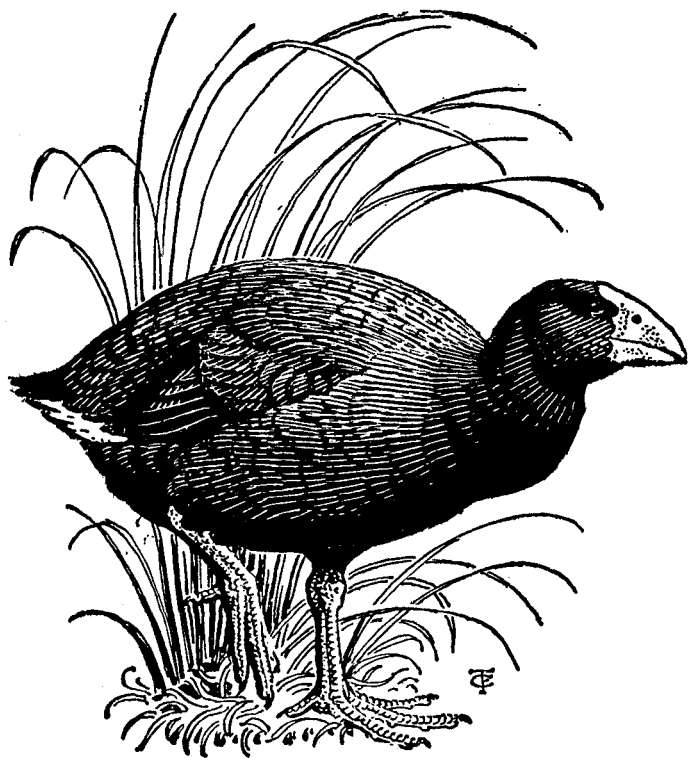


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## **FOODS AND FEEDING OF THE WRYBILL (*Anarhynchus frontalis*) ON ITS RIVERBED BREEDING GROUNDS**

By R. J. PIERCE

### ABSTRACT

The feeding ecology of the Wrybill was compared between two sites — a flood-prone riverbed and a stable riverbed. Larvae of aquatic insects, particularly mayfly (*Deleatidium* spp.), were the main prey of Wrybills, which captured them by a variety of methods. The sideways-bent bill was useful in capturing insects from the undersurface of stones where they would normally have been inaccessible to birds with shorter, straight, or even upcurved bills. The evolutionary significance of the bent bill is discussed with reference to climatic trends during and since the Pleistocene period. During floods, aquatic prey was relatively unavailable to Wrybills, causing them to switch to riparian foraging.

### INTRODUCTION

The shingle riverbeds of the eastern South Island provide breeding grounds for a variety of New Zealand birds, particularly members of the order Charadriiformes. One species, the Wrybill (*Anarhynchus frontalis*), breeds entirely within these habitats (Falla *et al.* 1970), occurring on the riverbeds from late winter (August) until mid-summer with comparatively few remaining from February to April (pers. obs.). From late summer until mid-winter the bulk of the population occurs on extensive tidal mudflats in Auckland province (Sibson 1963).

Few studies have been made of the feeding behaviour of the Wrybill since the early twentieth century. This is surprising considering that it is the only living species with a sideways bent bill. Oliver (1955)

records the 28-30 mm long bill as being bent to the right by up to 12°. However, bill angles of eight Canterbury Museum specimens range from 14-23° (R. Hay, pers. comm.). Wrybill feeding techniques on North Island mudflats have been described recently by Turbott (1970) who found that tilting of the head to the left followed by a sideways sweep of the bill from right to left was a common feeding movement on mudflats. Like other riverbed birds, the Wrybill has been little studied on the breeding grounds and some aspects of their feeding ecology have been left for speculation only. Potts (1871) saw the value of the curved bill in fitting close to a stone. He wrote "... the bird is enabled to follow up retreating insects by making the circuit of a water-worn stone with far greater ease than if it had been furnished with the straight bill of the plover or the long flexible scoop of the avocet." Potts' account was quoted again by Buller (1873 and 1882). The value of the curvature of the bill for feeding was disputed by some later authors (Stead, 1932; Soper, 1963 and 1972; Turbott, 1970). Stead wrote of the bent bill that "... there can be very few occasions when the peculiarity is of any decided benefit to its possessor for over nearly all the riverbeds on which the bird feeds, the stones are so much buried in sand as to make the bent bill quite unnecessary."

The above accounts showed that there are gaps and contradictions in the knowledge of Wrybill feeding on riverbeds, largely because authors have formed impressions rather than made quantitative measurements. The purpose of the present paper is to present some general patterns of the riverbed feeding of adult Wrybills, with particular reference to how the bent bill is used.

### STUDY AREAS

Most field work was carried out from 5 October 1975 until 23 August 1976 in two study areas, on the Rakaia River and on the Cass River delta (Fig. 1). These riverbeds were chosen because they presented contrasting habitats as well as having relatively high concentrations of Wrybills.

The Rakaia River study area was situated about 70 km inland and 340-370 m above sea-level. The four kilometres of riverbed studied consists of flat expanses of shingle and sand, dissected by streams and old streambeds. Patches of sand are sometimes extensive at the edges of streams. Silt commonly settles on the streambeds in areas of quieter water, but is generally absent from the riffles or rapids. Stones in the river channels and on the shingle-banks are typically smoothly rounded. Floods were frequent during the study period and the streams altered their courses by continually eroding one bank and depositing on the other. Only the more stable shingle-banks were vegetated, the largest plants being lupins (*Lupinus arboreus*), gorse (*Ulex europaeus*) and tussocks (*Poa* spp.). Within the study area, ten

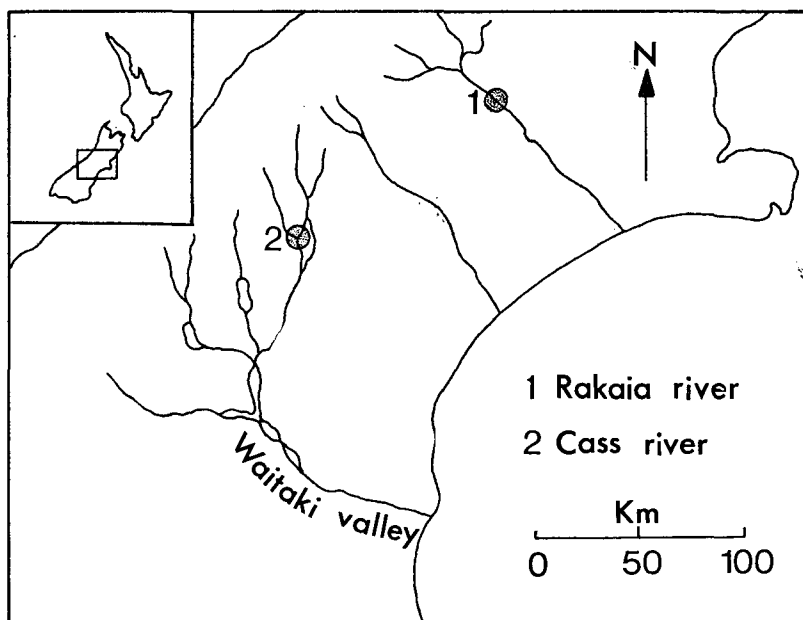
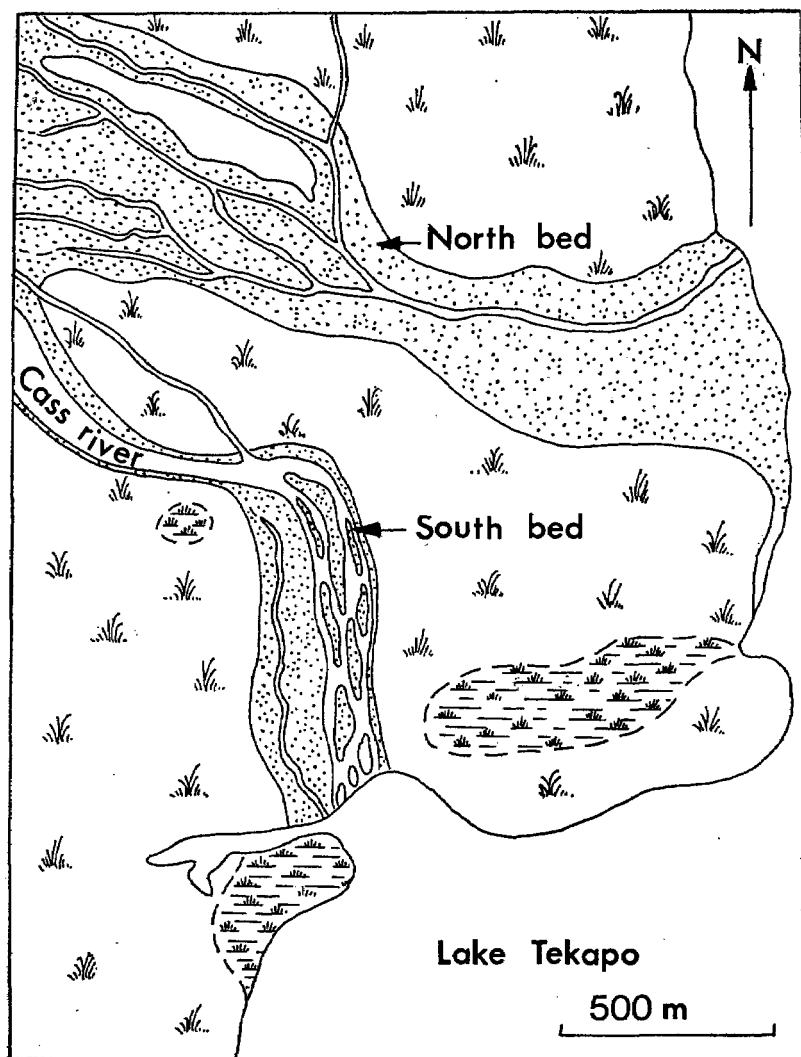


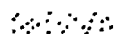
FIGURE 1 — Map of study areas.

Wrybill pairs were located on or near the south bank, and these were regularly visited.

The second study area was situated on the delta of the Cass River where it flows into Lake Tekapo at about 700 m above sea-level. The two-kilometre-wide delta consists of two distinct areas of shingle riverbed separated by tussock grassland and muddy ponds or mudflats (Fig. 2). Since 1973 the river has flowed along the narrow southern bed which is poorly braided and subject to flooding. The northern bed, which had been the main river course before 1973, is wider. Several small streams, which are fed by seepage from the main river and from swampland, dissect this northern bed and they remained clear and at a fairly constant level throughout the study period. Average stone-size in these streams is much less than in the Rakaia River, and mud forms on the beds of some of the pools. Shallow pools comprised a greater surface area of the streams than did riffles. Small plants (including tussocks) have proliferated on this old riverbed since 1973, but lupins and gorse are absent from the entire delta. During the study period, at least seven pairs of Wrybills nested on the shingle-banks of the northern bed and their feeding was studied and compared with that of Rakaia River Wrybills. No feeding data were collected from the southern bed of the delta.



