. We refer them to P. externa because of similarity in length (Table 3), stoutness of shaft, concavity of the proximal portion of shaft and depth of sulcus extensorius. The tibiotarsus of P. externa is larger than that in any of the species of Pterodroma known to occur on Henderson (Table 2).

This is the first record of P. externa from Henderson or anywhere in the Pitcairn Group. Pterodroma externa is known to breed only on Juan Fernandez Is., ca. 4600 km east of Henderson. It has been recorded at sea from the Hawaiian, Marshall, Gilbert, Phoenix, and Line Islands. Both specimens are from Lone Frigate Cave (USNM 388630, 8-10 m from entrance, depth 0-10 cm; USNM 426539, Pit 1, depth 0-6 cm). Because petrels do not come ashore except on breeding islands, we conclude that P. externa once nested on Henderson Island. Bones of this species should be sought elsewhere in the Pitcairn Group, on Easter Island, and perhaps in the Gambier or Austral Islands as well.

Pterodroma sp.
Undetermined petrel

MATERIAL: NISP = 4, MNI = 3; 3 carpometacarpi (388627, 426377, 426378), 1 ulna (428361).

REMARKS: These bones, all from Lone Frigate Cave, represent an unknown species of Pterodroma larger than P. nigripennis, P. hypoleuca, or P. cooki, but smaller than any other living species, including all those recorded on Henderson (P. ultima, P. neglecta, P. alba, P. arminjoniana, P. externa). Although these four fossils seem to represent a uniquely sized species of Pterodroma, we hesitate to use them as a basis for documenting an extirpated or extinct species for Henderson, given the uncertainties in species-level systematics and osteology of Pterodroma.

Puffinus nativitatis
Christmas Shearwater

MATERIAL: NISP = 1; 1 tibiotarsus (427192)

REMARKS: The breeding status of Puffinus nativitatus on Henderson is uncertain, although nesting is likely. This shearwater breeds through much of Polynesia (Hawaii, Kiribati, Marquesas, Tuamotus, Australs, and Pitcairn Group), including Pitcairn, Ducie, and perhaps Henderson.

Procellariidae sp.
Undetermined petrels/shearwaters

MATERIAL: NISP = 457; 11 skulls, 1 sclerotic ring, 2 mandibles, 3 atlases, 77 vertebrae, 2 synsacra, 3 sterna, 6 furculae, 2 coracoids, 18 scapulae, 3 humeri, 19 ulnae, 7 radii, 7 ulnare, 4 carpometacarpi, 3 manus digit II, phalanx 1, 65 other manus phalanges, 2 femora, 4 tibiotarsi, 3 tarsometatarsi, 215 pedal phalanges.

REMARKS: Although most of these fragmentary procellariid bones are undoubtedly of Pterodroma alba, they are too incomplete to identify beyond the family level.

Family HYDROBATIDAE
Nesofregetta fuliginosa
White-throated Storm-petrel

MATERIAL: NISP = 1, MNI = 1; 1 tarsometatarsus (426290).

REMARKS: This specimen is slightly longer than comparative specimens at USNM, but is indistinguishable qualitatively. Nesofregetta fuliginosa is the only storm-petrel that breeds widely in Oceania, with breeding records from Vanuatu, Fiji, Kiribati, Tubuai, Marquesas, Gambiers, and Samoa. It visits the Society, Tuamotu, and Marshall islands. Previous archeological records are from Mangaia, Cook Islands (Steadman 1985) and Henderson (Steadman and Olson 1985).

Order PELECANIFORMES
Family PHAETHONTIDAE
Phaethon rubricauda
Red-tailed Tropicbird

