

THE AUK

A QUARTERLY JOURNAL OF ORNITHOLOGY

VOL. 75

JANUARY, 1958

No. 1

THE NESTING OF THE SHEARWATER *PUFFINUS CARNEIPES*

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THE Flesh-footed (or Fleshy-footed) Shearwater (*Puffinus carneipes*) is a pelagic bird breeding in south temperate latitudes on islands off southern Australia and off New Zealand and ranging north across the Equator, sometimes to the Pacific coast of North America. It is designated "Pale-footed Shearwater" in the A.O.U. Check-list, but I use the name by which it is generally known where it breeds.

APPEARANCE

The Flesh-footed Shearwater is a large and powerful petrel, about 18 inches long and weighing some 20 ounces. It is clad in brownish-black plumage and has a fan-shaped tail, a pale beak, and pale, flesh-colored legs. Superficially the bird resembles the dark phase of the more widespread Wedge-tailed Shearwater (*P. pacificus*), but that species has a smaller, darker beak, leaden-gray in color, while the tail is longer and truly wedge-shaped, not slightly rounded as in *carneipes*. These differences make the two species separable in the field, contrary to Alexander's suggestion (1945) that they "can hardly be distinguished in life". There is also some resemblance in color to the Sooty Shearwater (*P. griseus*) and the Short-tailed (Slender-billed) Shearwater (*P. tenuirostris*); but both these species have dark bills and grayish legs, and *griseus* has whitish under-wing coverts, while *tenuirostris* is distinctly smaller, with a shorter tail.

DISTRIBUTION

The known breeding grounds of the Flesh-footed Shearwater are widely separated, with a gap of over two thousand miles. The western population breeds on islands off the southwest coast of Australia; the eastern population on Lord Howe Island east of Australia and on islands around northern New Zealand. Campbell (1900) found a few eggs on the



Flesh-footed Shearwater—feeding young. (Photo by J. Warham)

mainland of southwestern Australia opposite Mutton Bird Island, Torbay; but C. Allen tells me (*in litt.*) that they last nested there in 1937, since when, because of depredation by foxes, breeding there has been discontinued.

Two races may be recognizable, *P. carneipes carneipes* Gould of Western Australia (from Cape Leeuwin to the Recherche Archipelago, 700 miles to the east), and *P. carneipes hullianus* Mathews from Lord Howe Island and New Zealand (Hindwood, 1945).

Although no banded birds have yet been recovered, the many records of Flesh-footed Shearwaters from the north Pacific show that this is a trans-equatorial migrant to Japanese and North American waters. Summarizing records of the species for North America, Duvall (1945) suggests that "it perhaps is fairly regular in occurrence off the Pacific coast of the United States and Canada".

There are at least two records of the bird from Ceylon, and one of these, picked up in June 1944 on the beach near Mt. Lavinia, is stated to belong to the Western Australian race (Hill and Burn, 1944). There is as yet no evidence that this race reaches the Pacific Ocean. Gibson-Hill (1953) suggests that the west Australian birds on leaving their breeding grounds "move westward round Cape Leeuwin, making for the waters south of Houtman's Abrohlos. Thence they strike out diagonally across the southern part of the Indian Ocean, finishing up somewhere in the broad patch of open sea north of the Mascarene Islands. Here they pick up the monsoon in June, and are carried round with it in a broad sweep, first northwards, past the Seychelles, then eastwards between the Maldives and Laccadives, past the southwest coast of Ceylon, and so down again towards Australia, skirting the Fremantle coast, southward bound, in October".

Serventy (1953) has pointed out that specimens of *P. carneipes* have been taken off California during the February to September period as well as later in the year, thereby paralleling the occurrence in that area of the South American breeding Sooty Shearwater (*P. griseus*), rather than that of the New Zealand *P. bulleri* and the Australian *P. tenuirostris*, which breed during the same period as do the known populations of *P. carneipes*, but occur off California from October to February. Serventy suggests that there may possibly be an as yet unknown breeding place of *carneipes* somewhere in southern South America, with a regime more like that of *griseus*.

According to Serventy and Whittell (1951) the foraging range during the breeding season, the southern summer, is extensive. Serventy (*in litt.*) tells me that a shearwater taken off Amsterdam Island in the Indian Ocean on January 3, 1952 (Paulian, 1953) ascribed to *P. pacificus*,

proved, when examined by Serventy in 1955 at the Museum d'Histoire Naturelle in Paris, to be a specimen of *P. carneipes*. This individual was almost three thousand miles from the nearest known breeding grounds, and of course could be a non-breeding bird.