Shingle



Stream



Tussock grassland



Mudflat

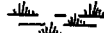


FIGURE 2 — Cass River delta.



## METHODS

Field observations were made from elevated shingle-banks, using 8 x 40 binoculars and a 13-40 x telescope. Because they were very active and quite tame, the birds were more easily viewed through binoculars. Sexes were differentiated by the black forehead line of the males (absent in females) and juveniles by the lack of a black pectoral band. Each non-incubating bird was watched either for an hour or, more often, until it was lost from view. Notes were made on habitats, sub-habitats, feeding methods, peck rate, feeding success and search rate.

### *Habitats*

Two habitats were distinguished — aquatic (shallow water) and riparian (shingled river-edge). The aquatic habitat was subdivided into riffles (broken water), pools (unbroken water), backwashes and transitional areas. Backwashes were defined as pools separated from the main flow of river water. Transitional areas were used for indeterminable situations, particularly where backwashes merged with pools. The riparian habitat was readily sub-divided into shingle-banks and the water-edge. Shingle-banks consisted of elevated areas of stones, shingle and sand, not immediately influenced by river water. The water-edge consisted of the edges of streams where debris collected, and the damp area immediately above.

### *Feeding methods*

Feeding methods in the aquatic habitat were classified according to whether they were 'direct pecks,' 'clockwise movements' or 'probes.' Direct pecks were very rapid movements after each of which the bill was quickly withdrawn. Clockwise movements involved tilting of the head to the left followed by a left to right movement of the bill. Probing was a prolonged action in which the bill was pushed at a steep angle into the streambed.

Direct pecks and clockwise movements were subdivided according to where the bill was directed. These subdivisions were 'water-surface,' 'in-water' and 'around-stones.' Water-surface feeding was defined as pecking to a depth not greater than one third bill-length, while in-water feeding was at greater depths. Although these divisions possibly led to some interpretative error, water-surface pecks were generally directed at floating insects, with the bill held at a distinctly shallower angle to the water surface than when pecking at submerged prey. In-water pecks, in contrast, were almost always directed at benthic animals, with the bill held at a steep angle and plunged well into the water. Around-stone feeding was directed at the base of, or under, a partly submerged stone. Clearly many of the in-water movements would have been around-stone movements around submerged stones. Feeding methods in the riparian habitat were recorded similarly but fewer categories were required.

Peck rate in both habitats was measured as the number of feeding actions per minute. Peck rate and feeding methods could often be recorded concurrently, particularly when feeding methods were fairly stereotyped. Success rate (percent successful pecks) could be recorded for Wrybills at close quarters only, because small prey items were mandibulated to a very small extent. Several of the larger prey types could be identified in the bills of Wrybills. The search rate (distance travelled per minute) was estimated in metres. This proved more practical than counting the steps taken by birds, and could be recorded concurrently with peck rate.

### *Collection of prey samples*

Samples of the riverbed fauna were collected where Wrybills had been observed foraging for ten or more minutes, and later identified and counted. As Wrybills took relatively few prey from the sample areas, the faunal composition and numbers would not have been significantly changed by the foraging birds. In the aquatic habitat these samples covered 0.5 m<sup>2</sup>. A square wooden-framed Surber sampler with a 0.5 mm mesh net was operated for two minutes during which time the surface layer of shingle was stirred by hand. In some situations currents also had to be created by hand. In the riparian habitat, the quadrat samples covered 1.0 m<sup>2</sup>, and all invertebrates were collected by hand. All aquatic and riparian samples intended for weighing were preserved in 10% formalin and later dried to constant weight at 80°C. Average dry weights of animals per 1.0 m<sup>2</sup> were then calculated. It was not possible to use fresh material for weighing because many aquatic insects emerged soon after collection.

## RESULTS

### *Aquatic Foraging*

#### INVERTEBRATE FAUNA

The aquatic fauna at Wrybill feeding stations on the Rakaia River is summarised in Appendix 1. The dominant animals were mayfly larvae of the genus *Deleatidium*, with densities ranging 0-775 per m<sup>2</sup> (average 85 per m<sup>2</sup>). Any seasonal changes in mayfly numbers and biomass were obscured by river condition, which had a marked effect on mayfly abundance. Floods caused temporary but spectacular declines in the numbers of mayflies in shallow water with an average of only 2 per m<sup>2</sup> at those times. As the river subsided, densities of 200-775 per m<sup>2</sup> were recorded, and even greater densities sometimes occurred in landlocked pools (R. Hay, pers. comm.). Free-living (uncased) caddisfly larvae of the families Hydrobiosinae and Hydroptychidae were the second most common animal group of the Rakaia River aquatic fauna and their total biomass per m<sup>2</sup> approached that of mayflies. Floods made caddisflies as well as mayflies much less available to Wrybills.

The aquatic fauna was more varied in the Cass River streams (Appendix 2) than in the Rakaia River, with many additional invertebrate groups being recorded. Cased caddisfly larvae of the families Leptoceridae and Sericostomatidae, and mayfly (*Deleatidium*) larvae were the most numerous animals. Numbers of cased caddisflies ranged approximately 66-1000 per m<sup>2</sup>, with an approximate average of 560 per m<sup>2</sup>, while numbers of mayflies ranged 114-310 per m<sup>2</sup> with an average of 176 per m<sup>2</sup>. As on the Rakaia River, free-living caddisfly larvae were an important group in terms of biomass. Numbers of invertebrates in the stable Cass River streams fluctuated much less than in shallow water situations on the flood-prone Rakaia River, and densities of mayflies, for example, never approached the extremes for Rakaia River.

In both study areas mayfly larvae were found to be negatively phototactic, clinging to the undersurface of stones during the day. Stones that were free of silt, and were partly covered in algae, normally supported mayflies. These conditions were characteristic of the riffles and it was here that mayflies were most abundant and Wrybills most frequent. Mayfly larvae moult to a sub-imago phase, which flies from the water and shelters in a damp terrestrial site where it completes a final moult to the imago (adult) phase within three days and flies away (Penniket 1969). Both mayfly and stonefly larvae were seen to emerge in the early afternoon at both study areas.

Free-living and cased forms of caddisfly larvae were also usually found on the undersurface of stones. McFarlane (1969) reported caddisflies emerging from the water in the evening or at night and this was confirmed for at least the Cass River study area.

## FOOD TAKEN

Mayfly larvae appeared to be the staple diet of Wrybills at each river, despite diverse aquatic faunas, particularly on the Cass. Mayfly sub-imagos floating on the water surface were also taken, as were drifting mayfly larvae. On both riverbeds, Wrybills were occasionally seen mandibulating large free-living caddisfly larvae. No cased caddisfly larvae were seen being mandibulated by Wrybills and none was eaten when large numbers of cased larvae were provided experimentally at the edge of a Cass stream. Wrybills may not eat cased caddisflies because of a low energy return. I extracted 300 caddisfly larvae from their cases, dried them and the cases at 80°C, and then calculated their dry weights. The average dry weight of the extracted larva was only 0.7 mg compared with 2.9 mg for mayfly larvae (Appendix 2). Caddisflies and mayflies were recorded by Cummins & Wuycheck (1971) as having relatively similar energy values per gram of dry weight, hence the average energy intake per individual caddisfly was probably much lower than per individual mayfly on the Cass River streams. Moreover, the dry weight of extracted caddisfly larvae averaged only 17% of the total dry weight of extracted

caddisfly larvae plus case, the remaining 83% consisting of a sand and/or silt case which would have been largely unpalatable to Wrybills. However, it is possible that Wrybills take some cased caddisflies when tactile feeding.

On the Rakaia River, when ten dead bullies (*Gobiomorphus cotidianus*) averaging 3.0 cm long were provided at the river edge, one was eaten. On another occasion, one bird was seen attempting unsuccessfully to eat whole a dead 7.0 cm long bully at the water-edge. Wrybills were sometimes seen with fish eggs on their mandibles at the Cass River, and it is possible that eggs of aquatic insects, as well as those of fish, were an additional food at both rivers.

#### SUB-HABITATS FREQUENTED

On the Rakaia and Cass Rivers, the riffles had highest mayfly densities and were the preferred aquatic sub-habitat of Wrybills (Fig. 3). This was contrary to Turbott's (1970) observation that Wrybills on the riverbeds obtained most of their food from the "... soft muddy drifts on the riverbeds and the softer interstices between shingle ...". On the Rakaia River "muddy interstices" were in the form of silt and occurred only along the quieter stretches of water. These quieter stretches (pools) had low mayfly densities and were not favoured by Wrybills (Fig. 3a). Muddy pools were common on the Cass River streams, but they also had low mayfly densities and were less often frequented by Wrybills than were the silt-free and mud-free riffles (Fig. 3b). Similarly, backwashes and transitional areas had lower mayfly densities than the riffles and were not favoured by Wrybills.

#### FEEDING METHODS

In aquatic feeding, Wrybills walked moderately fast through shallow water, maintaining an on-going search path and seldom retracing their steps. The relative frequencies of the different bill movements that birds used when feeding are given as percentages in Figure 4. These frequencies were not found to differ significantly between sexes, nor with time of day and season, although comparatively few observations were made in August and none in September.

Direct pecks were the main bill movements, accounting for 59.5% of Rakaia River observations and 54.1% of Cass observations. Most of these direct pecks were of the 'in-water' category and were probably directed mainly at benthic prey, because the bottom-dwelling mayfly and caddisfly larvae were frequently seen to be captured. Wrybills were often seen to alter the direction of the chase, suggesting that moving prey was the target or at least that the prey had moved. It is likely that direct pecks to the base of stones may have been directed at mayfly larvae which, having detected the approaching bird, were seeking the shelter of the stones. Surface pecking was used to capture floating insects and was also used at some land-locked pools where mayfly larvae often swam to the water surface.

