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Pipping in the Eggs of the Red-footed Booby *(Sula sula)*

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The sequence of events during pipping of the eggs has not been adequately described for the Red-footed Booby *(Sula sula)*. Thus, Verner (1961) stated that "pipping of the egg occurred up to a full day before hatching," without specifying whether "pipping" referred to star-fracture of the shell, formation of a pip-hole, or internal pipping (penetration of the aircell by the embryo's beak). The only other observations in sulids are those of Nelson (1971) who reported that "the first starring of the egg to complete emergence of the chick takes 36 to 48 hours" in Abbott's Booby *(Sula abbotti)*. Nelson (1978) also reported that, in the artificially incubated egg of the North Atlantic Gannet *(Sula bassana)*, the embryo began to breathe into the aircell 60 hours before hatching and the shell pipped 42.8 hours before hatching. In view of the importance of pipping in the regulation of water loss from the egg (Ar and Rahn 1980; Whittow 1980, 1984; Pettit and Whittow 1983; Whittow and Grant 1985; Whittow et al. 1985) it seemed important to obtain further information on both the sequence of events during pipping and the water loss from the pipped eggs of the Red-footed Booby.

STUDY AREAS AND METHODS

Observations were made in the Red-footed Booby colonies at Ulupau Crater, Oahu (21° 27'N; 157° 44'W), during the period 14 April to 18 May 1985; Kilauea Point, Kauai (22° 13'N; 159° 24'W), in the main Hawaiian Islands, 1-7 May 1985; and on Tern Island, French Frigate Shoals (23°52'N; 166° 17'W), 7-30 June 1980.

The sequence of events during pipping was established by examining unpipped eggs daily, and pipped eggs twice daily, until the eggs had hatched. Internal pipping was detected by listening carefully for "cheeping" sounds from the embryo; cheeping is possible only after the embryo has filled its lungs with aircell gas. The water loss from naturally incubated, pipped eggs was determined by weighing the eggs at intervals (Rahn and Ar 1974) on an Ohaus field balance (Model 1010-10) at the nest site. Under field conditions eggs could be weighed accurately to the nearest 0.01 g. The eggs were weighed at intervals of 5.2-5.8 hours, but only on two occasions in any particular egg, in order to minimize any prolongation of hatching time as a result of removal of the egg from the nest.

RESULTS AND DISCUSSION

Twenty-three eggs were examined specifically to document the pipping sequence and many additional casual observations were made. The initial event in the pipping process is believed to be penetration of the aircell by the embryo's beak (internal pipping). This belief is based on observations on only two eggs, in which the embryo could be heard to "cheep" even though the shell was completely intact. Cheeping could have occurred only if the embryo was able to fill its airways with aircell gas. The small number of eggs in which cheeping was detected may simply mean that, in most instances, the embryos were not cheeping during the short period of time (approximately one minute) that the eggs were examined. It is possible also that the embryo has to inhale aircell gas for some time before it begins to make cheeping sounds. Nelson (1978) cites observations on the artifically incubated egg of the North Atlantic Gannet which revealed that the embryo began to cheep eight hours after beginning to breathe into the air cell.

The second event during pipping was a single star-fracture of the shell towards the blunt pole of the egg. The star-fracture was expanded radially from its center and a small pip-hole was later enlarged (Fig. 1). Cheeping sounds by the embryo were frequently heard in star-fractured eggs. An intermediate stage between a pip-hole and the hatching of the chick was never seen, suggesting that this stage is of short duration. The initial star-fracture of the shell took place 32 hours 23 minutes and 33 hours 39 minutes, respectively, before hatching, in two eggs. The interval between the formation of a pip-hole and hatching was measured in eleven eggs. The mean (± standard deviation) was 22 hours 13 minutes (±9 hours 45 minutes). Subtracting this value from the mean time between star-fracture and hatching (for the two eggs to which reference was made above) yields a "star-fracture to pip-hole" time of 10 hours 48 minutes. Thus, the duration of the star-fracture stage of pipping is less than half that of the pip-hole stage, which may explain why it was not observed as frequently.