MATERIAL: NISP = 104, MNI = 6; 1 skull (427002), 1 rostrum (338560), 2 jugals (388589, 426714), 8 pterygoids (388800, 426282, 426528, 426529, 427035, 427047, 428168, 436260), 9 quadrates (388590, 388752, 388867, 426517, 426748, 426749, 426968, 428942, 428943), 12 mandibles (388839, 417154, 426337, 426538, 426712, 426713, 428169, 428874, 428985, 428989, 428990, 429006), 2 atlases (428145, 428987), 20 vertebrae (388782, 388783, 388798, 388840, 417107, 417115, 417156, 417157, 426523, 426524, 426811, 426812, 426813, 426940, 428100, 428988, 428991, 428992, 428993, 428994), 1 synsacrum (388652), 3 sterna (427001, 427006, 427007), 3 ribs (426543, 427046, 428887), 8 furculae (388655, 388767, 388832, 426332, 426924, 427226, 428984, 428996), 4 coracoids (427130, 428875, 428995, 429002), 3 scapulae (388842, 426339, 429003), 6 humeri (388670, 426892, 427136, 428672, 428872, 428998), 2 ulnae (428873, 429007), 7 radii (388653, 426338, 428876, 428986, 429001, 429004, 429005), 3 carpometacarpi (388669, 388841, 426321), 2 manus phalanges (428999, 429000), 1 femur (428719), 5 tibiotarsi (338559, 388654, 426275, 428944, 428997), and 1 tarsometatarsus (417071). Within the total number of specimens are 13 bones that, because of their fragmentary nature, are identified as Phaethon cf. rubricauda, and 3 bones as Phaethon sp. None of these is distinguishable from P. rubricauda.

REMARKS: Phaethon rubricauda is common through much of the tropical Pacific and on all islands in the Pitcairn Group. Previous archeological records include Mangaia, Cook Islands (Steadman 1985) and Henderson (Steadman and Olson 1985).

Family FREGATIDAE
Fregata minor
Great Frigatebird

MATERIAL: NISP = 2, MNI = 2; 1 jugal (426519), 1 quadrate (426547).

REMARKS: Fregata minor is widespread in the tropical Pacific, including all four islands in the Pitcairn Group.

Order CHARADRIIFORMES
Family LARIDAE
Anous stolidus
Brown Noddy

MATERIAL: NISP = 12, MNI = 4; 1 rostrum (428703), 5 coracoids (426236, 426237, 426336, 428696, 428853), 1 scapula (426654), 1 humerus (428706), 2 ulnae (426918, 427222), 2 tibiotarsi (388859, 426952).

REMARKS: This species breeds nearly throughout the tropical Pacific, including all islands in the Pitcairn Group. Anous stolidus occurs commonly in archeological sites from many islands in Polynesia.

Gygis alba
Common Fairy-Tern

MATERIAL: NISP = 151, MNI = 16; 4 crania, 2 rostra, 1 pterygoid, 10 quadrates, 9 mandibles, 6 synsacra, 9 sternae, 14 furculae, 28 coracoids, 22 scapulae, 8 humeri, 9 ulnae, 5 radii, 7 carpometacarpi, 6 manus phalanges, 8 tibiotarsi, and 3 tarsometatarsi. Included are 7 bones identified as cf. Gygis alba.

REMARKS: This distinctive bird is found nearly throughout the tropical Pacific, including all islands in the Pitcairn Group. The bones of Gygis alba from Henderson are slightly larger overall than modern specimens from the Cook Islands. Bones of G. alba are common in archeological sites from almost all regions of Polynesia.

Family SCOLOPACIDAE
Heteroscelus incanus
Wandering Tattler

MATERIAL: NISP = 1, MNI = 1; 1 ulna (428635).

REMARKS: Heteroscelus incanus breeds in Alaska and northwest Canada and migrates

to the tropical Pacific, including most of Polynesia. It has been recorded on Ducie, Oeno and Henderson in the Pitcairn Group. Tattlers are most commonly found along shorelines, especially where fringing reefs are present.

Numenius tahitiensis
Bristle-thighed Curlew

MATERIAL: NISP = 2, MNI = 1; 1 scapula (426516), 1 synsacrum (388797).

REMARKS: Numenius tahitiensis ranges widely in the Pacific as it migrates from breeding grounds in Alaska to spend the fall, winter, and spring on tropical Pacific islands, especially those of eastern and central Polynesia. This curlew has been recorded on all islands in the Pitcairn Group. It prefers open habitat such as shallow reefs, beaches, fields, and airport runways.