TIME AND SITE OF STUDY

The present observations were made during a visit with my wife to Eclipse Island from January 26 to February 11, 1956. Eclipse Island, a manned lighthouse off the south coast of Western Australia, lies at approximately 35° 10' S., 117° 55' E. and has a planar area of about 400 acres. The coastline is entirely rocky and there are no beaches. Much of the level ground is bushy. A description of the island and a list of its avifauna have been given elsewhere (Warham, 1955b). Apart from man, the introduced rabbit, and the Hair Seal it supports no resident mammals.

In addition to *P. carneipes*, which breeds during the southern hemisphere summer, Eclipse Island has two winter-breeding petrels, the Little Shearwater (*P. assimilis*) and the Great-winged Petrel (*Pterodroma macroptera*), whose habits there had been studied during previous visits (Warham, 1955a, 1956). Both these birds were present in some numbers during this 1956 summer visit, and towards the end of our stay, in February, all three species might be heard calling on the wing or on the ground at the same time. The breeding season of the Flesh-footed Shearwater on Eclipse Island seems to coincide roughly with that of the New Zealand population (Falla, 1934); on the other hand the non-migratory Great-winged Petrels breed about two months earlier than their fellows in northern New Zealand (Warham, 1956).

Our visit was authorized by the Commonwealth of Australia Marine Branch. We are indebted to the lighthousekeepers and their families for much assistance, to Mr. A. Bentley of Albany for transport, and to Mr. W. McAuliffe for his kindness in checking the progress of marked nests after our departure. I am particularly grateful to Dr. D. L. Serventy of the C. S. I. R. O., Wildlife Survey Section, Perth, for reading the manuscript, suggesting a number of improvements, and for allowing me to use some hitherto unpublished information on *P. tenuirostris* for comparative purposes.

METHODS

In order to ascertain the attentiveness of the adult birds, six burrows were chosen whose nesting chambers were either under a mat of vegetation or near the surface. These burrows were fitted with false roofs, which could be raised slightly after dark and inspected with a torch.

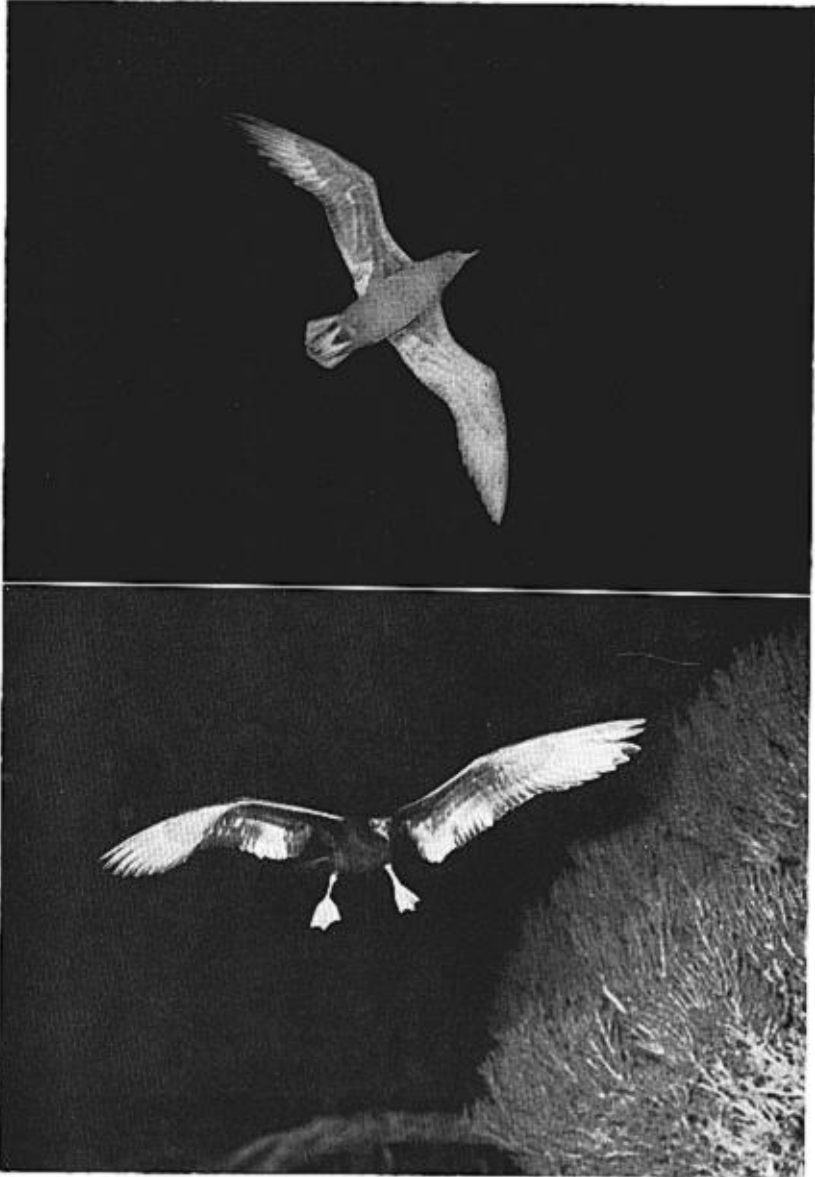
Each parent and chick was banded with colored and monel metal bands so that individuals could be recognized without handling. Some birds were banded during the day, others at night. In no instance did any bird leave its nest when replaced, although all struggled hard and pecked viciously. These marked nests were checked at least once nightly around 21:00 hours and again the following morning. A ring of short sticks placed at the entrance was found useful as an additional check on whether the chick had received a visit during the night. There was no time to undertake an extensive banding program and only 100 birds, all but 5 being adults, were marked with numbered monel metal rings inscribed "Write Wildlife, C. S. I. R. O. Canberra, Australia".