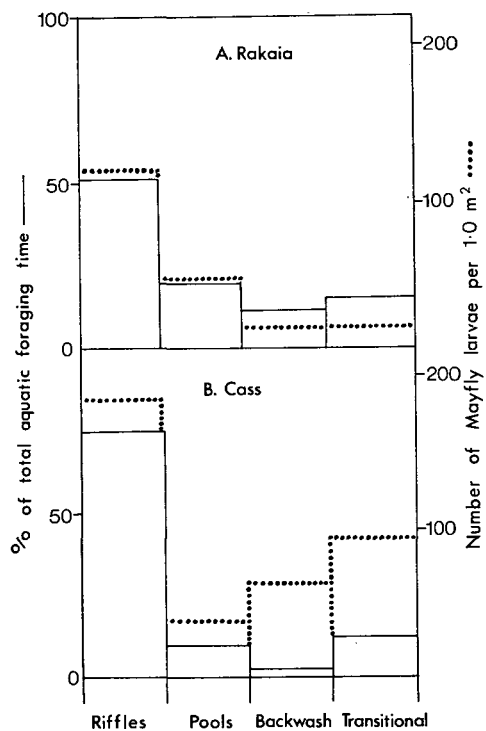


FIGURE 3 — The relationship between preferred aquatic subhabitats of Wrybills and the abundance of mayfly larvae.

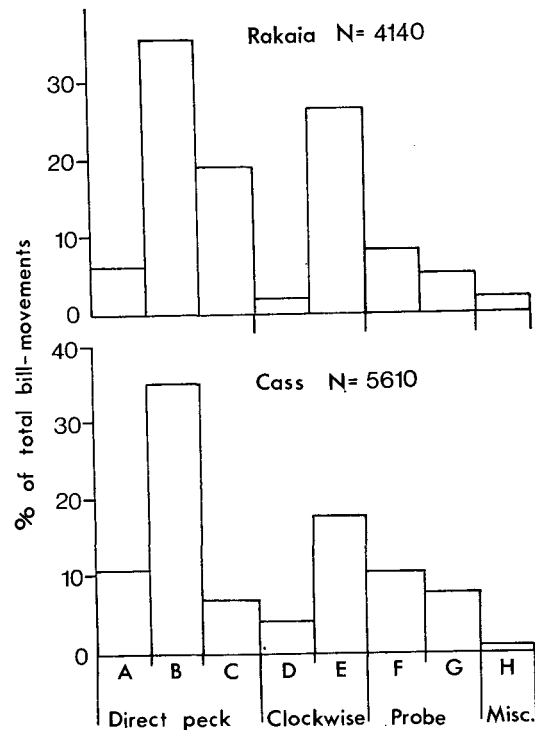


FIGURE 4 — Frequency of bill-movements in aquatic feeding. A: surface. B: in water. C: around stone. D: in water. E: around stone. F: direct. G: clockwise. H: miscellaneous.

Clockwise bill movements accounted for 27.1% of Rakaia observations and 22.4% of Cass observations. These movements involved the head being tilted to the left side and the bill being pushed forward and/or to the right. In most clockwise bill movements the bill was pushed under a stone where prey appeared to be felt for and not necessarily seen first. It is well known that sensory nerve endings are numerous in the bills of birds (e.g. Heather 1966) and they are particularly important in waders that probe for their food (Heppleston 1971). As mayfly larvae typically cling to the under-surface of stones, they would not be easily accessible to birds with short, straight bills such as the Banded Dotterel (*Charadrius bicinctus*). The long, sideways bent bill of the Wrybill, by contrast, appears effective in capturing these mayflies but, for this to be so, the head needs to be tilted to the left so that the curvature of the bill more closely fits the undersurface of a stone (Fig. 5). Wrybills always employed

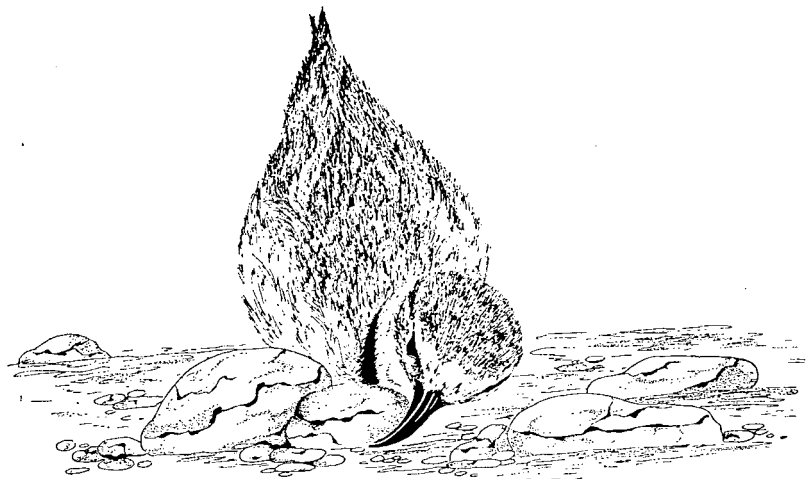


FIGURE 5 — Clockwise feeding around a stone. Mrs J. Clough, del.

this head tilting when feeding by clockwise bill movements. An up-curved bill like that of the Terek Sandpiper (*Xenus cinereus*) would be unsuited to feeding under stones, because the mandibles cannot be opened between the undersurface of a stone and the stones beneath, except very clumsily. The mandibles of the Wrybill are not so restricted because they open sideways to a stone's surface with ample freedom of movement to capture large or small prey.

Soper (1963 and 1972) suggested that clockwise bill movements could only help to capture insects if the bird circled each stone in a clockwise direction. On the Rakaia and Cass, Wrybills were seldom seen circling individual stones in that manner, and even then they

were often merely following up prey which had escaped an initial direct peck. Clockwise circling of stones is unnecessary because a Wrybill is highly manoeuvrable and can swing its body around more than 90° in a single step. Thus, all the stones to the right of a bird's path of movement are accessible to clockwise bill movements and, if the body is swung to the left, further stones (formerly to the left of the bird) are made accessible. In some cases, clockwise bill movements were used exclusively throughout a period of observation, but it was more usual for this method to be interchanged with direct pecks.

The third most common bill movement was probing but accounted for comparatively few observations at each river (Fig. 4), and was usually restricted to areas of small stones. Miscellaneous bill movements included direct pecks at insects on emergent stones and in algae, anticlockwise movements (from right to left) and aerial insect-catching. Foot-trembling, used by some other New Zealand plovers (Heather, 1977; Phillips, 1977), was not seen to be used by Wrybills.

#### PECK RATE AND SUCCESS RATE

Peck rates for the Cass River and under three river conditions for the Rakaia River are given in Table 1. Highest peck rates occurred on the Cass River and on the Rakaia during low or dropping water levels, that is, in conditions of high prey densities. During floods or rising water levels on the Rakaia, when prey densities in shallow water were low, peck rate was significantly lower as birds had to forage more widely for their food.

TABLE 1 — PECK RATES AT CASS AND RAKAIA RIVERS COMPARED

River	River condition	Minutes of observation	Range of pecks per min.	Mean pecks per min.	Statistical significance between Rakaia and Cass (t-test)
Cass	stable streams	550	12 - 56	30	—
Rakaia	very low	55	14 - 53	26	N.S.
Rakaia	moderate	350	2 - 42	18	S.
Rakaia	flood	242	3 - 42	13	H.S.

N.S. = not significant

S. = significantly different (at  $p = 0.01$  level)

H.S. = highly significantly different (at  $p = 0.001$  level)

When clockwise feeding movements were used exclusively, peck rates were higher than in normal feeding in the same sub-habitat, but success rate was considerably less (Table 2). As a result, prey intake per minute of clockwise feeding was only half that for normal feeding. This does not mean that biomass ingested was only half that for direct pecking, because clockwise feeding may have obtained, on average, larger prey such as free-living caddisfly larvae normally found only under stones and less accessible to direct pecks.

TABLE 2 — FEEDING SUCCESS AT CASS RIVER

Bill-movement	Minutes of observation	Range of pecks per min.	Mean pecks per min.	Successful pecks (%)	Prey intake per min. (nos.)
Mixed (= normal feeding)	195	12 - 42	26	81%	21.1
Clockwise	24	27 - 46	39	26%	10.1

### SEARCH RATE

On both the Rakaia and Cass Rivers, the distance walked by Wrybills in search of food corresponded closely with peck rate, as expected (Fig. 6). The higher the peck rate, indicating abundant prey, the less the distance walked; conversely, the lower the peck rate, indicating low prey density such as during floods, the greater the distance walked.

#### *Riparian foraging — the effects of floods*

Because the Cass River streams remained at fairly constant levels throughout the study, mayfly larvae and other aquatic prey were always available to Wrybills. Consequently, Cass Wrybills did almost all of their foraging in the streams (Fig. 7). On the Rakaia River in contrast, rising water levels and floods following the rapid onset of snow melt in October caused Wrybills to spend a higher proportion of their foraging time searching for riparian rather than aquatic prey (Fig. 7). Riparian-foraging birds on the Rakaia spent, on average, about equal proportions of time in the shingle-bank and water-edge sub-habitats, although observations may have been biased against birds on shingle-banks where they were difficult to locate.

### SHINGLE-BANKS

The shingle-bank invertebrate fauna is summarised by season and presented in Appendix 3. Unlike the aquatic fauna (Appendix 1), total numbers and biomass of invertebrates remained low throughout the sampling period. Carabid beetles and spiders were the most regularly recorded animals, but by December these were outnumbered by the several families of dipteran flies. Carabid beetles and spiders were usually beneath stones and were not easily found by Wrybills. Mayfly sub-imagoes and some dipteran flies e.g. *Anabarhynchus* sp. were fairly inactive, did not penetrate far under stones, and were presumably more readily found by Wrybills.

Wrybills were observed feeding on all of the larger, more common invertebrates — beetles, flies, mayflies and spiders. Although spiders were not seen to be eaten in normal feeding, at least four out of twenty small, live spiders provided experimentally near a foraging Wrybill were found and eaten. Very small insects (about the size of sand-



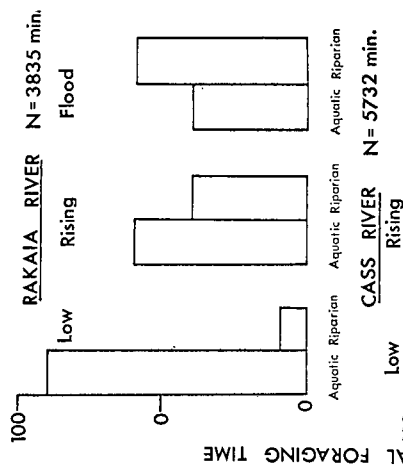


FIGURE 7 — The foraging habitats preferred by Wrybills at different water levels.

