THE BIOLOGY OF AN ENDANGERED SPECIES, THE DARK-RUMPED PETREL (*PTERODROMA PHAEOPYGIA*), IN THE GALÁPAGOS ISLANDS

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The Hawaiian or Dark-rumped Petrel (*Pterodroma phaeopygia*) is restricted as a breeding species to the Galápagos Archipelago (*Pt. p. phaeopygia*) and to the Hawaiian Archipelago (*Pt. p. sandwichensis*), but it is a common member of the avifauna of the tropical eastern Pacific Ocean. As with most species of this large and widespread genus, little is known of its breeding biology. Loomis (1918) summarized the scant data available at that time, and Lévêque (1963, 1964) gave details of distribution and some breeding information and drew attention to conservation problems. Larson (1967) has recently given a few details of breeding in Hawaii.

From November 1965 to July 1967 I was resident in the Galápagos, and in the breeding seasons of 1966 and 1967 was able to study a small nesting colony of this species in the uplands of Santa Cruz (= Indefatigable). After I left, the latter season's observations were completed by Tj. de Vries and Miguel Castro. Little time was available for the work and the difficulties involved meant that many of the data were incomplete. However, because of the paucity of information on this genus and the unlikelihood of obtaining any better on this species in the immediate future, it is advisable to place the details on record.

DISTRIBUTION IN THE GALÁPAGOS

In the Galápagos the Dark-rumped Petrel breeds only in the humid and thickly vegetated uplands of the main islands (fig. 1). Nowhere is it known to breed below about 180 m in altitude. At least at present, it prefers thickly vegetated areas with sufficient soil for burrowing, but it may possibly have been eliminated in some other areas. The highlands of many of the islands are unexplored, and knowledge of the breeding distribution is fragmentary and based largely on calling birds.

On Santa Cruz the first nest was recorded by R. H. Beck in July 1906 in the forest on the northwest of the island at about 370 m (Loomis 1918). The main nesting areas are, however, on the south and southeastern parts of the island above about 250 m. Formerly the species was far commoner and bred down to 180 m, but these areas have now been cleared for agriculture.

On San Cristóbal (= Chatham) the species was reported as breeding by Lévêque (1963) and birds are still heard calling at night. There is no information as to the numbers present or the breeding area, but as most of the highlands have been cleared for cattle raising it is unlikely that the island is a stronghold for the species.

San Salvador (= James or Santiago) is thought by some of the local settlers to have the largest population of any of the islands. Although this island has no resident human inhabitants, there are very large numbers of pigs which destroy the petrels and the tortoises.

Local people on Floreana (= Charles) report numbers of calling birds in the highlands, and it undoubtedly nests there.

It is possible that the petrels nest on all five of the volcanos of Isabela (= Albemarle), but they have been reported regularly only from Santo Tomas, where they have the local name of "los vaqueros" as they are most active at about 04:00 when the cowboys are awakening (J. Gordillo, pers. comm.). Otherwise in the Galápagos they are known as "pata pegada" (= foot stuck together, or webbed). During a crossing of Volcán Alcedo in September 1966, I spent two nights on the mountain and heard only a single petrel call in flight. However, D. Weber (pers. comm.) heard birds calling early in the morning of 1 August 1967 and found an area suitable for nesting, but no actual nests, on the southeastern slopes. There is no information relating to Cerro Azul or Volcán Darwin and Volcán Wolf.

Lévêque (1963) cited Fernandina (= Narborough) as a breeding area but he never actually visited the highlands. Roger Perry, who has been to the crater of Fernandina on four occasions, has never seen the Dark-rumped Petrels there, and the only record appears to be a bird seen by A. Root and W. McCrory at dusk in July 1966. My visit to the summit was in the first week of April, which would have