In three instances adults vomited food while being handled. This food consisted of slivers of small fish about 2 inches long; no cephalopod beaks were noted.

In order to study the behavior of birds within the nesting chamber a blind was set up on top of a suitable nest so that after dark the false roof could be removed and the birds' actions observed with the aid of a red light. This method, found successful during previous work with the Manx Shearwater (*P. puffinus*) on Skomer Island, West Wales, and with the Little Shearwater (*P. assimilis*) on Eclipse Island, proved to be feasible also with the Flesh-footed Shearwater. Electronic flash photography was used to record the arrival of the adult at the nest and its feeding of the chick. As had been my experience with other shearwaters, the flashes were ignored by the Flesh-footed birds and although the slight noise of discharge made them pause momentarily they did not break off their current activity.

FLIGHT AND LOCOMOTION ABOUT THE NESTING AREA

Flesh-footed Shearwaters were never seen flying over the island by day. At night the incoming birds flew fast—their wings are long and thin (Plate 2). Like other members of their genus with which I am familiar, most birds made several circuits of the nesting area before settling and often took two or three runs up to the alighting point before their final touch-down. When coming in to land the birds swept into the wind with spread webs acting as brakes, and when a yard or so above the ground they suddenly raised their wings, stalled and dropped to the ground with a thud (Plate 2). Occasionally they remained where they fell, but more often some momentum was retained and they ran forward for a few yards before resting. It was clear that most individuals were well orientated on landing, as it was common to see a bird alight and immediately run straight to a burrow into which it would disappear without hesitation (Plate 3). Nor were they reluctant to land among



Flesh-footed Shearwater. (*Above*) Night flight above breeding ground. (*Below*) About to alight. Photos. by J. Warham.

trees, as the Greater Shearwater (*P. gravis*) apparently is (Rowan, 1952); in fact, nests were most plentiful beneath scrubby tea-trees (*Leptospermum*) which grow to about 30 feet. The Flesh-footed Shearwater did not usually crash land into these as the Little Shearwaters often did. Instead they alighted in clear spaces between the trees or along the island paths where these cut across the Tea-tree belts. Certain spots were favored landing grounds and by sitting quietly there after dark we could watch the birds alighting and rapidly dispersing to their burrows.