Because of the small number of observations of cheeping prior to star-fracture of the shell, and the intermittent nature of cheeping, it remains uncertain precisely how long prior to star-fracture of the shell penetration of the aircell occurs. The mean interval between the initial star-fracture of the egg shell and the emergence of the hatchling was approximately 33 hours. This is not greatly different from the corresponding interval in the eggs of Abbott's Booby (Nelson 1971), when allowance is made for the longer incubation period of the egg of Abbott's Booby. It seems likely that Verner's (1961) observations in the Red-footed Booby's egg refer to the interval between the formation of a pip-hole and hatching. Thus, as far as is known, the sequence of events during pipping in the eggs of the Red-footed Booby is probably similar to that in the North Atlantic Gannet's eggs (Nelson 1978). The pipping process in the eggs of the Red-footed Booby differs from that in the Red-tailed Tropicbird *(Phaethon rubricauda)*, the other tropical pelecaniform seabird for which such information is available, in two respects: (1) "cheeping" was not detected in the tropicbird's egg prior to star-fracture of the shell, which appears to be the initial event in the tropicbird; (2) the duration of pipping is much longer in the tropicbird (Whittow and Grant 1985).

The daily weight loss of two eggs that were unpipped when first weighed and had a pip-hole on the second occasion was 198 and 241 mg/day, respectively, with a mean value of 220 mg/day. The weight loss of five eggs that had a pip-hole on both occasions that they were weighed was considerably greater: 768 mg/day (±63 SD). These data

permit an *estimate* to be made of the water loss from pipped eggs. Thus, the initial star-fracture of the shell occurs 33 hours 1 minute prior to hatching (see above) and a pip-hole is formed 22 hours 13 minutes before the egg hatches. If the rate of water loss from star-fractured eggs is taken to be 220 mg/day, and that from eggs with a pip-hole 768 mg/day, then the total water loss from pipped eggs may be estimated to be 810 mg.

This estimate of the water loss from pipped eggs of the Red-footed Booby may be considered in relation to the total water loss from the eggs over the entire incubation period. Thus, the cumulative water loss from unpipped eggs was estimated by multiplying the incubation period (45 days; Verner 1961; Nelson 1969), less the star-fracture-to-hatch-interval (33 hours 1 minute), by the daily water loss from unpipped eggs (175 mg/day; Whittow, Pettit, Ackerman and Paganelli, unpublished observations). The value (7,618 mg), when added to the water loss from the pipped egg (810 mg), yielded a total water loss from the egg over the entire incubation period of 8,428 mg. This represents 14.5% of the weight of the freshly-laid egg (58.29g; Whittow, Pettit, Ackerman and Paganelli, unpublished data). This figure is rather lower than the values (16.1-18.6%) for four tropical Procellariiformes previously reported (Pettit and Whittow 1983). The water loss from pipped eggs amounted to 9.6% of the total water loss from the egg, although the duration of the pipping period (from the initial star-fracture of the shell to hatching) represented only 3.1% of the incubation period. Similar data are not available for other sulids, but the water loss from pipped eggs represented a larger percentage of the total water loss in the Red-tailed Tropicbird (Whittow and Grant 1985), another tropical pelecaniform seabird, than in the Red-footed Booby. This is most likely the consequence of the different modes of pipping in the two species. As noted above, in the Red-tailed Tropicbird, star-fracture of the shell, which results in an increased water loss, is the initial event during pipping and it occurs earlier in the incubation period.

CONCLUSIONS

It was concluded from these observations that the initial event during pipping in the eggs of the Red-footed Booby seems to be penetration of the aircell by the beak of the embryo, followed by star-fracture of the shell. A pip-hole was formed approximately 22 hours before hatching. It was estimated that the total water loss from the eggs over the incubation period represented 14.5% of the weight of the freshly-laid egg and that the water loss from pipped eggs was 9.6% of the total water loss from the egg.