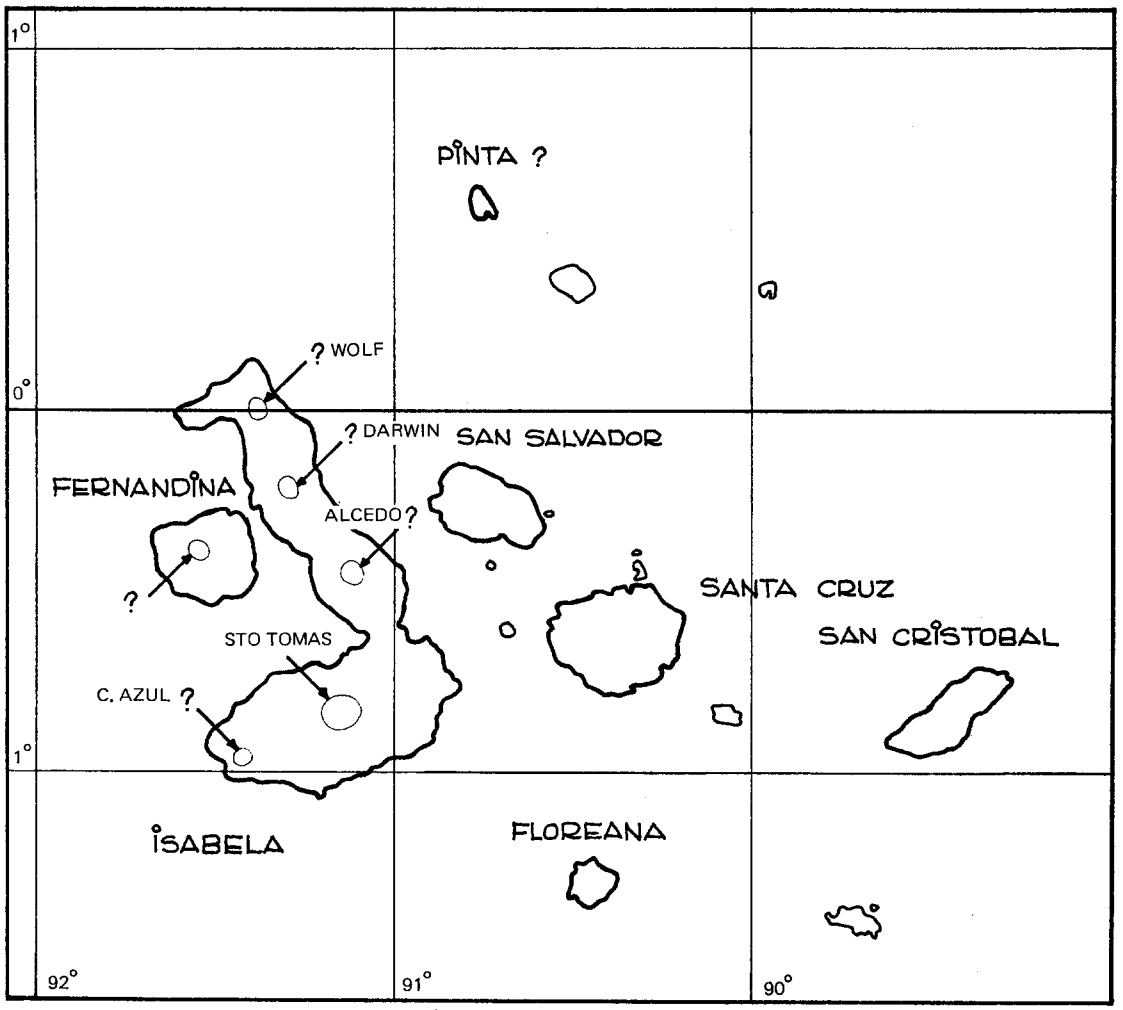

FIGURE 1. Breeding colonies of the Dark-rumped Petrel in the Galápagos.

been too early for breeding birds, but there are some rather restricted but suitable areas for burrowing.

Marchena (= Bindloe) was mentioned by Lévêque (1963) as a possible breeding area, but a crossing of the island in December 1966 showed it to be entirely unsuitable. I have no information on Pinta (= Abingdon) but it appears suitable for the species.

None of the other islands appears to be suitable for nesting, although petrels may visit them. For instance, I found the remains of petrels killed by the Short-eared Owl (*Asio flammeus galapagoensis*) on Tower (= Genovesa) and Cowley. In this connection it should be mentioned that on Plaza (off Santa Cruz) on 19 September 1966, I found remains of a Wedge-tailed Shearwater (*Puffinus pacificus*) which had been eaten by a Short-eared Owl. This shearwater has not been previously recorded from the islands.

STATUS ON HAWAII

The species apparently once bred on Hawaii, Maui, Molokai, Oahu, Kauai, and Lanai but has been exterminated or drastically reduced by mongooses, pigs and man (Munro 1944). It is at present known to breed only on Maui and Hawaii; it possibly also breeds on Kauai and Molokai in small numbers (Richardson and Woodside 1954; W. B. King, R. L. Walker, D. H. Woodside, pers. comm.). The population in Haleakala Crater (Maui) probably numbers 100–1000 pairs (Larson 1967); an undetermined number, but probably more than on Maui, breed on Hawaii (W. B. King, pers. comm.). It is considered to be in danger of extinction on all islands.