The first Flesh-footed Shearwaters would arrive about 30 minutes after sunset, their numbers building up very quickly thereafter. These early birds, which I suspect were mostly nesters rather than unemployed birds—that is, birds without eggs or chicks (Richdale, 1944)—were silent. Watching was mainly done while there was still enough light to see the birds' movements (many nights were fairly light with the moon obscured by cloud). Calling did not seem to increase greatly on the few really dark nights we had and we saw no evidence that flying birds are guided to their burrows by the calls of their mates, as Glauert (1946) suggested. If, as seems probable, Flesh-footed Shearwaters do not breed until they are 5 or more years old, in line with recent findings for the smaller Short-tailed Shearwater, *P. tenuirostris* (Serventy, 1956) and the Fulmar, *Fulmarus glacialis* (Fisher and Lockley, 1954), nesting birds may well have several seasons experience of their chosen islands and perhaps of a particular part of that island during their "apprentice" years as unemployed birds. If so they would develop a knowledge of the topography of the area which would be invaluable in their later years as breeding birds. This possibility is reinforced by D. L. Serventy's findings with *P. tenuirostris* on Fisher Island, Bass Strait, where young birds begin to appear on the island at 3 years old and non-breeding birds of 5, 6 or 7 years of age are found repeatedly in the same general area.

Our stay coincided with a period of waning moon and it had been hoped that this might enable the effect of moonlight on the birds' activities to be gauged. However, heavy clouds made the nights much darker than they would otherwise have been; on the only night when the moon was bright there was a noticeable diminution in aerial activity and song on the part of the shearwaters although the moon seemed not to affect the attentiveness of the birds at the study nests at several of which reliefs were made and food dispensed.

Flesh-footed Shearwaters are not as ungainly on the ground as are Little Shearwaters and Manx Shearwaters. They can run quickly with a fairly upright carriage and do not wave their wings about as much as many shearwaters do; their light colored legs glint in a torchlight as they

scuttle off when disturbed. The legs seem to be placed further forward in this species than in *P. puffinus* or *P. assimilis*, and this may account for their better performance on the ground.

Eclipse Island is so hilly and winds so frequent that the birds had little difficulty in becoming airborne; indeed, they could fly without any preliminary run; presumably the forward position of their legs increases the effectiveness of their initial leap.

RAFTING

The assembling of shearwaters towards evening on the sea near their island nesting grounds has been noted in several species. It is well known in the Manx Shearwater (Lockley, 1942), and occurs in the Greater Shearwater at the end of the nesting season, apparently as a prelude to migration, (Rowan, 1952). During previous visits to Eclipse Island from July 9 to 24 and September 9 to 24, 1954, when Great-winged Petrels and Little Shearwaters were nesting, no signs of off-shore rafts by these two species could be seen despite repeated sweeps of the sea with the aid of the lighthouse telescope. I had concluded that probably the petrels do not congregate in this way, while reserving judgment on the Little Shearwaters in view of their small size and the difficulty of detecting them on the surface of the persistently choppy winter seas.

I soon found, however, that part at least of the island's Flesh-footed Shearwater population formed into rafts offshore towards evening, although only one such assemblage was seen daily. This raft was always located in approximately the same area no matter what the wind strength or direction; it lay about one mile south of a promontory known as Black Rock. Up to 700 birds were counted here on some evenings but this could only represent a small fraction of the island's breeding birds whose numbers must run into thousands. Presumably there were other rafts further out where they would probably be invisible, particularly in warm weather when heat haze prevents effective use of binoculars or telescopes.

Assembling would begin well before sunset. Thus on February 10 with sunset at 19:10 hours (West Australian Standard Time based on 120° W) a single bird was sighted at 17:00 hours and this had been joined by 20 others by 17:50 hours. By 18:20 this group had grown to 70 birds. Newcomers usually alighted some yards in front of those already settled so that, with an easterly breeze, the flock appeared to be creeping gradually in that direction, each bird facing the wind. By 18:25 some 150 birds were present and at 19:10 a compact flock of 200. Ten minutes later the whole raft was seen to break up and all were glimpsed flying in groups just above the waves. About the same time

the first single and silent birds were circling over the island. The way in which the numbers of shearwaters appearing overland built up so quickly once the influx had begun seemed to be correlated with the dispersal of resting flocks at sea and their convergence upon the island.

In the early evening, when the rafts were beginning to form, it was possible occasionally to glimpse the light webs of the feet as the incoming birds turned in the evening sun, a point which emphasized that the birds were in fact *carneipes* and not *Pterodroma macroptera* which, though similar in size and coloring, have black legs and dark webs.