ACKNOWLEDGEMENTS

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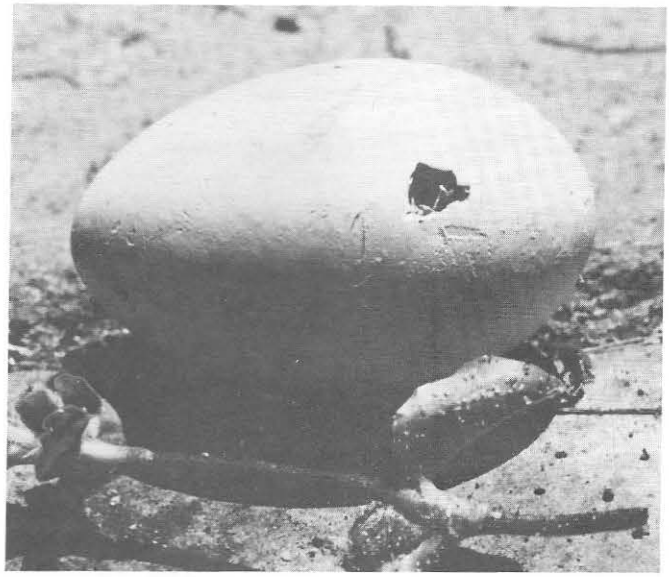

Figure 1. Egg of a Red-footed Booby showing pip-hole. The egg was removed from its nest for photography.

Photo by G.C. Whittow

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1987 MAUI CHRISTMAS COUNT PU'U O KAKA'E

Fern P. Duvall, II

On 3 January 1988, a Maui Christmas Count at Pu'u O Kaka'e ended the eight year long quiescence since a previous Maui Christmas Count had occurred. We established a new count circle on the northeast slopes of Haleakala. It was comprised of over 70 percent forest, largely native forest and alpine shrubland habitats, and so it differed markedly from the old Pu'u O Kali count circle which was situated on the southwestern slopes of Haleakala and contained for the most part greatly disturbed non-native habitat. The 1987 count circle had been chosen especially to provide the counters with a fair probability of finding Hawaii's native forest passerines (including endangered species) and access to native forest areas.

The span of elevational ranges in the current circle was extreme: from sea level to 10,023' elevation on the summit of Haleakala. Habitat types in the count circle of Pu'u O Kaka'e varied, due to the elevational extremes and land usages, from residential and open pasture-rangelands in the south and western portions to densely forested sparsely used portions in the north and eastern sections. Observers could, and did, select actively from nearly any desired temperature, precipitation and elevational gradient in which they were interested in counting birds.

Habitat coverage for Pu'u O 'Kaka'e (% total party hours): Alpine scrub 11%; wet native forests 60%; lowland exotic forests 11%; residential, parks, and rangelands 16%; and ocean and shore 2%. Weather conditions on count day ranged from mostly sunny and warm (80° F) with light winds in the lowlands to windy, cold (35° F) and nearly continuous drizzle or rainy conditions on upslope and alpine areas. The upper Haleakala party even had to postpone an early start since the summit road was closed due to hazardous icing conditions. Notwithstanding, seventeen observers, in five parties, spent just over 42 total party hours (34.1 on foot and 8.2 by car) traversing just over 104 total party miles (20 on foot, 84 by car).

On the count day, 1067 individual birds of 30 species were tallied (Table 1). 'Apapane brought in the greatest species count (200) followed by Japanese White-eye (173) and Common Mynas (117). With individual counts of over fifty, in addition to those just named, were only: House Finch (69), Rock Dove (58), and Hawaiian or Black Noddy (55).

Table 1.