THE STUDY AREA

The colony observed was at the base of a weathered and overgrown parasitic tuff crater known locally as Media-Luna or La Copa. At

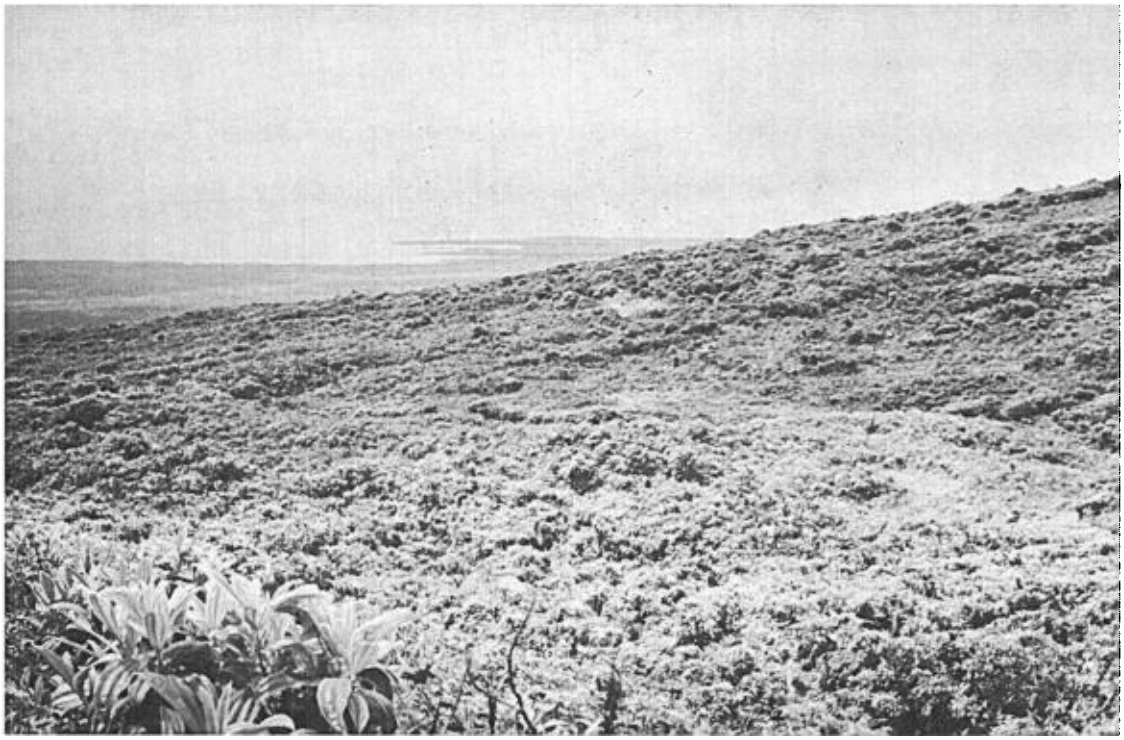

FIGURE 2. General view of the upper *Miconia* zone at Media Luna, Santa Cruz.

560 m, this is at the upper limit of a vegetation zone of *Miconia robinsoniana*, a 1-3-m-tall endemic bush of the family Melastomaceae (fig. 2). During the breeding season the area is almost permanently shrouded in mist.

The majority of the nests were in the steep banks of a watercourse which is usually empty or contains a mere trickle but which fills very infrequently in years of heavy rain when the area would be unsuitable for nesting. The vegetation of *Miconia* bushes, the tree fern *Hemitelia multiflora*, and bracken *Pteridium* sp. is extremely dense and dripping with water. A few nests were under boulders but the majority were dug by the birds in the earthen banks (fig. 3). A few nests were above the *Miconia* zone in open areas. The burrows were as deep as 2 m but many were far shorter or ran parallel to the bank so that inspection holes could be made into the nesting chamber.

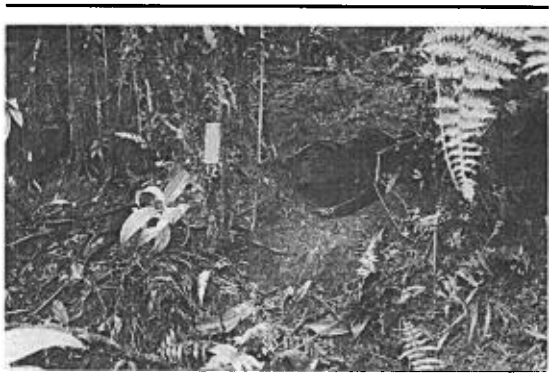

FIGURE 3. Nesting burrow of a Dark-rumped Petrel in the steep bank of a rarely filled water course.