Order GRUIFORMES
Family RALLIDAE
Porzana atra
Henderson Island Rail

MATERIAL: NISP = 6, MNI = 2; 1 coracoid (428717), 3 tibiotarsi (428276, 428832, 428857), 2 tarsometatarsi (426530, 436396).

REMARKS: This flightless rail is found only on Henderson Island. The only other rail known from the Pitcairn Group is the widespread and volant Porzana tabuensis (Spotless Crake), which has been recorded on Oeno and Ducie. Porzana atra inhabits the forest floor where it rustles through the leaves searching for food and making a "peet" call resembling that of an American Woodcock (Scolopax minor). Rails were fairly common on Henderson in 1987.

Order COLUMBIFORMES
Family COLUMBIDAE
Gallicolumba sp.
Unknown Ground-dove

MATERIAL: NISP = 1, MNI = 1; 1 tarsometatarsus (proximal end) (388744).

REMARKS: This fragmentary specimen represents a species of Gallicolumba rather than Ducula or Ptilinopus because of these characters: tuberositas musculo tibialis cranialis abuts medial foramen vascularium proximalium (located more distad in Ducula and Ptilinopus); medial foramen vascularium proximalium smaller; in medial aspect, proximal margin of shaft thinner; in plantar aspect, medial margin of shaft more smoothly recurved; sulcus flexorius longer, sharper.

USNM 388744 is larger than the tarsometatarsus of Gallicolumba erythroptera, which occurs in the Tuamotu Group today and has been extirpated in the Cook and Society Islands. The Henderson specimen is much larger than in G. rubescens of the Marquesas, but smaller than in the extinct Gallicolumba new species 2 of the Marquesas, Society, and Cook Islands (Steadman 1989). USNM 388744 resembles the tarsometatarsus of G. erythroptera and G. rubescens more than that of G. new species 2 in the smoothly curved, shallow proximo-medial margin of the shaft, the presence of a lateral foramen vascularium proximalium, and the shallower fossa infracotylaris dorsalis (Steadman in press).

This is the southeasternmost record for any species of Gallicolumba. The nearest congener is G. erythroptera, which occurs on certain islands in the southeast portion of the Tuamotu Group, about 1000 km west-northwest of Henderson.

Ptilinopus insularis
Henderson Island Fruit Dove

MATERIAL: NISP = 54, MNI = 11; 2 rostra (417136, 428679), 1 mandible (426533), 2 synsacra (426335, 428756), 5 sterna (426595, 427008, 427009, 428166, 428760), 17 coracoids (417155, 426407, 426408, 426527, 426535, 426727, 426728, 426850, 426932, 426933, 427227, 428156, 428652, 428680, 428763, 428767, 428855), 5 scapulae (426525, 426526, 426930, 428681, 428762), 3 humeri (417106, 426289, 428945), 4 ulnae (426596, 426597, 428678, 428764), 3 radii (388799, 426962, 428806), 1 pelvis (428650), 2 femora (388681, 428615), 7 tibiotarsi (426961, 428472, 428757, 428758, 428759, 428765, 428766), 1 tarsometatarsus (426849), and 1 pedal phalanx (428761).

REMARKS: This species is regarded as endemic to Henderson because it has never been recorded elsewhere. In light of the numerous range extensions of other Polynesian columbids based upon archeological specimens (Steadman 1989), we would not be surprised if P. insularis once occurred on islands other than Henderson, especially Pitcairn Island. Fruit-doves were fairly common on Henderson in 1987.

Order PSITTACIFORMES
Family PSITTACIDAE
Vini stepheni
Henderson Island Lorikeet

MATERIAL: NISP = 2, MNI = 1; 1 scapula (417131), 1 tibiotarsus (426966).

REMARKS: This small parrot is found only on Henderson Island. As with Ptilinopus insularis, whether it is truly endemic to Henderson can be tested through the collection and analysis of archeological avifaunas from adjacent islands. Lorikeets were fairly common on Henderson in 1987.

Order PASSERIFORMES
Family SYLVIIDAE
Acrocephalus vaughani taiti
Henderson Island Reed-Warbler

MATERIAL: NISP = 1, MNI = 1; 1 rostrum (428718).