VOICE

Both Falla (1934) and Hindwood (1945) comment on the Flesh-footed Shearwater's voice. Falla notes that in New Zealand during November the din at night associated with courtship and mating is considerable and that the birds begin to call before alighting, using a "sharp mewling note like that of a kitten". Hindwood, writing of birds flocking to fish offal in the sea at Sydney, New South Wales, notes that they infrequently used a sharp note "not unlike that of a Pomarine Skua (*Stercorarius pomarinus*) but of a higher pitch."

During our stay on Eclipse Island, when hatching was taking place, there was still some calling after dark from birds on the wing and much more from others on the ground. I suspect that by this time the noisiest period had passed since calling is usually greatest among shearwaters before egg-laying, when many unemployed birds visit the breeding grounds. Indeed, on some nights, the Little Shearwaters, which would not have eggs for another five months, were more noisy than their nesting Flesh-footed relatives.

The song of the Flesh-footed Shearwater, given both on the ground and in the air has three phrases: 1. A brief introductory or "warming up" phrase, a series of short "gug, gug, gug's" leading into 2. The main phrase, a trisyllabic asthmatical crooning with the middle syllable stressed, "ku -kooo -ah" which is repeated from three to six times in succession and tends to become increasingly hysterical in tone, the "kooo" degenerating to a scream towards the end. The first two syllables are given as the breath is expelled, the final sob on the intake. 3. The tailpiece is a splutter rapidly dying away and not unlike the introductory phrase.

As obtains with other shearwaters, sitting birds will sing in daylight from within their nests stimulated by the noise or vibration of footsteps. Courting birds also include in their repertoire a variety of quiet cackling sounds, not unlike those used by a broody hen.

COURTSHIP BEHAVIOR

Although the bulk of the eggs were hatching during our stay in late January and early February, courtship behavior was to be seen both from birds with eggs and from others believed to be non-breeders. The behavior was much like that noted for other members of the genus, and in line with Falla's observations (1934) at New Zealand colonies. Crooning duets in which the participants crouched side by side, heads together and napes arched, were frequent. These were interspersed with bouts of mutual preening when the birds dabbled at each other's heads and necks. This was sometimes done so vigorously that the recipient jumped back as if hurt. Crowing from one pair would often be echoed by others in the area so that for a few minutes the sounds would rise to a *crescendo* only to die away again abruptly. Quite crude imitations of their song would result in a wholehearted response in nearby birds.

THE NEST

Flesh-footed Shearwaters on Eclipse Island are all burrowers; no eggs were seen on the surface nor any in niches among the rocks. Burrows are found wherever the soil is deep enough, from the top of the island at about 350 feet above sea level to within about 40 feet of high tide mark. Presumably because they are so much bigger, few attempts are made at burrowing into the rocky slopes, as the Little Shearwaters do so successfully. The Flesh-footed Shearwaters were concentrated on relatively level ground, particularly beneath the belts of tea-tree where the soil is deep. Such places were honeycombed with burrows. The entrance tunnels vary from 3 to 6 feet in length (average about $4\frac{1}{2}$ feet) sloping down at from 15 to 30 degrees so that the nesting chamber may be as little as 6 inches or as much as 2 feet below the surface depending on the configuration of the ground. Where this was clothed with a mat-like heathery scrub several burrows were found, which were not really underground at all, being merely shallow hollows scooped in the soil and effectively shaded from above by the tightly packed herbage.

The few nesting chambers which could be inspected without destruction of the nest were about 30 inches long by 12 inches wide and 9 inches high. A feature of the nests was the way the mouths of the tunnels in use were clogged with dead grasses and herbage, apparently dragged there by the birds themselves. Daytime checks revealed that those with their entrances blocked in this way were almost always occupied; conversely unblocked burrows were generally empty. The effect of choking the entrances like this was to make the burrows look disused, but the real purpose of the habit might be to cut down the amount of light reach-



Flesh-footed Shearwater. (*Above*) Walking to burrow. (*Below*) Arrival inside nesting chamber. Photos. by J. Warham.

ing the birds within. The herbage would offer little or no barrier to the entrance of marauding skinks. Despite the amount of material jammed in the mouth of the tunnel, the chambers themselves were sparsely furnished with a lining of grasses, dead pigface (*Carpobrotus*) stems, and the like.