The nesting habitat is different from that of many Dark-rumped Petrels in Hawaii where some colonies occur in almost barren areas of lava and others in clearings in scrub thickets (Larson 1967). The birds there may have been driven in recent years from the lower thickly vegetated areas, as Bryan (1908) found birds in habitats similar to those now used in Galápagos, or perhaps the remaining colonies are relicts.

In 1967, outside the study area, Castro recorded successful breeding by three pairs of Dark-rumped Petrels in a cave in Bellavista farmland at 180 m. Although soft soil was present, there was no burrowing and the eggs were on the surface.

In the study area, 80 occupied burrows were found in the two seasons combined, but only half of these were accessible. The whole rather scattered colony probably numbered about 120 pairs.

During 1966 the colony was checked on 46 days between 21 May and 16 December, and in 1967 on 17 days from 8 May to 12 December. The majority of nests were inspected at every visit, any young and some adults

TABLE 1. Weights (g) of adult Dark-rumped Petrels.

	n	$\bar{x}$	Range	SD
Before laying	10	385	350–470	34.5
♂ ♂ incubating	16	430	380–500	28.9
♀ ♀ incubating[a]	8	429	365–480	32.5
Unsexed incubating	16	425	380–490	29.2
With large young	1	345		
Failed breeders	15	375	350–410	16.8

[a] Not including two birds (330, 385 g) which had just laid.

weighed, band numbers of birds checked (except for some birds on hatching eggs), and birds without eggs examined for molt and state of brood patch. Birds were sexed by cloacal inspection during the laying period.

THE ADULTS

Birds were weighed when conditions allowed and the results are shown in table 1. All the heaviest birds were incubating and had large food reserves in their stomachs. Normal body weight was probably close to that of pre- and failed-breeders.

No birds at the colonies were seen in wing or tail molt but some birds underwent a partial body molt. Even among birds collected at sea among the islands by the 1906 California Academy of Sciences Expedition (skins in their museum) there is only a single molting bird, a male collected off Isabela on 24 April, replacing the outer primary on one wing. A bird taken 26 March 1935 at 9°15′N, 85°25′W was regrowing the two outermost primaries (skin in Mus. Nat. d'Hist., Paris; C. Jouanin, pers. comm.). The molt then must take place outside the breeding season and away from the colonies.

BREEDING CYCLE

Loomis (1918) stated that the species was found throughout the year in Galápagos waters. However, at present there appears to be a well-marked period in January and February when the birds are either very scarce or altogether missing from Galápagos. The first birds for the 1965 season were reported on 20 February (three birds) and the last on 6 January 1966 (one); the dates for the 1966 season were 19 March (two) to 8 December (one). There are no accurate dates for the 1967 season but the first for the 1968 breeding was reported on 7 February. The observations of Lévêque (1963) showed a similar withdrawal. It should be mentioned that Castro, who supplied many of the above dates, thinks that possibly the species may remain near San Cristóbal in small numbers from January to April.

Local settlers in the highlands report that the birds are usually first heard calling, apparently as they first return to land, at the end of April. The first records I have for the two seasons were 5 May 1966 and 23 April 1967, but birds were heard calling on Floreana on 15 March 1968 and on San Salvador on 4 April 1968 (Sr. Cruz, R. Perry, and T. de Vries, pers. comm.). This calling continued until mid-September but was most intense from May to July. With the lessening of breeding activity and the numbers of birds present which did not breed in August and September (last nonbreeders seen), there was a partial cessation of calling. By October relatively few birds were seen at sea and presumably the nonbreeders had left and the adults were foraging well away from the islands.

DAILY CYCLE

The birds had a well-marked daily cycle and visited the colonies only at night. During the day the birds were normally well away from land but in the late afternoon they gathered inshore in small flocks on the water. The first birds flew inland at dusk (about 18:40) at about 70–100 m over the coast, calling "kee-kee-kee." Birds then passed the night inland and returned to the sea at dawn, when large numbers of birds could be seen, and less frequently heard, gliding over the coasts with only occasional bursts of flapping. Birds usually passed over the coastline at an altitude of at least 70 m, but as soon as they were over the sea they dropped rapidly and skimmed the waves.

Birds called throughout the night at the colonies but the earliest returning birds made little noise and the peak of calling was from 04:00 to dawn. The main flight note I have written as "kee-kee-kee-(c)ooo" with the first three notes being sharp and the last one drawn out. There were many variations and sometimes the long, drawn-out note was used alone both in flight and in the burrow. It could finish either drawn out or abruptly. Allowing for the difficulties in expressing these peculiar sounds, they agree with some of the notes described for the Hawaiian race (Richardson and Woodside 1954). The pattern of calling is, however, different from that noted by Larson (1967), who reported that 1.5 hr after sunset there was a peak of calling which quickly died away.