MAUI CHRISTMAS COUNT - 1987

Species	Sectors 1	2	3	4	5	Total
White-tailed Tropicbird	3	—	—	—	—	**3**
Cattle Egret	—	—	8	—	—	**8**
Black-crowned Night-Heron ('Auku'u)	3	—	—	—	—	**3**
Hawaiian Goose (Nene)	—	—	—	4	—	**4**
Chukar	—	—	—	—	9	**9**
Japanese Quail	—	—	—	2	—	**2**
Ring-necked Pheasant	—	2	4	—	10	**16**
Lesser Golden-Plover (Kolea)	7	2	10	18	5	**42**
Wandering Tattler ('Ulili)	2	—	—	—	—	**2**
Black Noddy (Noio)	55	—	—	—	—	**55**
Rock Dove	—	—	58	—	—	**58**
Spotted Dove	8	—	18	1	—	**27**
Zebra Dove	1	—	18	—	—	**19**
Short-eared Owl (Pueo)	—	1	—	—	—	**1**
Eurasian Skylark	—	8	36	—	—	**44**
Melodious Laughing-thrush	8	1	1	2	—	**12**
Red-billed Leiothrix	—	20	—	2	—	**22**
Northern Mockingbird	—	—	—	—	6	**6**
Common Myna	41	—	65	3	8	**117**
Japanese White-eye	50	27	77	16	3	**173**
Northern Cardinal	12	4	8	1	—	**25**
House Finch	15	8	33	1	12	**69**
Common 'Amakihi	—	20	—	4	7	**31**
Maui Creeper	—	36	—	5	—	**41**
'I'iwi	—	22	—	14	—	**36**
'Akohekohe	—	8	—	—	—	**8**
'Apapane	—	79	—	121	—	**200**
House Sparrow	5	2	20	—	—	**27**
Maui Parrotbill	—	1	—	(probable)	—	**1**
Nutmeg Mannikin	3	—	—	2	—	**5**
TOTAL INDIVIDUALS	**213**	**241**	**356**	**196**	**60**	**1066**
TOTAL SPECIES	**14**	**16**	**13**	**15**	**8**	**30**
PARTY HOURS	**6.5**	**20**	**6.5**	**5.25**	**4**	**42**

Of the 16 different species of passerine birds counted, six were endemic species of Hawaiian forest birds. Despite the rain some real treats did appear. The party of Betsy Gagne in the Waikamoi Preserve was able to list two endangered Maui species—the Maui Parrotbill (one bird) and the 'Akohekohe or Crested Honeycreeper (eight birds). A probable Maui Parrotbill was also heard calling on the East Maui Irrigation Flume Trail, though heavy rain precluded seeing the bird.

Only one additional species was seen in the count period but not on count day; it was a notable and unpropitious Maui record, too. An adult Red-vented Bulbul was sighted on 24 December 1987 in the Pukalani area. [Luckily the bird seems to have vanished (perished?!) since then.]

Although the first Christmas Count at Pu'u O Kaka'e was an enjoyable occasion, the participants were already planning the next year's count on count day—it was the idea of getting deeper into the remote parts of the circle's native forest to see such species as the Po'ouli, Maui Nukupu'u, Maui 'Akepa, and maybe even the hitherto ethereal "blackbirds" that fired up the imaginations.

SECTORS COVERED AND PARTICIPANTS

1. **Hana Highway** (Huelo to Nahiku junction) - Leader: Marie Morin, Mary Evanson, Lorna Harrison, Joseph Reardon-Smith.
2. **Upper Waikamoi Preserve and Hosmer's Grove** - Leader: Betsy H. Gagne, Wayne Gagne, Patricia Moriyasu, Charles Probst, Jr.
3. **Upcountry Maui** (Makawao, Pukalani, Kula) - Leader: Joel Simasko, Marjorie Adams, Renate Gassmann-Duvall.
4. **East Maui Irrigation Waikamoi Flume** (Makawao and Koolau Forest Reserves, elev. 4000′ to 4400′) - Leader: Fern. P. Duvall II, Edith and Kristy Wyndham.
5. **Upper Haleakala National Park** (elev. 6800′ to 8000′) - Leader: Lloyd Loope, Alex and Charles Wyndham.

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RECENT OBSERVATIONS December 1987 through February 1988

(Editor's note: This article is excerpted from Bob Pyle's record of bird observations for the Hawaiian Islands. Refer to future issues of American Birds for a full account.)

ABBREVIATIONS: FFS = French Frigate Shoals; H = Hawaii Is.; K = Kauai Is.; M = Maui Is.; O = Oahu Is.; JCNWR = James Campbell Nat. Wildl. Ref. on Oahu; KMCAS = Kaneohe Marine Corps Air Station on Oahu; PHNWR = Pearl Harbor Nat. Wildl. Ref. on Oahu.

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WEATHER: A series of storms brought unusually heavy rainfall for the season throughout the islands, resulting in expanded habitat for waterbirds and in well-watered dryland habitats that depend upon winter rains to start the annual growing season. Improved habitat for nesting landbirds and wetland species is expected to promote increases in bird populations for the coming spring.