REMARKS: This subspecies of the Pitcairn Island Reed-Warbler is endemic to Henderson, where it was common in 1987. No warblers are found on Ducie or Oeno.

Aves sp.
Indeterminate birds

MATERIAL: NISP = 33. These fragmentary bones are undiagnostic at any level.

DISCUSSION

The 1987 excavations on Henderson Island demonstrate that a very large sample of bird bones might be needed if the goal is to represent the prehistoric avifauna as completely as possible. The sample analyzed by Steadman and Olson (1985) included 303 identifiable bird bones representing 12 species. Our sample of nearly 2800 bones represents 16 species, seven of which were not in the smaller sample (Tables 1, 2). Likewise, the sample of 303 bones included three species not present in the larger sample.

Sampling artifacts are especially significant in recording rare species, whether seabirds or landbirds. Each of the seven species recorded in the larger but not in the smaller sample is represented by only one to four bones. The three species that occurred in the smaller but not the larger sample are represented by three to nine bones each. This relatively larger representation is related to the heavier exploitation of landbirds (6.9% versus 2.3% of all bones; Table 1) by the people responsible for the smaller sample. In spite of the great numbers of Pterodroma alba bones in both samples, this petrel still survives on Henderson. Conversely, the seemingly low numbers of bones of most landbirds reflect the loss of three species of pigeons on Henderson. Landbirds, being less transient, tend to be more vulnerable to local overexploitation. The interior of Henderson is characterized by jagged, crevassed limestone (see Kirch 1988). Despite the harsh terrain Polynesians undoubtedly ranged over the entire island seeking food and water. The lack of tillable soil on Henderson would have prevented the development of agriculture, while the steep, narrow reef and scarcity of reef passages would have made fishing a dangerous, undependable activity. All of this points to a heavy dependence upon birds for food.

Whether the depletion of birds was a primary factor in the eventual abandonment or collapse of Henderson culture, we cannot be sure. We are certain, however, that the Polynesians were involved in the loss of certain populations of seabirds and landbirds on their island. At a minimum, the Polynesian hunters reduced some bird populations to a point where the birds became more difficult to obtain. The absence of basalt for adzes and pearlshell for fishhooks (Sinoto 1983) as well as the depletion of indigenous birds contributed to the harsh existence led by the prehistoric inhabitants of Henderson Island.

ACKNOWLEDGMENTS

This research was supported by National Science Foundation Grant BSR-8607535 and the Smithsonian Institution, including private funds generously provided by S. Dillon Ripley. We thank the government and people of Pitcairn Island for permission, cooperation, and friendship. Logistical support and assistance given by the Captain and crew of R/V RAMBLER are gratefully acknowledged. We appreciate comments on the manuscript by N.G. Miller, S.L. Olson and W.N. Mathis. For access to modern specimens, we thank the staff of USNM and UWBM. Figures 1 and 2 are by D.S. Pahlavan. Figures 3-4 (Appendix) are by Virginia C. Steadman. This is contribution number 605 of the New York State Museum and Science Service.

LITERATURE CITED

Baumel, J.J., A.M. Lukas, J.E. Breazile & H.E. Evans, eds. 1979. Nomina Anatomica Avium Academic Press, London. 664 pp.

Bourne, W.R.P. & A.C.F. David. 1983. Henderson Island, Central South Pacific, and Its Birds. Notornis 30, 233-243.

Fosberg, F.R., M.-H. Sachet & D.R. Stoddart. 1983. Henderson Island (Southeastern Polynesia): Summary of Current Knowledge. Atoll Research Bulletin 272, 1-47.

Kirch, P.V. 1988. Polynesia's Mystery Islands. Archeology, May/June 1988, 26-31.

Pratt, H.D., P.L. Bruner & D.G. Berrett. 1987. A Field Guide to the Birds of Hawaii and the Tropical Pacific. Princeton University Press, Princeton. 409 pp.

Sinoto, Y.H. 1983. An Analysis of Polynesian Migrations Based on Archaeological Assessments. Journal de la Societe des Oceanistes 39, 57-67.