PREBREEDING PERIOD

Unfortunately the difficulties involved in finding nests before laying, when burrows were partly overgrown and paths had to be made with a machete, meant that many nests were

TABLE 2. Measurements (mm) of eggs of the Dark-rumped Petrel.

Galápagos		Hawaii[a]
65.0 × 45.0 (65g)	61.2 × 46.3	64 × 45
59.0 × 43.3 (62g)	58.4 × 44.0	66 × 46
61.1 × 44.8 (64g)	58.5 × 41.6[b]	67 × 46
58.8 × 47.0 (69g)	62.0 × 44.3[b]	
66.1 × 44.1 (66g)	61.4 × 44.1[c]	
60.2 × 40.0	61.5 × 39.0[c]	

[a] Larson (1967).
[b] Lévêque (1964).
[c] Loomis (1918).

not located early in the 1966 season. However, combining the two seasons, birds were found in burrows in 18 instances out of 118 nest-checks prior to laying (the maximum time before laying was 46 days). In a few instances both birds were present. During this time the burrows were enlarged and a definite nest was made of dry vegetation. In all recorded instances the birds remained faithful to their burrows from one season to the next.

EGG PERIOD

The approximate laying dates were known for 22 eggs in 1966 and 16 eggs in 1967; 36 of these were laid between 16 June and 25 July, with a peak at the beginning of July. The other dates were between 25 July and 2 August, and 10 August. This is slightly later than the dates in Hawaii (Richardson 1957; Larson 1967).

A single egg is laid and this is white and usually ovate. The measurements are given in table 2. The mean for 13 eggs weighed within three days of laying was 65.7 g (range, 60.5–73 g; SD, 2.9). Twice females were caught immediately after laying; they weighed 385 and 330 g and their eggs 65.5 and 65 g, or 17 and 20 per cent of the female, respectively.

Three accurate (± 1 day) incubation periods were obtained: 50, 50, and 54 days. The rough data for another seven nests are in agreement with them. These are similar to those for related species (table 3).

Because of the infrequency of my visits, the duration of incubation spells was difficult to determine. In six nests it was known that the incubation period was divided into four completed spells and one broken by hatching. The longest recorded spell was 13–16 days and there were minimal spells (all possibly incomplete at first and last check) of 8 days (three instances), 9 days (two), 10 days (three), and 11 days (four). There were also two maximum spells of 8 and 9 days. Incubating birds lost 10–15 g per day in weight, and the weight range of adults was 330–500 g, suggesting an average spell of about 12 days. Overall it seems that usually a bird would spend perhaps 10–13 days incubating. There was no evidence that incubating birds were fed by their mates.

Larson (1967) suggested that in Hawaii each adult incubated 3–5 days at a time. He was reasonably sure that an adult would stay for 12 days, but his data may be less accurate than mine. Data for other species are given in table 3.

Eggs were rarely found without incubating birds in attendance and it is likely that the eggs are resistant to chilling as in other Procellariiformes (Matthews 1954), presumably an adaptation to food shortage when both birds might have to be away feeding. However, in the present colony this would be of no advantage as eggs, if not protected by the adults, were eaten by the introduced black rat (*Rattus rattus*).

YOUNG

Only two accurate growth curves (fig. 4) were obtained. These two young fledged 109–110 days and 109–112 days, respectively, after hatching, and more than a week after the parents had deserted them. One of the young (hatched 8 August 1966) grew much faster than the other (hatched 26 August 1966) but the latter bird probably had a slightly higher fledging weight. Unlike many other Procellariiformes, the chicks at their peak weights,

TABLE 3. Some aspects of the breeding biology of five gad-fly petrels.

	Days				
	Incubation period	Incubation spells	Fledging period	Desertion period	Feeding frequency
Dark-rumped Petrel	50–54	10–13	109–111	ca. 7	50%
Dark-rumped Petrel[a]	50–55	3–5	115	14–21	
Cahow[b]	51–54	8–14	90–100	4–10	75%
Great-winged Petrel[c]	53	8	128–134	0	14%
Kermadec Petrel[d]	50–52	?	90+	10–14	?
Phoenix Petrel[e]	ca. 53	5	96+	?	?