Some burrowing was still taking place, the birds pecking with their bills and scratching the spoil out in a dusty stream using their feet one at a time. Some of this activity was doubtless from unemployed birds and some from breeders which were cleaning out tunnels partly clogged by daytime falls of the dry earth.

INCUBATION AND HATCHING

The incubation period of the Flesh-footed Shearwater's single egg still seems to be unknown and our visit was too late in the season to ascertain it. According to Serventy and Whittell (1951), the bulk of egg laying in 1943 was found by A. V. Newman to take place during the first week of December. Probably both sexes assist in incubation, but we could not be sure of this point since banded birds either had chicks, chipping eggs or hatched their eggs before changeovers occurred. Incubating shearwaters remained quietly inside their burrows by day and were resentful of interference, striking hard with their sharp bills at anything inserted into the nest and crowing angrily.

At hatching the chick cheeps lustily while smashing its way out of the egg. One nest was found through the persistent calling of the chick, which had already hacked a hole about half-an-inch wide in its shell. Eggshells were not removed, but simply trampled into the debris at the bottom of the cavity. We found that hatching reached its peak from about January 30 to February 3.

Day-old chicks of the Flesh-footed Shearwater are clad in down about one inch deep on the back. This down is medium gray above and light gray on the breast, belly and under the wings. The beak is gray-blue, the legs flesh-gray and the webs flesh colored.

BEHAVIOR AT THE NEST

Brooding the young.—In two instances where the time of hatching was known, the chicks were brooded for only two days before being left on their own by day. In three other cases where the chicks were found soon after hatching and their ages estimated with reasonable accuracy, these were brooded for 2, 3 and 3 days respectively before being abandoned by day. Both sexes took turns at brooding the chick. At one nest a chick, left alone after 3 days, was brooded again on the 5th day by the mate of the bird which had last been seen on the chick. This was the only

instance encountered where a nestling once left alone by day was subsequently brooded again.

Behavior of nestlings.—Once it has been left on its own by day the chick spends most of its time sleeping and tucking its bill into the down of the back. It looks like a gray fluffy ball. When handled it strikes at the fingers with its soft bill, perhaps reflecting the fierceness of the adult, but the movements it makes are the same as it uses against the parents when begging for food. The voice of the newly hatched chick is a soft piping, indistinguishable to me from that of other shearwaters at this stage of their lives. Chicks sometimes ejected a small amount of pale brown oil when handled, but none seemed to be able to squirt this substance, in the way that the Fulmar chick does. The bird sits in a neat cup of grasses, feathers and other items which it collects from the corners of its chamber, reaching out with its bill to add other scraps to the collection when the opportunity arises. This habit it shares with *P. puffinus* and *P. assimilis*.

Feeding the young.—It was customary to enter the blind at sunset, since if the chick was to be fed the parent would generally appear with the early waves of incoming birds. Both parents fed the young. Entry to the burrow was generally preceded by a series of chirrupings from the chick which seemed to sense the old bird's presence, even though I had heard nothing. Sometimes the parent would crow as it entered, sometimes it was silent. The chick would not have long to await for its meal. Either might initiate the feeding process, the adult by lightly preening the young one's head with partly opened bill or, more often, the chick by driving its beak repeatedly towards the adult's head and chirruping continually. The adult would then open its beak so that the two became interlocked. The chick fell silent, its eyes closed and wings vibrated as it was fed. After about 5 seconds the bills were separated and both birds swallowed. The chick would be fed repeatedly in this manner, getting about 6 feeds in 10 minutes. High-speed photographs (Plate 1) show how the chick's beak lies on top of the adult's cupped tongue so that the disgorged food can be diverted from the one to the other. The old birds were sometimes quite silent when feeding, sometimes made peculiar gurgling noises.

Occasionally both adults would visit the nest and duetting might then take place. It seemed that the older the chick the more infrequently the visits of the two parents coincided. It was found that during the chicks' first 10 to 12 days in the nest they were visited on average about 6 times. The nestlings were seldom visited without being fed.

Other behavior of adults.—When food had been disgorged the adult bird would generally wander back up the tunnel to squat quietly outside,

perhaps to sleep with head tucked into the scapulars. Many birds were seen resting like this within a few minutes of the arrival of the main body after dark.

One night a parent bird tore at the vegetation surrounding the nest cavity, throwing pieces of it over its shoulder. This may have been a displacement activity, since my red light was flickering at the time. Another bird shortly after entering the nest indulged in an orgy of scratching, using both feet in turn and getting covered with dust and earth in the process.