Spencer, T. & G. Paulay. 1989. Geology and Geomorpology of Henderson Island. Atoll Research Bulletin (this volume).

Steadman, D.W. 1985. Fossil Birds from Mangaia, Southern Cook Islands. Bulletin of the British Ornithologists' Club 105(2), 58-66.

Steadman, D.W. 1989. Extinction of Birds in Eastern Polynesia: A Review of the Record, and Comparisons with other Pacific Island Groups. Journal of Archaeological Science 16, 177-205.

Steadman, D.W. In press. New species of Gallicolumba and Macropygia (Aves: Columbidae) from archeological sites in Polynesia. Los Angeles County Museum Contributions in Science.

Steadman, D.W. & S.L. Olson. 1985. Bird remains from an archaeological site on Henderson Island, South Pacific: Man-caused extinctions on an "uninhabited" island. Proceedings of the National Academy of Sciences, USA 82, 6191-6195.

Williams, G.R. 1960. The Birds of the Pitcairn Islands, Central South Pacific Ocean. Ibis 103, 58-70.

Table 1. Archeological avifaunas from Henderson Island. Data of Steadman and Olson (1985) are based upon bones collected by Y.H. and A. Sinoto in 1971. M = migrant. NISP = number of identified specimens. % = % of NISP in entire sample of bird bones.

	Steadman & Olson (1985)		Schubel & Steadman (herein)	
	NISP	%	NISP	%
Pterodroma alba Phoenix Petrel	165	54.4	1961	70.1
Pterodroma externa Juan Fernandez Petrel	-	-	2	0.07
Pterodroma sp. (small) Unknown petrel	-	-	4	0.14
Puffinus nativitatis Christmas Shearwater	8	2.6	1	0.07
Procellariidae sp. Unknown petrel/shearwater	-	-	457	16.4
Nesofregetta fuliginosa White-throated Storm-Petrel	3	1.0	1	0.04
Phaethon rubricauda Red-tailed Tropicbird	20	6.6	104	3.7
Sula sula Red-footed Booby	3	1.0	-	-
Fregata minor Great Frigatebird	9	3.0	2	0.07
Anous stolidus Brown Noddy	4	1.3	12	0.4
Gygis alba Common Fairy-Tern	70	23.1	151	5.4
Heteroscelus incanus (M) Wandering Tattler	-	-	1	0.04
Numenius tahitiensis (M) Bristle-thighed Curlew	-	-	2	0.07
Porzana atra Henderson Island Crake	8	2.6	6	0.2
Gallicolumba sp. Ground-Dove	-	-	1	0.07
Ptilinopus insularis Henderson Island Fruit-Dove	1	0.3	54	1.9
Ducula cf. aurorae Polynesian Pigeon	9	3.0	-	-
Ducula cf. galeata "Nuku Hiva" Pigeon	3	1.0	-	-
Vini stepheni Henderson Island Lorikeet	-	-	2	0.07
Acrocephalus vaughani taiti Henderson Island Warbler	-	-	1	0.04
Aves sp. Unknown bird	-	-	33	1.2
Totals	303	100.0	2795	100.0
% landbirds		6.9	2.3	

Table 2. Modern and prehistoric birds of Henderson Island. Modern records are derived from Williams (1960), Bourne and David (1983), and Fosberg et al. (1983). ? = recorded from Henderson, but breeding status uncertain. M = migrant (not included in landbird totals). COMBINED TOTALS = modern + prehistoric.