[a] Larson (1967)
[b] Wingate *in* Palmer (1962)
[c] Warham (1956)
[d] Oliver (1930).
[e] Ashmole *in* Lack (1967); Ashmole and Ashmole (1967)

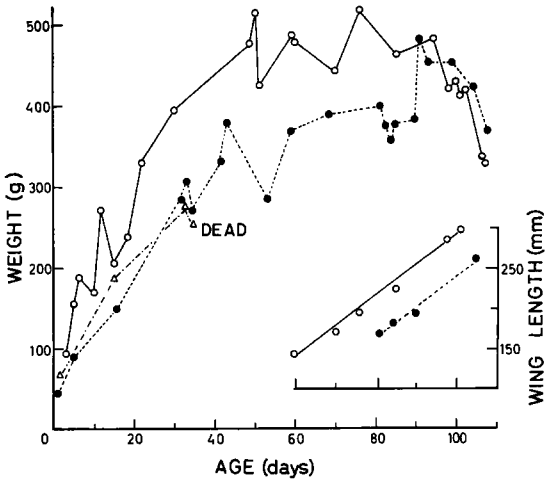

FIGURE 4. Growth curves of two successful and one unsuccessful young Dark-rumped Petrels in the study burrows in 1966. The young which died was possibly killed by a black rat.

FIGURE 5. A four-week-old Dark-rumped Petrel chick.

apparently fat and healthy, were little heavier than the maximum weight of adults. I have suggested elsewhere (1966; 1969) that the growth of procellariiform young to a maximum weight (up to twice the adult weight) sometime before fledging serves two complementary functions. First, it allows the chicks to survive if the adults are forced to leave the colonies due to food shortage; and second, it allows the adults to leave the colonies earlier than if they had to continue feeding the young (especially important in migratory species). In the Galápagos it may be that food for the Dark-rumped Petrel is predictable, or that there is no need for the adults to leave early for a long migration. Four other young were known to have fledged at about 300 g, and in one of these the desertion period could not have been longer than six days.

Chicks were weighed overnight in 14 instances and on seven of these the chicks had been fed, the increases being 20, 20, 25, 32, 44, 45, and 95 g. The weight of the other seven decreased 10–40 g, and it is unlikely that any of them had been fed. The average decrease, 21 g, should be added to the increases in the fed chicks to give the true amount fed. Food regurgitated by four young consisted of squid (three) and fish (one), mixed with stomach oil. Unfortunately all the food was too digested to be identified further, suggesting that it had been caught well away from the colony. Loomis (1918) mentioned the remains of pteropods and coelenterates in the stomachs of this species, and also that they "were very fond of this [turtle] fat and it was used to decoy them within gunshot." Larson (1967) recorded fish, squid, and a stomatopod crustacean regurgitated by adults and young.

The young chick apparently has not been described. On hatching it is covered with long gray down which is pale (almost white) on the front and sides of the throat, and similarly colored, but shorter, in the center of the belly. Even at hatching the bill is thick and recognizable as belonging to this genus. The egg tooth is white. The second down appears (fig. 5) at about 10 days and the first feathers show after about five weeks. The juvenal plumage is similar to that of the freshly molted adult except that the whitish tips to the feathers of the upper parts are more conspicuous, especially on many of the wing coverts.

NESTING SUCCESS

The nesting success was extremely low. In the 1966 season, when 38 burrows were followed closely, at least 30 eggs were laid, and probably many more, but only two young were fledged. Some burrows were so deep that it was impossible to be sure when the nest failed; but seven eggs disappeared, three others were cracked or broken, and one was deserted or perhaps one of the adults was dead. Of 11 young which were lost, 10 disappeeared soon after hatching, probably when the adults first left the chick unattended. There can be little doubt that these losses were due to the black rat, whose droppings were to be found in every hole and cranny. In one hole containing a 35-day-old chick, we found a recently dead rat that had apparently been killed by an adult petrel. Although the chick appeared well fed, it died soon after.

In 1966, 24 additional occupied burrows, which I did not disturb, produced only two

fledglings, suggesting that the low productivity was not due to my interference. Eggs were laid in at least 11 of these holes as broken eggshells were found in the entrances, kicked out when birds were enlarging the burrow after the failure of the nest. Thus, from 62 occupied burrows with a minimum of 41 eggs, only four young fledged. Thirty burrows were checked again in 1967 and at least 26 eggs were laid but no young fledged despite far less disturbance than in 1966.