On the few occasions when the nests were checked in the early hours of the morning, the adult bird seen there earlier that night was still present. It would seem that although the chick is fed shortly after the adult's arrival, the latter does not leave the island until the approach of dawn.

FLEDGING

Before leaving Eclipse Island five nests, located close to dwellings and containing young of known ages or whose dates of hatching were known to within two days, were numbered. Lighthouse-keeper W. McAuliffe undertook to check these nests, occasionally at first, and then nightly towards the end of April when the young would be expected to be ready to depart. This was duly done. Of these birds one 37-day old chick was found dead in the nest after a spell of bad weather in March and another at 56 days old apparently succumbed to the attack of some predator, since it disappeared leaving a pile of feathers around the nest area. Of the remainder, one left on the night of April 28/29 at 95 ± 2 days old, one left on the night of May 1/2 at 93 days old, and the other on night of April 25/26 at 89 ± 2 days. This gives an average fledging of about 92 days; a period which compares with that for the Greater Shearwater (*P. gravis*) given by Rowan of about 84 days, for *P. tenuirostris*, of 94 days (Marshall and Serventy, 1956), and for the Great-winged Petrel on Eclipse Island of 130 days. Mr. McAuliffe noted that two of the chicks sat outside their burrows on the night preceding their final disappearance from the nest. His records indicate that he seldom saw any adults in attendance during the later stages. However his observations throw no light on whether the chicks were deserted by the adults before their final departure or whether they were fed intermittently right up to this time.

ENEMIES AND INTER-SPECIFIC COMPETITION

Procellariidae on Eclipse Island seem to have few enemies. Bad weather causes the death of an appreciable number of chicks and there is also some mortality around hatching time even in fine weather.

Raptorial predation seems to be low. A harrier, *Circus approximans*, a sea-eagle, *Haliaeetus leucogaster* and two hawks, *Falco berigora* and possibly *Accipiter fasciatus*, are potential predators, but all seem only casual visitors to the island and their effect must be small. But predation by skinks, particularly by the big king skinks (*Egernia kingii*) is probably quite serious, and many eggs with holes, apparently eaten by these reptiles, were noted.

The lack of avian predators would appear to make it unnecessary for these shearwaters to restrict their visitations of the breeding ground to the period after sunset, yet in their nesting they seem quite intolerant of daylight. Invariably the Great-winged Petrels were the first birds over the island in the evening, calling perhaps 30 minutes before the shearwaters first appeared. On Nightingale Island in the Tristan da Cunha group, Greater Shearwaters come ashore to court and sing in broad daylight despite the presence of skuas (which do not attack the adult birds). However, the density of shearwaters on Nightingale seems greatly in excess of that of *carneipes* on Eclipse: possibly the great shortage of nesting sites accounts for the diurnal visits of the Tristan birds.

Several authors have suggested that varied breeding seasons among petrels are advantageous or necessary in order that the limited nesting places be fully utilized. On Eclipse Island the winter-breeding Little Shearwaters require much smaller holes than the Flesh-footed species, but the winter-nesting Great-winged Petrels, while nesting freely on the surface, are also burrowers and certainly use many of the same burrows as do the Flesh-footed Shearwaters. It was interesting, therefore, to find Great-winged Petrels coming ashore in increasing numbers during our stay, many occupying potential nesting sites singly or in pairs, and a few even remaining on the island during the daytime. There was no sign of any competition between these and the Flesh-footed Shearwaters. There were many unoccupied burrows available, in some of which attempts had obviously been made at breeding but then were available for any bird prepared to occupy them. Had the petrels appeared 6 weeks earlier, however, when most of the shearwaters would have been laying and when non-breeding birds also were occupying burrows and "going through the motions" of breeding, then the petrels might have found difficulty in finding undefended sites. As it was, the petrels' arrival seemed nicely timed to take advantage of the increasing number of nest sites becoming available. One can visualize that by May, when the petrels must be present in great numbers, the remaining shearwater chicks in their burrows will have frequent visits from prospecting petrels. It seems possible that the same pairs return yearly to the same burrow and perhaps renew their alliances by meeting at the nest which they will

presumably attempt to occupy again. If the young *carneipes* has anything of its parent's aggressiveness it should have no difficulty in holding its own against the comparatively placid petrels. The reverse side of the picture may be different. In November the young Great-winged Petrel is ready to leave while the Flesh-footed Shearwaters are now numerous, egg-laying being only a month ahead. I should imagine that the petrel nestlings might then have difficulty in resisting eviction.