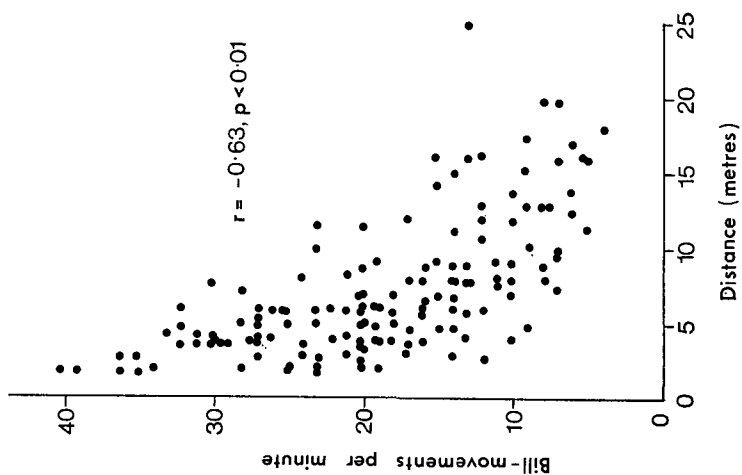


FIGURE 6 — The relationship between distance walked and feeding rate of aquatic-foraging Wrybills on the Rakaia and Cass Rivers, October 1975. Each dot represents observations of one bird for one minute.

flies or newly hatched spiders) were common prey, but their identity was not established. When foraging for sheltering insects, Wrybills typically probed beneath stones (in the manner of clockwise feeding in the aquatic habitat), although prey was more often captured by a direct peck, after it had been first located by the clockwise movement. Prey in more open situations were taken by direct pecks only.

Peck rates in the shingle-bank sub-habitat ranged from 6-28 bill movements per minute with an average of 14, based on 190 minutes of observation. However, most of these bill movements were clockwise sweeps, very few of which resulted in the capture of prey. On average, only five captures were made per minute and Wrybills were often seen foraging for two or three minutes without consuming any large prey, such as *Anabarhynchus*, or mature spiders. Average dry weights of these animals were nevertheless high, some individuals weighing as much as 30-40 mg, nearly twenty times the average dry weight of mayflies. If Wrybills ate one of these large animals about every 90 seconds, then that biomass alone would probably exceed biomass eaten in the aquatic habitat during floods.

Search rates in the shingle-bank sub-habitat averaged 20.0 m per minute compared with 7.2 m per minute in the aquatic habitat ( $t = 23.47$ , 148 df,  $P < 0.001$ ) during December. This high search rate correlated with the low density of prey on shingle-banks, similar to aquatic situations during floods so that, on shingle-banks, more ground had to be covered (and therefore more energy expended) in order to gain sufficient food.

#### WATER-EDGE

Invertebrate numbers and biomass of the water-edge are given by seasons in Appendix 4. Sandflies, cyclorraphan flies, hemipteran bugs and mayflies (dead and alive) were the dominant animals, but a variety of others occurred in smaller numbers. Total numbers were low in August (0.7 per m<sup>2</sup>) but were significantly higher in October-November (3.2 per m<sup>2</sup>) and December-January (4.5 per m<sup>2</sup>). Total biomass was also low in August, the bulk being made up of mayflies. From October to January, cyclorraphans comprised more of the water-edge fauna than any other invertebrate group, except on occasions when mayfly larvae became stranded as the river dropped, and at times of mayfly emergence. As no samples could be taken in September, the peak period of mayfly and stonefly emergence was probably missed. Subsequent observations on other rivers at that time of year, suggested that emerged mayflies and stoneflies were regular in the Wrybill diet. These also formed an important part of the diet of chicks (Pierce, 1976), the slow movements of these insects making them an ideal prey.

Food was normally obtained by direct pecks only, although clockwise feeding was sometimes employed at the stony edge of the river. As well as taking mayflies and stoneflies, adult Wrybills preyed on cyclorraphans, but these highly active flies were difficult to catch.

Hemipterans could not be identified for sure in the bills of Wrybills, but much of the smaller prey was probably of this sort. Some birds specialised for several minutes in catching small flies (probably sandflies) which were common on the sandy and silty stretches of the water-edge.

Peck rates in the water-edge sub-habitat ranged from 5-21 bill movements per minute with an average of 10 per minute, based on 115 minutes of observation. Success rate was about 90% for mayfly prey, but observations of Wrybill behaviour following pecks, suggested that it was comparatively low for sandfly and cyclorhaphan prey.

Search rates during water-edge foraging averaged 12 m per minute, based on 84 minutes of observation, and was intermediate between shingle-bank search rates (20 m per minute) and aquatic search rates (6 m per minute). This probably reflected the average density of the water-edge prey which was intermediate between shingle-bank prey and aquatic prey.

### DISCUSSION

Apart from those of Potts (1871) and Buller (1873 and 1882), published accounts of Wrybill feeding behaviour have suggested that the bent bill has little or no significance on riverbeds (e.g. Stead, 1932; Turbott 1970). However, in the Rakaia and Cass River study areas the feeding repertoire of Wrybills included a significant percentage of tactile bill movements (particularly clockwise bill movements) in which the curvature of the bill assisted prey capture. The bill appears to be pre-adapted for obtaining mayfly and caddisfly larvae from their inactive diurnal positions on the undersurface of submerged stones, where they are normally not visible to Wrybills. Larvae that are visible to Wrybills may also be gleaned from the curved surfaces of stones more readily by a bent bill than by a straight bill.

It is possible that birds are forced to feed by clockwise movements in late winter and early spring when aquatic prey is inactive during the morning because of low water temperatures. This trend was noted at Cass River in August and early September 1977, when almost all feeding movements were tactile. At this time also, other riverbed birds, notably Black Stilt (*Himantopus novaezealandiae*) and Pied Oystercatchers (*Haematopus ostralegus finschi*) were, like Wrybills, probing under stones, and Black-billed Gulls (*Larus bulleri*) were foot-paddling to stir up benthic insects. With their prey inactive, these four birds could not feed by sight alone, except late in the day. Any behavioural or morphological modification that increases the ability of these birds to capture prey during this potentially difficult time, clearly has survival value. Such adaptations are probably more important to the Wrybill than to the other three species, since its shorter legs prevent it from foraging in deeper water where prey density is often high. As Wrybills are small birds, they are probably susceptible to heat loss in very cold conditions (e.g. Kendeigh 1970). A combination

of subzero blizzard conditions, which frequently occur in late winter and spring, and a low intake of food, could result in their death. One can speculate that a bent bill had even more survival value during the glacial epochs of the Pleistocene Period, when many New Zealand bird species probably became extinct (Fleming 1962), and the suggested climatic deteriorations since then (Fleming 1963; Molloy 1969). Because of high mortality rates, evolutionary forces are strongest during bad years (MacArthur 1972), in the case of the Wrybill, such forces may have been particularly strong during prolonged cool periods. A scarcity of riparian insects and comparatively stable river levels (both results of a cold climate), coupled with heat-loss problems, would have selected for improved feeding techniques in the aquatic habitat. The bent bill may have permitted an efficient food intake, allowing the species to persist through adverse climatic conditions, such as occurred during glacial epochs. The winter-spring feeding methods of Wrybills on riverbeds are currently being investigated to elucidate the significance of clockwise feeding at that time of year.

It is interesting that on North Island mudflats, Wrybills sweep their bills through the mud from right to left (Turbott 1970), the opposite direction to clockwise feeding on riverbeds. On mudflats and the muddy edges to tarns at the Cass River delta, Wrybills sometimes fed from right to left, although from left to right more commonly; direct pecking and probing also occurred. Clearly, the long curved bill of the Wrybill has different uses and suits different habitats.

The specialised feeding niche (mayflies in riffles) occupied by Wrybills when river levels were low and/or stable, supported the MacArthur & Pianka (1966) time-energy model which predicts that "... a more productive environment should lead to a more restricted diet in the numbers of different species eaten." Conversely, as water level rose on the Rakaia, Wrybills changed from a relatively narrow (stenophagous) to a broad (euryphagous) diet, with many species of shingle-bank and water-edge invertebrates being taken, as well as aquatic invertebrates.

The switch to riparian feeding can be explained in terms of "profitability" which Royama (1970) defined as "the amount of food a predator can collect for a given amount of hunting effort." Clearly, at low water levels it was more profitable for Wrybills to forage in aquatic situations, where the biomass of food and the search rate could be low. At flood levels, however, the average numbers of mayflies (2.0) and caddisflies (0.1) per  $m^2$  in shallow water were very low, representing only 4.9 mg per  $m^2$ , and the search rates of birds needed to be high. On the other hand, average prey biomass per  $m^2$  in riparian areas exceeded 4.9 mg, except for the water-edge in August (Appendix 3 and 4). Assuming that prey species were equally available in all months, it was therefore more profitable during floods for Wrybills to forage for riparian prey than for aquatic prey. That many birds continued to forage aquatically during floods may have

been because they were feeding on drifting mayflies — particularly evident at the beginning of the spring thaw in October — or because the margin of difference between the total prey biomass of the two habitats may have fluctuated from time to time as physical conditions such as weather and water clarity changed.

The bent bill and flexible diet of the Wrybill adapt it to its specialised breeding environment on shingle riverbeds. In favourable conditions, mayfly larvae, its preferred prey, are obtained by direct pecking and by clockwise sweeps beneath the stones of riffles. In localities where river levels rise from time to time, it often shifts to shingle flats where it feeds on varied prey, where the bent bill is of no particular advantage.

APPENDIX 1 — Aquatic fauna in the Rakaia River study area. (N = 160 x 0.5 m<sup>2</sup>, each taken where Wrybills had foraged for ten minutes).

Animal Group	Life Form	Abundance		August-January		
		Average numbers per m <sup>2</sup>	Average dry weight per animal (mg)	Weight range of animals (mg)	Number weighed	Average dry weight per m <sup>2</sup> (mg)
<hr/>						
OLIGOCHAETA						
Lumbricidae						
<i>Eiseniella tetraedra</i>	adult	0.12	1.2	0.8 - 1.9	3	0.1
<hr/>						
INSECTA						
Ephemeroptera						
<i>Deleatidium</i> sp.	eggs	x100	?	-	-	?
	larvae	85.00	2.1	0.1 - 6.8	500	178.5
	imagos & sub-imagos	0.52	2.5	2.4 - 2.8	12	1.3
Plecoptera						
<i>Aucklandobius</i> sp.	larvae	0.63	1.1	0.3 - 2.3	25	0.7
Neuroptera						
<i>Archichauliodes diversum</i>	larvae	0.20	35	27 - 42	20	7.0
Trichoptera						
Hydrobiosinae & Hydropsychidae	larvae	14.88	7.5	0.2 - 18.0	210	111.6
	pupae	2.00	1.8	?	5	3.6
<hr/>						
PISCES						
<i>Gobiomorphus cotidianus</i>	eggs	10	0.3	?	100	3.0
<hr/>						
TOTAL FAUNA						305.8

APPENDIX 2 — Aquatic fauna in the Cass River study area. (N = 70 x 0.5 m<sup>2</sup>, each taken where Wrybills had foraged for ten minutes).