SEABIRDS -- A **Short-tailed Albatross** wearing band #000 returned again this winter to Sand Is., Midway on 1 Dec. (KM, TS), still showing some subadult plumage. A Black-footed Albatross was spotted on Mokuaeae islet off Kilauea Pt., K in early Jan. (BS). On Kilauea Pt., the Laysan Albatross colony increased to 31 birds this year with 10 active nests, as compared with 4 nests last year. The colony is well protected from dogs and other disturbance. Numbers of Laysans continue to swell on Oahu. Seventy-three albatross captured at Dillingham Airfield and KMCAS were banded and released elsewhere on Oahu (TO); another 21 captured at Dillingham were among the 39 birds banded there last winter. At least 20 were observed at Dillingham on 13 Feb. (AE,RD). The first eggs reported from Oahu were 3 laid at Dillingham in early December; these were abandoned after a winter storm (TO). A Laysan Albatross seen standing on the tip of Kalaupapa Peninsula (BH) on 12 Feb. is one of the few records from Molokai.

This winter, a pair of White-tailed Tropicbirds successfully nested in the crotch of a large *Casurina* tree not far from a previous nesting site in a garden box at a military residence on Midway (BE, KM); this was an unusual nesting, both for the locality and the type of nesting site.

Ten jaegers, almost certainly Pomarine Jaegers, were seen in Honolulu Harbor on 16 Feb. (PD).

Late fall sightings of gulls included one first winter Laughing Gull at Kealia Pond, M on 28 Nov. (GH) and solitary first winter Ring-billed Gulls at Kapiolani Park, O on 2 Dec. (PP), at Aimakapa Pond, H on 5 Dec. (banded at a nesting colony in Nevada; see David, *'Elepaio* 48:29), and at Kawaihae, H first on 19 Dec. (RD) and later at nearby Mauna Kea Beach on 3 Jan. (BH). Then, after a series of Pacific storms passed over the islands during late December and early January, gulls turned up everywhere. Laughing gulls were seen at Kii Pond and adjacent Amorient Pond (1-5 birds) from 9 Jan. and into March, at Aimakapa Pond (3 birds) during Jan. (RD), and single birds at Kealia Pond, M on 14 Feb. (TW), and at Hanapepe Salt Ponds, K on 15-16 Feb. (TTo). Three winter adult Bonaparte Gulls were at Kii Pond on 9 Jan. (AE, TP, RP) and on 18 Jan. (PD); and single Bonapartes were found at Hanapepe Salt Ponds on 15-16 Feb. (TTo) and at Kealia Pond, M on 24 Jan. to 4 Feb. (sev. ob.). One or two Ring-billed Gulls were reported frequently at Kii Pond from 9 Jan. into March and at Kealia Pond from 24 Jan. onward. A first winter gull of one of the large pink-footed species, thought by some to be a Thayer Gull, was seen irregularly at Kii Pond and nearby Hauula Beach, O from 16 Feb. into March (sev. obs.). Two others at Kure Atoll during March (JH) were probably first winter Herrings. And finally, an adult winter **Black-legged Kittiwake** was at Tern Is. FFS on 24-30 Jan. (KM). This was truly an outstanding winter for gulls in Hawaii.

A **Gull-billed Tern**, first record for the state, was discovered and photographed at Honouliuli Unit, PHNWR on 11 Jan. (PD, RD), but could not be located thereafter. This record is currently in press with the *'Elepaio*.

WATERBIRDS -- The new colony of resident breeding Pied-billed Grebes at Aimakapa Pond, H appears to be stabilizing at about 10 birds, though nesting continues, with two nests in Feb. (RD). Single Pied-billeds seen 3 Jan.-Feb. on Lokoaka Pond, Hilo (RD) and at Kealia Pond, M (RD, PD, 24 Feb.) suggest that the grebes may be dispersing from the original colony; on the

other hand, these two birds may instead be straggers from North America.

Hawaii's first **Red-necked Grebe**, a bird in winter plumage, was discovered on 20 Feb. on seldom-visited Helenanalu Res., K (TTo). By 10 March, the bird had come into nearly full breeding plumage (RP, PD) and was enjoyed by other observers until at least the third week of March.