SUMMARY

The breeding of the Flesh-footed Shearwater (*Puffinus carneipes*) (Pale-footed Shearwater of the A.O.U. Check-list) was observed during a visit to Eclipse Island, Western Australia in late January-February 1956, during the southern hemisphere summer. Nest, courtship, voice, flight and locomotion on land are described. Comparison is made with other shearwaters.

Some of the birds assemble in rafts offshore towards evening. They only come to the nests after sunset, seem to shun light, and to be less numerous on land on moonlight nights. Nest entrances are often clogged with dead herbage apparently dragged there by the birds themselves.

The single chick is brooded for 2 or 3 days by either or both parents, and during their early nestling period they are fed on the average about 6 nights in every ten. The feeding operation is described with photographs. From three records the fledging period was found to be about 92 days. It is unknown whether a starvation period occurs in this species. The birds seem to have very few enemies except skinks. The possibility of competition between these summer-breeding shearwaters and the winter-breeding Great-winged Petrels, which often use the same burrows, is discussed.

LITERATURE CITED

- ALEXANDER, W. B. 1955. *Birds of the Ocean*. Putnam's, London.
- CAMPBELL, A. J. 1900. *The nests and eggs of Australian birds*. Pawson & Brailsford. Sheffield.
- DUVALL, A. J. 1945. Random distributional records. *Auk*, **62**: 626-627.
- FALLA, R. A. 1934. The distribution and breeding habits of petrels in northern New Zealand. *Rec. Auck. Inst. Mus.* **1**: 245-260.
- FISHER, J. AND R. M. LOCKLEY. 1954. *Sea-birds*. Collins, London.
- GIBSON-HILL, C. A. 1953. Notes on the sea birds of the orders Procellariiformes and Pelecaniformes recorded as strays or visitors to the Ceylon coast. *Spolia Zeylanica*, **27**: 83-102.
- GLAUERT, L. 1946. The Little Shearwater's year. *Emu*, **46**: 187-192.
- HILL, O. W. C. AND Y. BURN. 1944. Note on the occurrence of the Pink-footed Shearwater on the coast of Ceylon. *J. Bombay Nat. Hist. Soc.*, **45**: 239-240.
- HINDWOOD, K. A. 1945. The Fleishy-footed Shearwater (*Puffinus carneipes*). *Emu*, **44**: 241-248.

- LOCKLEY, R. M. 1942. Shearwaters. Dent, London.
- MARSHALL, A. J. AND D. L. SERVENTY. 1956. Breeding periodicity in the Short-tailed Shearwater (*Puffinus tenuirostris* Temminck), in relation to trans-equatorial migration and its environment. Proc. Zool. Soc. Lond., **127**: 1-21.
- PAULIAN, P. 1953. Pinnipedes, Cétacés, Oiseaux des Îles Kerguelen et Amsterdam. Mem. l'Inst. Sc. de Madagascar, ser. A, **8**: 111-234.
- RICHDALE, L. E. 1944. The Sooty Shearwater in New Zealand. Condor, **46**: 93-107.
- ROWAN, M. K. 1952. The Greater Shearwater *Puffinus gravis* at its breeding grounds. Ibis, **94**: 97-121.
- SERVENTY, D. L. AND H. M. WHITTELL. 1951. A Handbook of the birds of Western Australia. Second ed., Paterson Brokensha Pty., Ltd. Perth, W. Australia.
- SERVENTY, D. L. 1953. Movements of pelagic sea-birds in the Indo-Pacific region. Proc. 7th Pacific Sci. Congr., **4**: 394-407.
- SERVENTY, D. L. 1956. Age at first breeding of the Short-tailed Shearwater *Puffinus tenuirostris*. Ibis, **98**: 532-533.
- WARHAM, J. 1955a. Observations on the Little Shearwater at the nest. West. Austral. Nat., **5**: 31-39.
- WARHAM, J. 1955b. The birds of Eclipse Island. Emu, **55**: 164-169.
- WARHAM, J. 1956. The breeding of the Great-winged Petrel *Pterodroma macrop-tera*. Ibis, **98**: 171-185.

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