This nesting success is far lower than that noted in other Procellariiformes: 33–47 per cent success in this species in Hawaii (Larson 1967); 28–67 per cent for the Cahow, *Pt. (hasitata) cahow* (Wurster and Wingate 1968); 75 per cent for the Manx Shearwater, *Puffinus puffinus* (Harris 1966); 60–75 per cent for the Short-tailed Shearwater, *P. tenuirostris* (F. I. Norman, pers. comm.); 26–59 per cent in Audubon's Shearwater, *P. lherminieri* (Snow 1965; Harris 1969); 45–50 per cent in the Fulmar, *Fulmarus glacialis* (Fisher 1952; Mougin 1967); 39–58 per cent in the Silver-grey Petrel, *F. glacialoides* (Mougin 1967); 33–65 per cent in the Cape Pigeon, *Daption capensis* (Prévost 1964; Pinder 1966); about 40 per cent in the Snow Petrel, *Pagodroma nivea* (Prévost 1964); and about 30 per cent in the Madeiran Storm Petrel, *Oceanodroma castro* (Allan 1962; Harris, in press).

In the study area in 1966 seven adults were found killed, at least some by the Short-eared Owl. In 1967 a further seven, all of which had been banded in the study area, were killed by feral dogs. As only 78 adults were banded in the two seasons combined, the adult mortality was far higher than might be expected. This low nesting success and high adult mortality, if typical for the Galápagos, gives cause for great concern for the future of this species.

DECLINE IN NUMBER AND CONSERVATION

Although man has brought about profound ecological changes on all the main islands in Galápagos, these have been for the most part undocumented. For this reason any discussion with regard to the Dark-rumped Petrel must be limited to Santa Cruz.

Before man arrived on the Galápagos, the petrels probably had only two serious predators, the Short-eared Owl and the Galápagos Hawk (*Buteo galapagoensis*). The latter species has been exterminated on San Cristóbal, Floreana, and almost so on Santa Cruz in the last 30 years, but it still occurs commonly on some other islands. Formerly it was known to have taken numbers of petrels both on the ground and in the air (A. Kastdalen, pers. comm.). The owl is stil present in large numbers. The rats native to Galápagos (*Oryzomys* and *Nesoryzomys* spp.) were common on several islands but have for the most part been eliminated wherever they have come into competition with the black rat.

Although the black rat has been recorded for more than a century on some islands, it has become common on Santa Cruz only since the 1930's (Rambeck, pers. comm.) and even as late as 1938 David Lack (pers. comm.) did not see any on Santa Cruz. The little evidence available suggests that the native species were far less destructive than the introduced rats.

Among the other introduced animals, pigs are probably the greatest threat to the petrels, as they eat both the adults and young and destroy the burrows. Pigs were introduced onto Santa Cruz about 1927, and by 1935 were abundant in many areas. At that time the settlers relied heavily on pigs for meat, but during the petrel breeding season the fat of the pigs was so tainted by the smell and taste of petrels as to be almost unusable (Rambeck, pers. comm.). Pigs are now rare in the uplands of Santa Cruz but still occur on Santo Tomas, Foreana, San Salvador (where they are extremely abundant), and probably San Cristóbal. Feral dogs are now common only on Floreana, Cerro Azul, and Santo Tomas, but even tame dogs can inflict heavy losses.

It seems that the petrels need rather specialized conditions for nesting, primarily good soil moist enough to allow burrowing, and perhaps thick vegetation. The nesting habitat on Hawaii is, however, different (Larson 1967) and it appears from other related species (discussed later) that this species might be able to adapt or withdraw to other habitats. The link between the present nesting areas and the *Miconia* zone on Santa Cruz is probably coincidental (as the plant does not occur on Isabela or Floreana) and has been brought about by man's destruction of the main areas in the *Scalesia* zone. Unfortunately, areas preferred by the petrels are also the best agricultural land, and it is not surprising that, on Santa Cruz and probably San Cristóbal, a large proportion of the land previously utilized by petrels has been cleared for agriculture.

The study area was right at the top of the *Miconia* zone, and the vegetation above this was mainly ferns and sedges. This high land is very wet during the breeding season and some parts are flooded, so the petrels can nest only in the higher banks and outcrops. How-

ever, this has not always been so, as dense vegetation once covered the highlands but was destroyed by several widespread forest fires between 1934 and 1947 (Rambeck pers. comm.). Apart from the human clearance, the lower level of the *Miconia* is determined by drought, and the upper level by relatively excessive cold and humidity (Kastdalen, pers. comm.), a complex situation presumably due to the extreme variability in Galápagos rainfall. It is likely that when the higher vegetation was more extensive, the uplands would have been suitable for petrels.

Whatever the causes, all the settlers agree that there has been a spectacular decline in the numbers of the petrels, at least on Santa Cruz, and this is still continuing.