Animal Group	Life Form	Average numbers per m <sup>2</sup>	Average dry weight per animal (mg)	Weight range of animals	Number weighed	Average dry weight per m <sup>2</sup> (mg)
TURBELLARIA						
Tricladida						
<i>Dugesia montana</i>	adult	0.11	2.3	-	2	0.3
OLIGOCHAETA						
Lumbricidae						
<i>Eiseniella tetraedra</i>	adult	0.29	5.0	3.2-6.0	8	1.5
HIRUDINEA						
Glossiphoniidae						
<i>Glossiphonia heteroclita</i>	adult	0.14	3.1	?	4	0.4
GASTROPODA						
<i>Potamopyrgus antipodarum</i>	adult	0.26	1.3	0.5-1.5	17	0.3
INSECTA						
Ephemeroptera	eggs	x 100	?			
<i>Deleatidium</i> sp.	larvae	176.01	2.9	0.1-7.2	500	510.4
	imagos & sub-imagos	0.37	2.5	2.1-2.7	17	0.9
<i>Nesameletus</i> sp.	larvae	0.08	7.1	4.5-12.1	3	0.6
Plecoptera						
<i>Aucklandobius</i> sp.	larvae	0.37	1.3	0.5-1.7	11	0.5
<i>Stenoperla prasina</i>	larvae	0.11	52.0	43.6-60.4	4	5.7
Hymenoptera						
<i>Salix</i> sp.	adult	0.08	1.5	1.3-1.6	4	0.1
Coleoptera						
<i>Hydora</i> sp.	adult	0.91	2.1	1.5-3.1	20	1.9
Trichoptera						
Leptoceridae & Sericostomatidae	larvae	560.00	0.7	0.1-3.9	300	390.32 <sup>1</sup>
Hydrobiosinae & Hydropsychidae	larvae	25.11	7.5	1.5-24.0	110	188.3
Diptera						
<i>Australosimulium</i> sp.	larvae	0.37	0.5	?	11	0.2
Tipulidae	pupae	6.11	1.5	?	24	9.2
PISCES						
<i>Gobiomorphus breviceps</i>	eggs	40	0.3	?	100	12.0
	fish	0.23	35.0	25.0-47.5	4	8.1
TOTAL FAUNA						1130.7

<sup>1</sup> Excludes larval cases

# APPENDIX 3 — Shingle-bank fauna in the Rakaia River study area.

Animal Group	Abundance											
	August N=100 m <sup>2</sup>				October - November N=140 m <sup>2</sup>				December - January N 105 m <sup>2</sup>			
	Average Nos per m <sup>2</sup>	Average dry weight per animal (mg)	Number weigh- ed	Average dry weight per m <sup>2</sup> (mg)	Average Nos per m <sup>2</sup>	Average dry weight per animal (mg)	Number weigh- ed	Average dry weight per m <sup>2</sup> (mg)	Average Nos per m <sup>2</sup>	Average dry weight per animal (mg)	Number weigh- ed	Average dry weight per m <sup>2</sup> (mg)
ARACHNIDA												
Araneida 2-3 spp.	.17	18.0	10	3.1	.13	31.0	25	4.0	.22	28.4	12	6.2
Acarina 1 sp.	.10	1.0	4	0.1	0	-	-	0	0	-	-	0
INSECTA												
Ephemeroptera												
<i>Deleatidium</i> sp.	0	-	-	0	.14	2.6	10	0.4	.10	2.1	20	0.2
Dermaptera												
<i>Forficula auricularia</i>	0	-	-	0	.10	1.6	4	0.2	0	-	-	0
Hemiptera												
Cicadidae	0	-	-	0	0	-	-	0	.04	52.5	2	2.1
Lepidoptera												
2-3 spp	0	-	-	0	.10	6.3	5	0.6	.04	5.0	5	0.2
Hymenoptera												
Formicidae	.04	0.5	5	<0.1	.12	0.5	10	0.1	0	-	-	0
Coleoptera												
Carabidae	.37	5.6	20	2.1	.65	5.9	30	3.8	.44	5.5	10	2.4
Trichoptera												
Hydrobiosinae	0	-	-	0	.02	3.0	5	0.1	-	-	-	-
Diptera												
<i>Australosimulium</i> sp.	.02	<1.0	2	<0.1	.11	<1.0	5	0.1	.14	0.3	10	<0.1
Therevidae												
<i>Anabarhynchus</i>	0	-	-	0	.05	26.5	2	1.3	.46	24.0	20	11.0
Tachinidae &												
Muscidae	0	-	-	0	.10	4.8	5	0.5	.10	4.3	15	0.4
TOTAL FAUNA	.70			5.4	1.52			11.1	1.54			22.5

APPENDIX 4 — Water-edge fauna in the Rakaia River study area.

Animal Group	Abundance											
	August N = 50 m <sup>2</sup>				October - November N = 65 m <sup>2</sup>				December-January N = 45 m <sup>2</sup>			
	Average age Nos. per m <sup>2</sup>	Average dry weight per animal (mg)	Number weighed	Average dry weight per m <sup>2</sup> (mg)	Average age Nos. per m	Average dry weight per animal (mg)	Number weighed	Average dry weight per m <sup>2</sup> (mg)	Average age Nos. per m <sup>2</sup>	Average dry weight per animal (mg)	Number weighed	Average dry weight per m <sup>2</sup> (mg)
OLIGOCHAETA												
Tubificidae	0	-	-	0	0	-	-	0	.04	1.3	3	0.1
INSECTA												
Ephemeroptera												
<i>Deleatidium</i> sp.	.30	2.4	10	0.7	.40	1.9	20	0.8	.62	1.5	18	0.9
Hemiptera												
Saldidae & Pentamidae	0	-	-	0	.52	1.4	10	0.7	1.40	1.1	15	1.5
Lepidoptera 2-3 spp.	.16	2.9	6	0.5	.19	7.1	10	1.4	.11	6.9	10	0.8
Hymenoptera												
<i>Salix</i> sp.	0	-	-	0	.38	1.5	4	0.6	.09	1.6	5	0.1
Coleoptera												
Carabidae	.06	5.6	1	0.3	0	-	-	0	.04	5.9	1	0.2
<i>Hydora</i> sp.	0	-	-	0	.17	1.7	5	0.3	.31	1.3	5	0.4
Trichoptera												
Hydrobiosinae	0	-	-	0	0	-	-	0	.07	1.3	4	0.1
Diptera												
<i>Australosimulium</i> sp	.18	<0.5	3	0.1	.95	0.4	10	0.4	1.00	0.4	10	0.4
Tachinidae & Muscidae	0	-	-	0	.62	3.2	10	2.0	.80	4.5	10	3.6
TOTAL FAUNA	.70			1.6	3.23			6.2	4.48			8.1



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## AUSTRALIAN PELICANS IN FIJI — A NEW BIRD RECORD

During 1978, Fiji experienced a minor invasion of Australian Pelicans (*Pelecanus conspicillatus*), a species not recorded there previously.

In August 1978, Litiana Senilaci photographed a pair of pelicans just off the mangrove-bound shore of Moturiki Island, which lies off the south-west coast of Ovalau. These photographs are now in the Fiji Museum. A group of several more pelicans was also seen there but not photographed.

On 7 October 1978, Albert Threadingham and Barry Lee observed a pair of pelicans swimming in coastal waters off Verata Point, south-east Viti Levu. Mr Threadingham is familiar with the species in Australia and is positive of his identification. These pelicans could quite possibly be the pair observed earlier at Moturiki.

A photograph and article in the *Fiji Times* of 14 October 1978 further confirmed the presence of these pelicans in Fiji waters, a Fijian illegally shooting a pelican from a rock off the Malau coast of northern Vanua Levu. The bird was unfortunately not preserved. According to its killer it had been in the area for some six months. The same newspaper article quoted Robin Mercer as saying he had been told of a pelican in the Lau Islands of eastern Fiji several months earlier.

By year's end, Osea Kaloumaira of Moturiki reported that two pelicans were still present off the mouth of the Waidalice River on the east coast of Viti Levu, these probably being of the same group as those seen earlier at Moturiki.

FERGUS CLUNIE, *Fiji Museum, Suva, Fiji.*



## FERNBIRD DUETTING WITH SPOTLESS CRAKE

By a Hawkes Bay farm lake in December 1977 my husband and I stopped to photograph Spotless Crake (*Porzana tabuensis plumbea*) and, opposite a tunnel in the raupo, started to play the taped crake calls. Immediately two Fernbirds (*Bowdleria punctata*) appeared. They duetted together and went through their whole repertoire, their bodies vibrating as they gave the "ticking" call.

When I played the Crake's single *pit* note, a Crake answered, which really excited one of the Fernbirds which sat beside me, reared itself up and duetted with the Spotless Crake! Fortunately, I was able to tape this. The sequence began with the Crake's *pit, pit, pit* reply to the tape followed by the *U-tick* of the Fernbird; then the Crake's *pit*, then the Fernbird's *U-tick*; then the Fernbird's *U* and the Crake's *pit*, and so on. At times, the *pit* of the Crake coincided with the *tick* of the Fernbird's *U-tick*.

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# BREEDING OF THE CAPE PIGEON (*Daption capense*) AT THE SNARES ISLANDS\*

By P. M. SAGAR

## ABSTRACT

Large numbers of Cape Pigeons (*Daption capense*) breed at the Snares Islands. Egg laying occurs in the second week of November and is probably synchronous. Both adults incubate the single white egg. Hatching occurs from the third week in December to the first week in January. Chicks are brooded continuously for up to 10 days and guarded for up to 15 days after hatching. Weight increases until the chicks reach mean adult weight about three weeks after hatching. Adults continue to feed chicks until they fledge, from 47 to 57 days after hatching. The colonies are then deserted for a period while adults moult at sea. The birds remain around the islands throughout the year. There was no evidence of predation during breeding. Exposure of nest site to wind and rain affected breeding success. Band recoveries suggest a strong nest site attachment from year to year.

## INTRODUCTION

The Cape Pigeon is a medium sized fulmarine petrel with a distinctive black and white pattern on its upper parts (Fig. 1). It has a circumpolar distribution and breeds on mainland Antarctica and many Antarctic and Subantarctic islands (Watson 1975). New Zealand breeding populations on the Antipodes, Bounty and Snares Islands are recognised as a distinct race, *Daption capense australe* (OSNZ, 1970).