	MODERN RECORD	PREHISTORIC RECORDS Steadman & Olson (1985)	Schubel & Steadman (herein)
SEABIRDS			
Pterodroma ultima Murphy's Petrel	X	-	-
Pterodroma neglecta Kermadec Petrel	X	-	-
Pterodroma alba Phoenix Petrel	X	X	X
Pterodroma arminjoniana Herald Petrel	X	-	-
Pterodroma externa Juan Fernandez Petrel	-	-	X
Pterodroma sp. (small) Unknown petrel	-	-	X
Puffinus nativitatis Christmas Shearwater	?	X	X
Puffinus pacificus Wedge-tailed Shearwater	X	-	-
Nesofregetta fuliginosa White-throated Storm-Petrel	-	X	X
Phaethon rubricauda Red-tailed Tropicbird	X	X	X
Sula dactylatra Masked Booby	X	-	-
Sula sula Red-footed Booby	?	X	-
Sula leucogaster Brown Booby	?	-	-
Fregata minor Great Frigatebird	X	X	X
Anous stolidus Brown Noddy	X	X	X
Anous minutus Black Noddy	?	-	-
Procelsterna cerulea Blue-gray Noddy	X	-	-
Gygis alba Common Fairy-Tern	X	X	X
LANDBIRDS			
Heteroscelus incanus Wandering Tattler	M	-	M
Numenius tahitiensis Bristle-thighed Curlew	M	-	M
Calidris alba Sanderling	M	-	-
Egretta sacra Reef Heron	?	-	-

Table 2 (continued)

	MODERN RECORD	PREHISTORIC RECORDS Steadman & Olson (1985)	Schubel & Steadman (herein)
Porzana atra Henderson Island Crake	X	X	X
Gallicolumba sp. Ground-Dove	-	-	X
Ptilinopus insularis Henderson Island Fruit-Dove	X	X	X
Ducula cf. aurorae Polynesian Pigeon	-	X	-
Ducula cf. galeata "Nuku Hiva" Pigeon	-	X	-
Vini stepheni Henderson Island Lorikeet	X	-	X
Acrocephalus vaughani taiti Henderson Island Warbler	X	-	X
TOTALS			
Seabirds	10-15	8	9
Landbirds	4-5	4	5
All birds	14-23	12	16
COMBINED TOTALS			
Seabirds	16-18		
Landbirds	7-8		
All birds	23-29		

Table 3. Measurements (in mm) of the tibiotarsus of Pterodroma, with range and sample size. F = female. M = male. U = sex unknown.

	Length without crista cnemiali	Length from crista fibularis to distal end
P. externa Lone Frigate Cave, Henderson Island (2U)	62.6, 62.6	42.3, 42.4
P. externa Modern specimens taken at sea, Central Pacific (3F)	59.8-62.8 3	42.2-44.1 3
P. externa Modern specimens taken at sea, Central Pacific (3M)	62.9-66.7 3	42.2-46.8 3
P. alba Lone Frigate Cave, Henderson Island (11U)	53.8 52.1-55.5 11	38.8 37.3-40.0 11