FUTURE OF THE SPECIES

The gad-fly petrels (*Pterodroma* sp.) have suffered from man's presence more than most groups of sea-birds because of their food value ("muttonbirds" of some islands) and the susceptibility to introduced predators. Although none can definitely be said to be extinct, as several "lost" species have been rediscovered, many have been drastically reduced in numbers (see review by Bourne 1965).

The Capped Petrel (*Pt. hasitata*) was reduced in numbers in the West Indies, first by man and then by the introduced mongoose, and is now restricted to the highlands of Haiti, whereas before it occurred on lower, more gentle slopes (Greenway 1958; Wingate 1964). The Cahow was hunted for food and then suffered from depredations by semi-wild hogs, and, later, rats and cats. Originally this species was probably found inland in the hills but was driven onto the coasts and isolated islets where it met competition from the White-tailed Tropicbird (*Phaethon lepturus*) (Wingate, *in* Palmer 1962). Recently a decline in the nesting success of the few remaining pairs is thought to be due to reduced fertility brought about by DDT (Wurster and Wingate 1968). Wingate (1964) thought that the black rat was unlikely to be a significant predator on either the Cahow or Capped Petrel. This is contrary to the views of Murphy and Mowbray (1951) who noted that the likelihood of finding Cahows was inversely related to the prevalence of rats.

The closely related Jamaica Petrel (*Pt. caribbaea*) on Jamaica is usually assumed to have been eliminated by the introduced mongoose, but a few may possibly still survive (Bourne 1965).

The Kermadec Petrel (*Pt. neglecta*) has been reduced, probably by humans on Mas Atierra, and by cats on Raoul Island (Oliver 1930; Murphy 1936). Cook's Petrel (*Pt. cooki*) was brought near to extinction by cats and dogs on Little Barrier Island (Oliver 1930), and the Mottled Petrel (*Pt. inexpecta*) has disappeared from most New Zealand breeding grounds as a result of the introduction of wild and domestic predatory mammals (Palmer 1962). Solander's Petrel (*Pt. solandri*) was exterminated by man on Norfolk Island, while on Lord Howe Island, where it formerly bred at sea level, it is restricted to the upper slopes (Oliver 1930; Hindwood 1940). The Cape Verde race of the Soft-plumaged Petrel (*Pt. mollis*) probably once bred among the mounain woods but these were felled and it is now found only on inaccessible ledges of inland precipices (Bourne 1955). Similarly on Madeira this latter species is now restricted to separate races on inland precipices or outlying stacks (Bannerman 1965).

In only a few species, such as the White-necked Petrel (*Pt. externa*) on Mas Afuera, Juan Fernández (Lonnberg 1920; Murphy 1936), Barau's Petrel (*Pt. baraui*) on Reunion (Jouanin and Gill 1967) and the Phoenix Petrel (*Pt. alba*) on Christmas Island (Ashmole and Ashmole 1967) are the populations still large, because they have been undisturbed or nest on inaccessible cliffs. Some of the foregoing species have managed to survive only on isolated rocks or inland precipices when driven out of their preferred habitats. In the Galápagos there seems little likelihood of this happening because the Dark-rumped Petrel does not occur on the coasts and is already at the upper level of the possible nesting habitat. In some islands it may be possible for them to colonize steep cliffs but these are very few. As the decline is due to both habitat destruction and introduced mammals, there seems to be no easy solution to the problem of conservation.

At present it is impossible to control rats but it might be possible, given adequate finances, to reduce pigs on some islands and to prevent the introduction of predatory mammals in those areas where they are not already present. The strongest possible control of land clearance is needed to safeguard the species, especially on Santa Cruz and southern Isabela.

SUMMARY

The Dark-rumped Petrel (*Pterodroma phaeopygia*) is endemic to Hawaii, where it is rare, and to the moist highlands of several islands in the Galápagos. In all places it is endangered by land clearance, introduced mammals, or both.

A study of a small nesting colony in dense vegetation on Santa Cruz showed that eggs were laid between 16 June and 10 August and the last chicks left the beginning of January. Birds molted while away from the Galápagos outside the breeding season. The breeding biology was similar to that of many Procellariiformes, with long incubation (50–54 days) and fledging (about 110 days) periods and incubation spells (about 12 days). Young were fed on about one night in two. Nesting success was extremely low, with only four young fledged out of a minimum of 67 eggs laid, due almost certainly to black rats (*Rattus rattus*). This, associated with losses of adults and agricultural encroachments on the breeding area, causes concern for the future of the species.

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