The annual cycle and breeding biology of the southern race have been described from Signy Island (67°40'S 45°38'E), South Orkney Islands by Pinder (1966) and Beck (1969, 1970) and from Adelie Land (67°S 139°E), on mainland Antarctica by Prevost & Mougin (1970). These are two of the southernmost breeding sites. This paper is based on observations made at the Snares Islands (48°02'S 166°36'E), one of the northernmost breeding sites, from 9 November 1976 to 3 March 1977.

## STUDY AREA AND METHODS

The Snares Islands are formed from granite with a gneissic structure (Fleming 1953). The group has precipitous cliffs with ledges and jumbles of rocks along most of its coastline.

An accessible Cape Pigeon colony (Fig. 2) was investigated on the north-west face of the North Promontory, North East Island

\* University of Canterbury Snares Islands Expeditions Paper No. 36

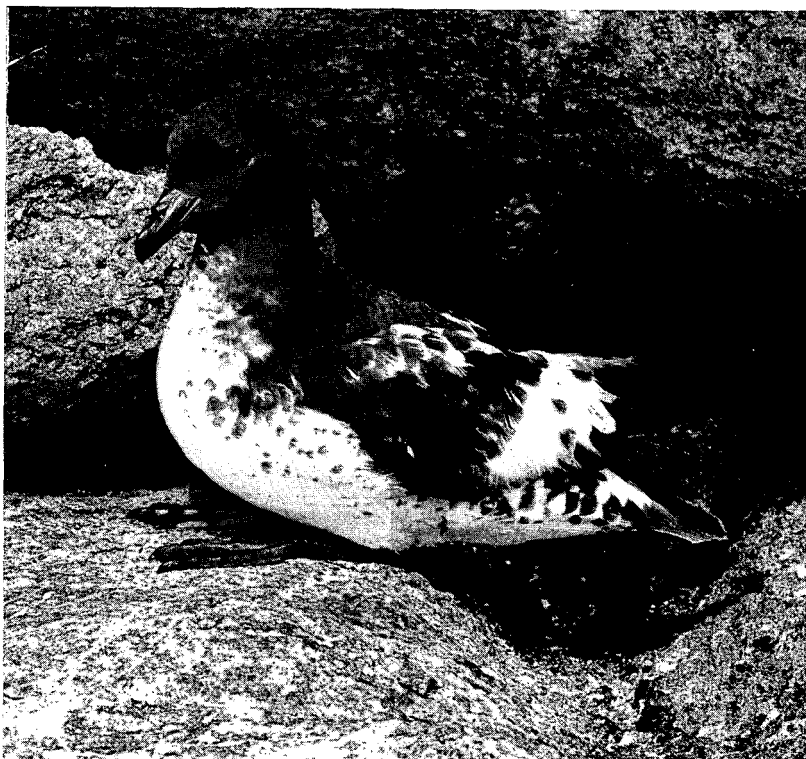


FIGURE 1 — Adult Cape Pigeon (*Daption capense*). Photo: P. M. Sagar

(Fig. 3). Access to all nests on the cliff face was possible, enabling a range of nest sites to be studied. G. J. Wilson (Zoology Department, University of Canterbury) and H. A. Best (Wildlife Service, Department of Internal Affairs) began some work on part of this colony in 1970-71 and 1974-75 respectively and their observations, incorporated in this paper, are gratefully acknowledged.

Thirty-six nests were marked with numbered metal squares placed under rocks adjacent to each nest. From 20 November 1976 to 20 February 1977 these nests were monitored at three-day intervals during the incubation and chick stages and daily during the hatching and fledging periods.

Two spring balances with capacities of 200 and 1000 g (accuracy  $\pm 5$  g) were used to weigh eggs, chicks and adults. Measurements were made with vernier calipers (accuracy  $\pm 0.1$  mm). Feeding data were obtained after the guard period (by which time chicks had become used to being handled) by weighing the chicks upon my

arrival at the colony. Chicks fed during my visit were reweighed. Chicks ejected small amounts (up to 10 ml) of oil and food material on occasions. Adults were not handled as they were liable to regurgitate large quantities of food material which would have been fed to the chick. The quantity of food fed to chicks was determined on 23 occasions. Three adult regurgitations were collected, preserved and analysed.

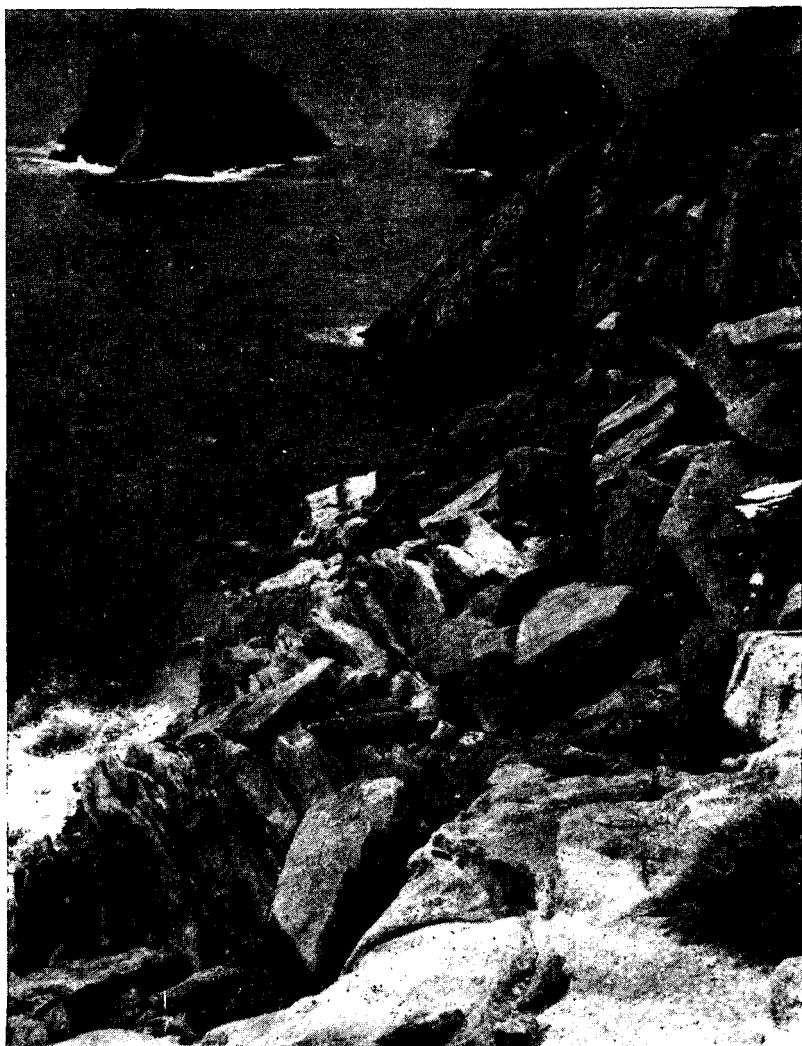


FIGURE 2 — Cape Pigeon study colony on the north-west face of the North Promontory, North East Island.

Photo: H. A. Best

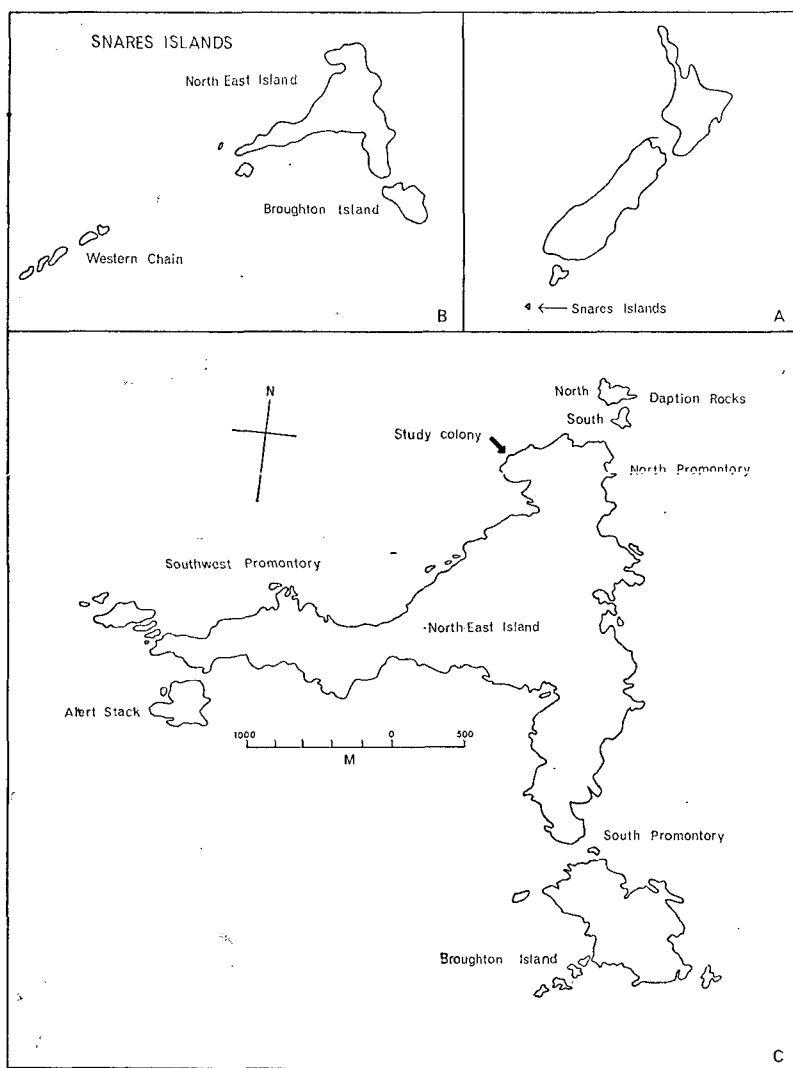


FIGURE 3 — Snares Islands, showing the location of place names mentioned in the text.

- A. New Zealand, showing the location of the Snares Islands.
- B. Snares Islands.
- C. North East Island, showing location of the study colony.

An unsexed adult from each of 10 nests was banded with a stainless steel leg band. All chicks were banded 30 days after hatching.

To avoid unnecessary disturbance to the colony standard measurements were obtained from 30 adults caught at sea, 50 m off North East Island on 2 February 1977.

## RESULTS

*Nesting habitat.* Rock ledges, crevices and jumbles of rocks on cliff faces were used extensively by Cape Pigeons at the Snares Islands. The most densely populated areas were the cliffs of the west coast of North East Island, the islets of the Western Chain, and North Daption Rock.