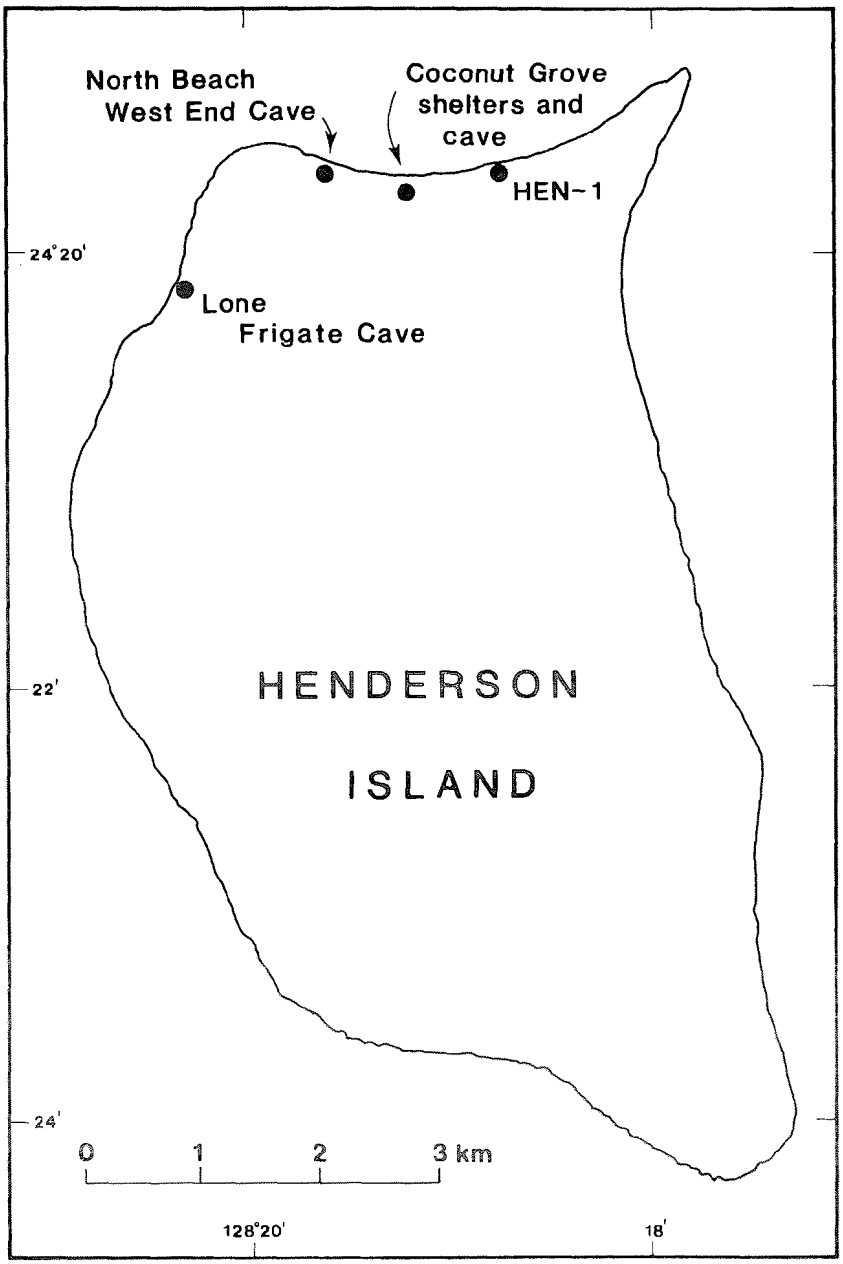

Figure 1. Henderson Island, showing localities where bird bones have been found.

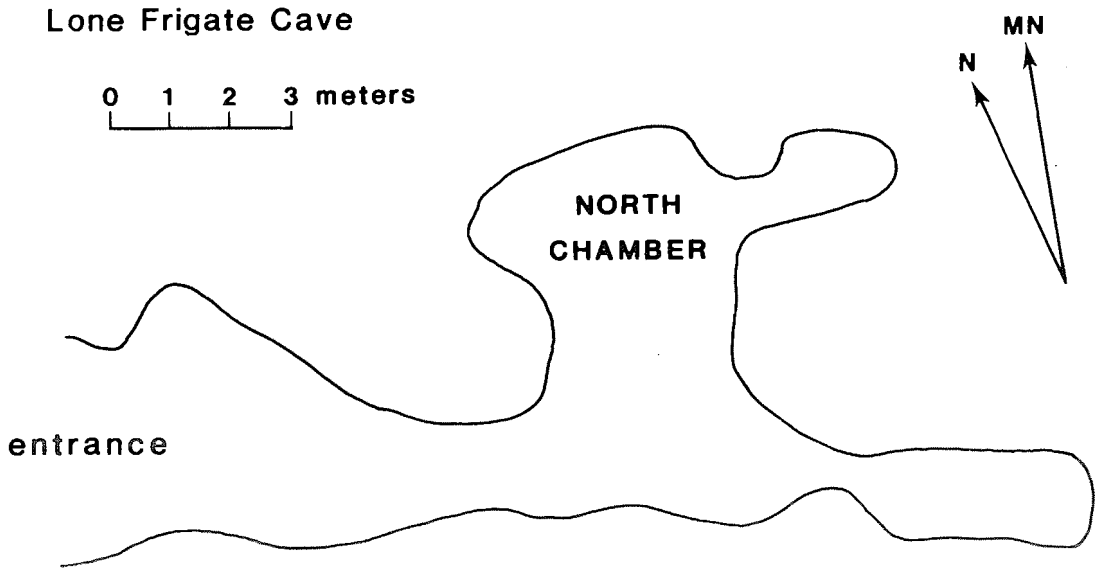

Figure 2. Plan view of Lone Frigate Cave, Henderson Island.