Cattle Egrets, intentionally released in Hawaii to serve as control agents for pasture insects, have now found control efforts turned on them. Large colonies near airports, and egrets foraging on the grassy verges of the runways, pose a hazard to aircraft, for the slow-paced and stolid flight of an egret proves no match to that of a jet and records show that the results of such a collision can be disasterous, though luckily there have been none here. Control efforts on Hawaii Island have reduced the colony at Lokoaka Pond near Hilo to five or fewer birds; the population appears much depressed elsewhere on the island.

One or more Great Blue Herons from last fall's invasion remained through the winter at Kii Unit, JCNWR and at Kanaha Pond, M. A Black-crowned Night-Heron seen on 20 Jan. at a temporary freshwater puddle on normally dry Kahoolawe (TS), testifies to the adaptability of this speices.

As many as 20 Fulvous Whistling-Ducks were reported this winter in the breeding colony at Amorient Aquafarm and adjoining Kii Unit, JCNWR. A nest found at Kii Unit on 15 Feb. had 9 eggs, 5 of which had hatched successfully a week later (GH).

A **Tundra Swan**, studied and photographed for half an hour at Kealia Pond, M on 3 Jan. (GH) was the second state record. Two straggling geese were a Brant at KMCAS on 27 Dec. (RW) through at least 25 Jan. (AE) and a Canada (Cackling) Goose at Waiakea Pond in Hilo, H. on 6 Jan. and 8 Feb. (RD).

The small introduced population of **Nene** at Kipu Kai, K produced 11 goslings from three nests in early Feb. (TTe). The adults continue to range over most of the southern lowlands of Kauai. Hopes are high that Nene may do well on Kauai where lowland habitat suitable for raising goslings is also free of mongoose.

Expanded wetlands resulting from heavy winter rains attracted good numbers of migratory ducks this winter. Many were drawn to Kii Unit, JCNWR where improved habitat provided abundant food. Males of regularly visiting species including Northern Pintails, Northern Shovelers, and American Wigeons seemed to acquire breeding plumage a month or so earlier than in recent years, perhaps because of improved habitat conditions (SB). The less common migrants -- Green-winged Teal, Ring-necked Duck and Lesser Scaup -- turned up at numerous ponds on the 4 major islands. Eurasian Wigeons were particularly noteworthy, with up to 8 males in breeding plumage at Kii Unit, JCNWR (GH, PD, AE), up to 5 males at Aimakapa (BH,RD), and an emaciated female at Tern Is. FFS for a week before it died on 31 Jan. (KM). Single Canvasbacks were found during the winter at Hanalei NWR, K (SB), on Oahu at Waipio (PD), Amorient Aquafarm and Punamano Unit, JCNWR (GH, AE, PD), and at Kealia Pond, M (RD). A male Tufted Duck wintered at Lokoaka Pond, H (6 Jan. and 8 Feb., RD), and a pair was discovered at Wailua Res., K on 19-20 Feb. (TTo). Single **Buffleheads** in female plumage were reported near Hilo, H (RD, KI), at Kealia Pond, M (AE), and at Hanapepe Salt Ponds, K (KI). This species formerly migrated more commonly to the islands.

SHOREBIRDS -- Once the rush of this year's very active fall migration had passed, shorebird sightings slowed down to a more familiar pace. Black-bellied Plovers remained through the winter at various localities, mostly as single birds except for 2 (PD) to 5 (RD) found at Kealia Pond, M on 24 Feb. Two Semipalmated Plovers turned up at Opaeula Pond, H. on the semiannual waterbird survey (25 Jan., RD); while one was spotted at a reservoir on Hansen Rd., M. on 26 Jan. (AE). Two **Killdeer** were found at Hanalei NWR, K, first on 5 Feb. (SB, TH) and again on 21 Feb. (TTo), but not afterwards.

An overwintering Spotted Sandpiper first seen 5 Dec. at Napoopoo, Kona coast, H was still there in March (RD, BM). The one Western and 3 Least Sandpipers seen at Waipio, O during fall remained there and at nearby Honouliuli Unit, PHNWR through the end of Feb. Two small sandpipers at Tern Is., FFS through January were identified as Westerns (KM). What appeared to be an odd Pectoral Sandpiper with an unusually long, slightly down-curved bill was scrutinized closely by numerous observers at Waipio from 28 Jan. (PD) into late March. Two winter-plumaged Sharp-tailed Sandpipers found at Sand Is., Midway on 7 Dec. (KM,BE) were an unusual winter record for the species. As many as 4 Dunlin and 15 Long-billed Dowitchers were reported through the winter at numerous ponds on Oahu and Maui. A snipe found at Waipio on 4-5 Feb. (PD) may well have been a **Common Snipe**.