Nests on open ledges (17) and under rock overhangs (16) were used in the study colony. Three nests were in caves. Rock overhang and cave sites were more plentiful on the higher and less precipitous slopes of the cliff face (see Fig. 2). These higher nests were under jumbles of rocks surrounded by peat and *Poa astonii* tussock, about 50 m above sea level. Open ledges were used generally on the lower and more precipitous slopes of the cliff face, where they were the main sites available. The lowest nest was about 20 m above sea level.

Most nests were slight scrapes in granite fritter and peat washings, lined with granite chips and, especially in higher nests, *Poa astonii*. There was plenty of dead vegetation close to most of these higher scrapes. Bones of Buller's Mollymawk (*Diomedea bulleri*), Cape Pigeon, Sooty Shearwater (*Puffinus griseus*) and Fairy Prion (*Pachyptila turtur*) also have been found in Cape Pigeon nests (G. J. Wilson, pers. comm.).

On the sparsely vegetated Snares Western Chain, Fleming & Baker (1973) and Sagar (1977) reported only granite chips in Cape Pigeon nests. These observations indicate that Cape Pigeons build their nests only from materials at hand.

*Nest site retention.* Twenty-five breeding birds of unknown age were banded by G. J. Wilson in 1970-71. Nine of these were found breeding in 1976-77. At least three of these birds were using the same nest sites as in 1970-71, while at least two had changed to nearby nest sites. Three birds, banded as breeding adults by H. A. Best in 1974-75, were breeding at the same nest sites in 1976-77. None were found on different sites.

*Egg laying and the egg.* Cape Pigeons lay a single white egg. At the Snares Islands, the full egg-laying period has not been determined. Birds were found on eggs on 21 November 1974 (H. A. Best, pers. comm.) and 20 November 1976 (this study), the earliest visits made to the colony during breeding (no eggs were laid after 20 November 1976). However, by using the average incubation period of 45 days established by Prevost (1964) and Pinder (1966) and calculating back from the known hatching dates at the Snares, the egg-laying period was estimated as being from 7 to 20 November 1976 (mean 11 November).

Measurements of 36 eggs: 57.3-64.1 x 39.9-44.7 mm, mean 61.2 mm (s.d.  $\pm 1.85$ ) x 42.6 mm (s.d.  $\pm 1.20$ ). Weight of 36 eggs: range

48-67 g, mean 60 g (s.d.  $\pm 3.8$ ). These measurements are smaller than those reported from Signy Island (range 57-67 x 40-47 mm, 51-75 g; mean 62 x 43 mm, 62 g) by Pinder (1966) and from Adelie Land (range 60.0-67.0 x 41.0-45.8 mm, 55-75 g; mean 63.0 x 43.6 mm, 67 g) by Prevost and Mougou (1970). These data confirm the suggestion by Oliver (1955) that eggs of the New Zealand race are smaller than those of the southern race.

*Incubation and hatching.* Both adults incubate, but observations were not made frequently enough to determine shift lengths.

Hatching occurred between 22 December 1976 and 4 January 1977 (Fig. 4), with a mode of 24 December 1976. The time taken from the first pipping of the egg to its hatching varied from 2 to 5 days. Egg shell remains were left either in or to one side of the nest. The chick was protected continuously, by at least one adult for 8-15 days after hatching. After 8-10 days the chick was too large to be brooded and sat beside the parent at the nest (Fig. 5).

*Chick growth and development.* Weight records for 20 chicks have been given in Figure 6 and for six chicks in Figure 7. Growth rates were linear during the first 8-9 days, followed by a decrease in the rate of weight gain from 9-17 days. This corresponded to the period when chicks were first left unguarded at the nest and probably coincided with the start of homeothermy. Considerable fluctuations in body weights occurred after 18 days, but chicks overall gained steadily in weight. Chicks reached mean adult weight about three weeks after hatching. The heaviest weights (up to 665 g) occurred 26 to 42 days after hatching. A gradual decrease to the mean fledging weight of 404 g followed.

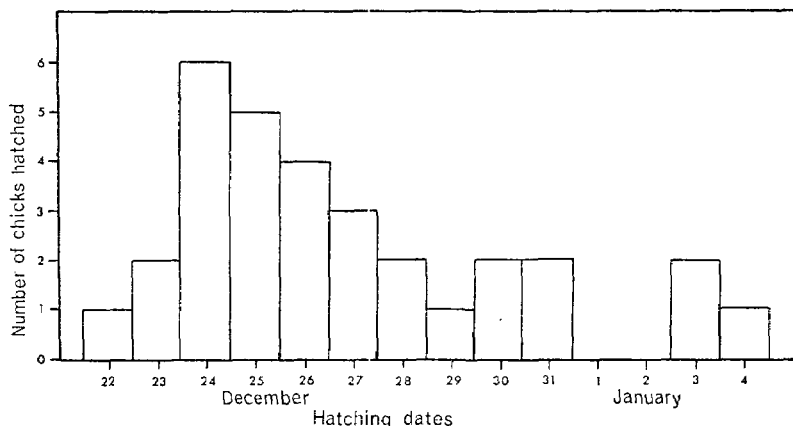


FIGURE 4 — Hatching dates for Cape Pigeons at the Snares Islands, 1976-77 (N = 31).





FIGURE 5 — Adult Cape Pigeon at nest with chick during the guard stage.

Photo: H. A. Best

Bill and tarsus lengths of 20 chicks were measured throughout the nestling period. Plotted data (Fig. 8) show that both bill and tarsus grew at a steady rate; 30 days after hatching, mean chick tarsal lengths were almost of adult size, while bill length of chicks reached mean adult size at about 45 days.

Initially chicks were covered with grey protoptyle down, except under the wings and about the base of the bill and eyes. From 10 days after hatching this was gradually replaced by mesoptyle down, dark grey dorsally and off-white on the breast and abdomen. Primary and secondary pins were visible about 10 days after hatching and these burst their sheaths at about 16 days. Tail pins were visible about 19 days after hatching. Down was lost as feathers appeared, until the chicks were fully feathered about 40 days after hatching. At this time the dark grey and white plumage of chicks was easily distinguished from the dark brown and white plumage of the adults, which by then had worn plumage.

*Food and feeding.* The hyperiid amphipods *Hyperia luzoni* and *Parathemisto gaudichaudii*, the euphausiid *Nictyphanes australis* and the decapod *Munida gregaria* were identified from three regurgitations taken from breeding adults at the colony.

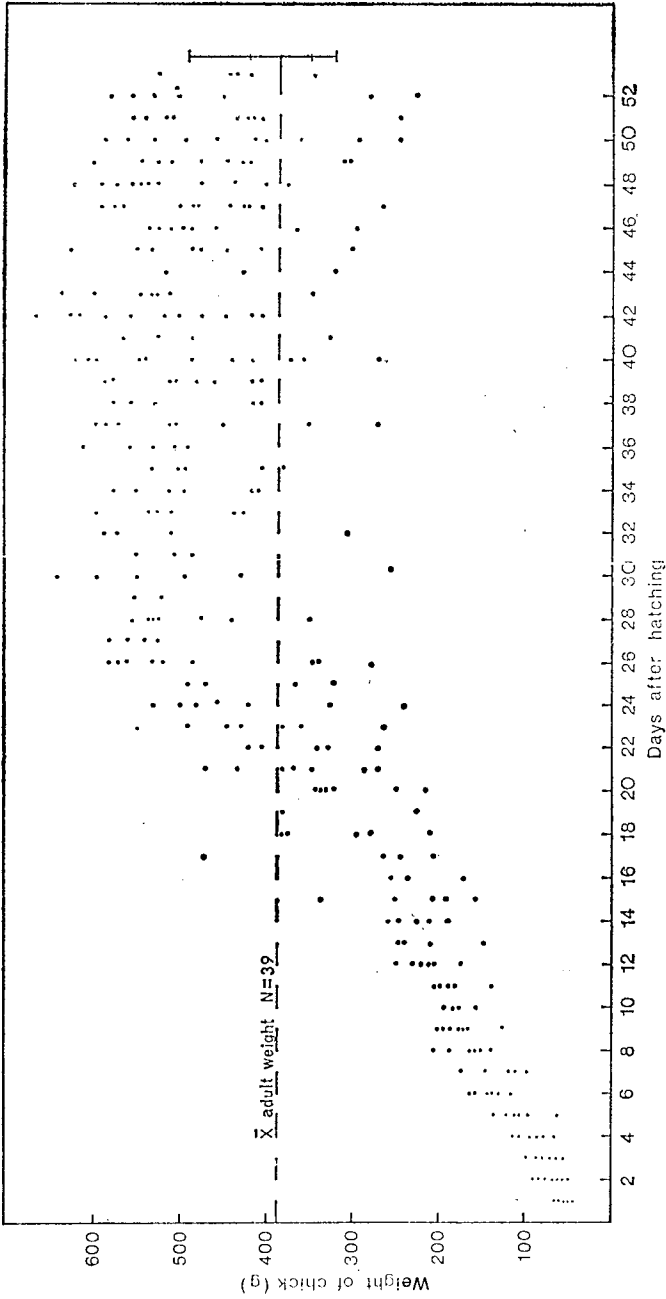


FIGURE 6 — Scattergram of weight records for 20 Cape Pigeon chicks.