(To be continued next month.)

Thane K. Pratt

PREHISTORIC HAWAIIAN BIRDS
April 1988 Program

Peter Luscomb introduced the evening's speaker, Dr. Alan Ziegler, with his slide show on "Prehistoric Hawaiian Birds," subtitled by Alan as "The Lone Ranger and How He Got to Be That Way." Dr. Ziegler is a graduate of the University of California at Berkeley. Formerly the vertebrate zoologist at B.P. Bishop Museum, Ziegler is now a consultant who specializes in the identification of fossil vertebrates.

Hawaii has, and has, had a variety of endemic birds, Ziegler pointed out. Some became extinct after Capt. Cook's arrival, but at least 25 species had already died out in Polynesian times and earlier. Alan explained that in 1971 Joan Aidem discovered the skeleton of a huge flightless goose in the sand dunes on Molokai. This discovery led to increased exploration for fossil remains, revealing an extinct flightless ibis, a flightless rail, hawks, owls, and perching birds.

The flightless goose was larger than the Nene, but had a flat sternum (breast bone) and small musculature for its wings. The wings were tiny and would not have supported flight. Ziegler showed slides comparing the skeletons of a Nene and the flightless goose to reveal these differences, as well as differences in skulls and leg bones.

Subsequently, Frank Howarth of Bishop Museum found on Maui a middle-sized rail, also flightless. Lava tubes on Maui had "sky lights" through which the birds fell and, being flightless, were unable to escape. Fossil remains of flightless geese were also found in sink holes on Oahu, some dating back 800 years, with indicaitons that they were cooked and eaten by Hawaiians. A large sink hole, measuring 6 feet by 9 feet, with clear, fresh water revealed many bird bones, including petrels and a crow as large as a raven.

The question arose how flightless birds arrived here. Originally they were flighted, but through the course of evolving became flightless. Alan compared the evolution of the horse, from a 3-toed animal in a marshy environment to a 1-toed animal in a hard, dry land, over 10 million years or so, and the evolution

of birds from a flighted to flightless condition in the relatively short time of 500,000 years. One logical explanation is that birds in Hawaii, in a equable climate, did not need to migrate, and had no ground predators. Also, a flightless bird could exist on 15%-20% less food and water, as flying consumes huge amounts of energy. Ziegler recounted how neoteny, which is the retention of juvenile characteristics in adult birds, could result in "instant" flightlessness. He showed how the pectoral girdle of adult flightless geese was almost identical to that of newly-hatched flighted geese. Later came the predator man, with his feral pigs and dogs.

A lively question and answer period followed, as Alan has the gift of making old bones as exciting and challenging as the latest football game.

Betty L. Johnson

JUNE FIELD TRIP
WAIALAE IKI RIDGE

Forest birds will again be featured on this month's field trip to Waialae Iki Ridge, scheduled for Sunday, 19 June. 'Apapane, 'Amakihi and, with luck, 'Elepaio (emblem of our Society and journal) will be the native species sought on this outing. The ridge trail (a jeep road) passes first through thick, scrubby forests of guava and other exotic trees, then gradually enters native koa/ohia forest with a rich mixture of endemic trees, shrubs and other flora. All-in-all this will be an excellent opportunity to learn one's birds and plants, both natives and newcomers. Bring your binoculars, rain gear, sun screen, lunch, and water. We will meet at 7:30 AM on Punchbowl Street next to the State Library. For more information contact the trip leader, Bruce Eilerts, at 949-6843.

JUNE PROGRAM:
U.S. FISH AND WILDLIFE SERVICE
ENDANGERED SPECIES RECOVERY PLANS

At the 20 June 1988 general meeting of the Hawaii Audubon Society, Mr. William Kramer from the U. S. Fish & Wildlife Service will be presenting a talk on Hawaii's endangered species recovery plans.

Recovery plans, mandated by the 1973 Endangered Species Act, are plans which outline a process by which endangered species are restored to a nonendangered status.

Recovery plans have been developed for most of Hawaii's endangered birds. Plans are now being written for other endangered species (plants and insects). Mr. Kramer will explain how recovery plans are developed and then implemented. He will also talk about priorities and how the Fish and Wildlife Service has to deal with budget cuts and limited resources.

A part of this talk will deal with the Endangered Species Act: what it is, what role the Service plays in it and what its limits are. The program will be held at the Atherton Halau, Bishop Museum at 7:30 PM. Refreshments will be served.

FREE ICE CREAM!

Ice cream will again be served to those volunteering for paste-up of the *'Elepaio* at Thane Pratt's house on Saturday, 25 June, begining at 1:00 PM. Thanks to Pearl Johnson, Jaan Lepson, Lynne Matusow, and Bob Pyle for helping with the current issue! For more information, call me at 524-8464.

TKP

NOTICE TO AUTHORS

The *'ELEPAIO*, Journal of the Hawaii Audubon Society, invites authors to submit scientific articles on natural history of Hawaii and the Pacific. Scientific articles are subject to peer review. The *'ELEPAIO* also serves as a newsletter to inform members of conservation issues, Society events, and other subjects of interest to members. Manuscripts of articles and newsletter items may be sent to Thane Pratt at 1022 Prospect St., Apt. 1103, Honolulu, HI 96822. Articles not subject to peer review MUST BE RECEIVED BY THE 15TH OF THE MONTH to be considered for publication in the next month's issue.

SCIENTIFIC ARTICLES should be typewritten and double-spaced, and three copies should be submitted. Any photographs should be submitted as photographic prints, in color or black and white (they will appear in black and white). The prints should be 3.5 X 5 inches, or larger, and should be adequately cropped if cropping is required. Original copies of figures (e.g., maps, graphs) should be clear and clean, with lettering large enough to remain legible upon reduction to fit the newsletter format. Authors are advised to design their illustrations with the *'ELEPAIO's* columnar format and size in mind (please look at a copy of the journal).

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PUBLICATIONS OF THE SOCIETY

HAWAII'S BIRDS by H.A.S. (1984, revised 1987). An excellent, pocket-sized fieldguide to all native and well-established introduced birds. $4.95 plus $0.89 surface mail or $1.07 air mail. Hawaii residents add $0.20 State excise tax.

FIELD CHECKLIST OF BIRDS OF HAWAII by R. L. Pyle and A. Engilis, Jr. (1987). Pocket-sized card listing 125 species, with space for field notes. Post paid. $0.25 or $0.10 for 10 or more. (**NEW!**)

GUIDE TO HAWAIIAN BIRDING by H.A.S. and C. J. Ralph, ed. (1977). Where to go, what to see. All regularly visited islands. Post paid. $1.50.

CHECKLIST TO THE BIRDS OF HAWAII by R. L. Pyle (1983). Our reference for avian nomenclature in Hawaii. All naturally occurring birds, plus introduced species well-established. Post paid. $2.00.

CHECKLIST TO THE BIRDS OF MICRONESIA by P. Pyle and J. Engbring (1985). Similar to preceding but covers Micronesia. Post paid. $2.00.

BACK ISSUES OF *'ELEPAIO* and INDICES TO *'ELEPAIO*:
Vol. 1-40 -- $1.00 per issue, $10.00 per volume
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Overseas orders cost more. Contact the Society for added cost.

CALENDAR OF EVENTS

June 13 (Mon.) Board Meeting at Bishop Museum at 7:00 PM. Call Bruce Eilerts (941-5974) for details.

June 19 (Sun.) Field trip to Aiea Ridge. Meet at State Library on Punchbowl St. at 7:30 AM. Announcement on page 50.

June 20 (Mon.) General Meeting at Atherton Halau, Bishop Museum at 7:30 PM. Program: Endangered Species Recovery Plans, by William Kramer. Announcement on page 50.

June 25 (Sat.) *'Elepaio* paste-up at Thane Pratt's house, 1:00 PM. Call 524-8464.

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