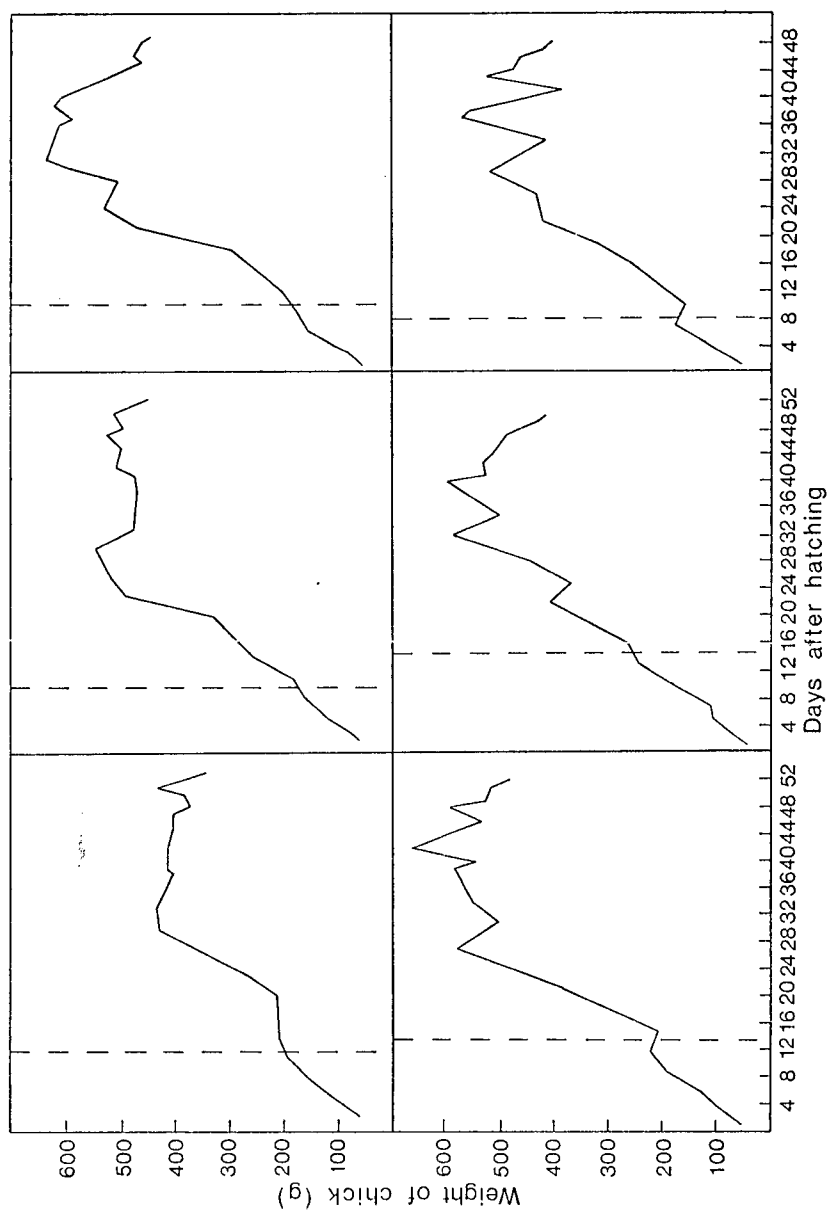


FIGURE 7 — Weight and age data for 6 individual Cape Pigeon chicks. The dashed line indicates the end of the guard period.

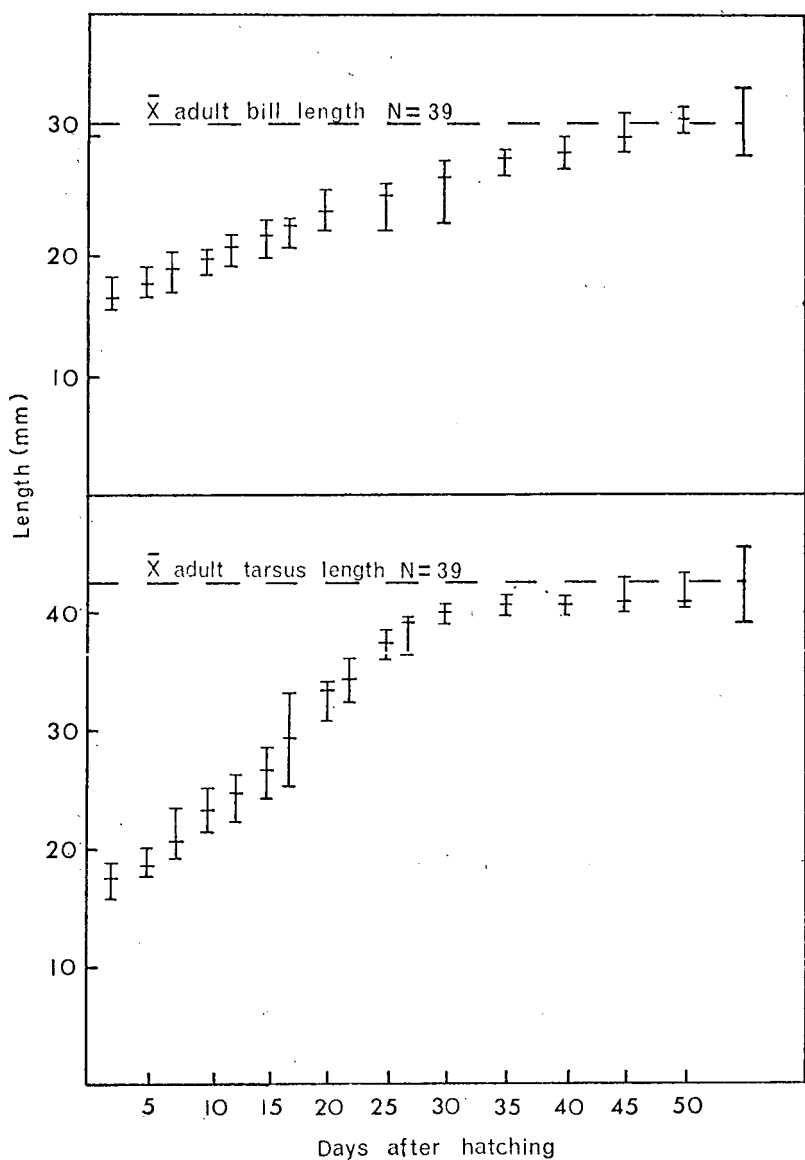


FIGURE 8 — Changes in bill and tarsus length with age for 20 Cape Pigeon chicks.

Chicks were fed at intervals throughout the day; no time preferences were recorded. Adults arriving at the colony to feed chicks appeared to have difficulty landing, making several low approaches over the colony before trying to land near the nest. In windy conditions a bird sometimes made many passes over the nest and if unsuccessful glided down to the sea. Several minutes later the bird would return to the colony to attempt landing again.

On landing by the nest the adult moved in a shuffling gait to the chick and, while "clucking," pecked the chick lightly about the head. The chick responded by fencing its bill with that of its parent, and feeding would then begin. Adults stayed at the nest for 2-20 minutes. The chick frequently became somnolent after being fed and the adult either departed immediately or stopped to preen and doze.

Feeding techniques varied with the age of chicks. The cross-bill technique, described by Harper (1976), was used until chicks were about 40 days old, by which time their bills were almost fully grown. Older chicks usually fed by facing the adult and placing their bill directly into the adult's open gape.

Twenty-three weight increases (range 5-75 g, mean 54 g) were obtained from chicks 36 to 45 days old. Four records of only 5 g increases in weight were from chicks that responded poorly to stimulation from their parents and possibly indicated that the chicks were already satiated.

Nine small pieces of granite (largest 1 cm<sup>2</sup>) were found in the gizzard of a dead 34 day old chick. A food bolus measuring 10 x 50 mm and containing *Poa astonii* leaves and rootlets (60% by volume), feathers (15%), white rubbery organic material (15%) and unidentified (10%) was in the crop. All these materials could be found around the nest.

*Fledging.* Twenty chicks flew from their nest sites between 12 and 20 February 1977, 47-57 days after hatching. Six chicks were still unfledged from 24 nests on 19 February 1971 (G. J. Wilson, pers. comm.) and three chicks were still unfledged from 37 nests on 18 February 1975 (H. A. Best, pers. comm.). These data indicate that there was little variation in the timing of the breeding cycle in those three years.

Chicks exercised their wings several days before fledging. Most chicks from nests under rock overhangs and in caves moved out just before fledging and had to negotiate large rocks before being able to take off. After the young had left the colony no birds were seen there again that season, and few were seen immediately offshore.

*Mortality.* Thirty-one eggs (89%) hatched and 20 chicks (55.5%) fledged from the 36 nests studied. Of the remaining eggs, two disappeared, two failed to hatch and were found to be infertile, and one chick died after first pipping the eggshell. Eight chicks died

within 10 days of hatching and three chicks from 11 to 34 days after hatching.

One dead chick came from a nest which, although under a rock overhang, was dampened by water seeping from the rock face behind. The rest, however, were from nests on rock ledges, fully exposed to the prevailing north-west winds and rain. This included the chicks of seven of the ten pairs breeding on the open-ledge sites of the lower and more precipitous slopes of the colony.

In 1974-75 24 eggs (64.5%) hatched and 21 chicks (56.7%) fledged from the 37 nests observed (H. A. Best, pers. comm.).

### DISCUSSION

The timing of the breeding cycle of Cape Pigeons at the Snares Islands differs from those reported from other localities. The estimated egg laying period (mean 11 November) at the Snares Islands is 17 days earlier than that reported at Signy Island (mean 28 November) by Pinder (1966). In Adelie Land eggs are laid from 27 November to 9 December (Prevost & Mougín, 1970), while at Heard Island (53°06'S 73°30'E) the first eggs were reported on 26 November 1949 and 25 November 1950 (Downes, Ealey, Gwynn & Young, 1959). Thus birds in higher latitudes lay later than birds in lower latitudes. This has been shown also for the Southern Skua (*Catharacta skua lonnbergi*) by Young (1977).

This study indicates a fledging period of 47 to 57 days, similar to the mean of 49 days suggested by Pinder (1966) at Signy Island and the 45 to 50 days suggested by Prevost & Mougín (1970) at Adelie Land.

Cape Pigeons at the Snares Islands breed with timing as closely synchronised as birds breeding further south. Beck (1970) considered this to be related to food supply, synchronised breeding allowing time for a complete post-nuptial moult in the breeding area before food became scarce in the autumn. The exodus of birds from the colonies at the Snares Islands after breeding could have been associated with moult. Horning & Horning (1974) reported that there was no seasonal fluctuation in Cape Pigeon numbers at the Snares Islands, indicating that there was no post-breeding exodus. These observations show that despite the post-breeding exodus from the colonies, some birds are present close inshore throughout the year.

Warham (1968) reported that in the Procellariiformes, populations of larger adults lay larger eggs. Cape Pigeons from Adelie Land are heavier than those from the Snares Islands, with means of 472 g (Prevost & Mougín, 1970) and 385 g respectively. Therefore the smaller eggs of the Snares Island Cape Pigeons are probably associated with lower body weight and may also reflect further differences between the two races. Egg size in the Fairy Prion also decreases from south to north (Harper, 1976).

Regurgitated food consisted essentially of neritic species. Fenwick (in press) described the behaviour of Cape Pigeons feeding on a shoal of *Parathemisto gaudichaudii* off the Snares Islands and suggested that the occurrence of amphipod shoals could affect breeding success.

Weight changes of chicks near fledging (Fig. 7) show that they are still being fed despite their general decline in weight. Both Harper (1976) and Harris (1976) concluded that the decline in weight of Fairy Prions and Puffins (*Fratercula arctica*) respectively prior to fledging was due not to reduced feeding but rather to physiological changes and increased activity at the nest.

Although Southern Skuas bred to within 50 m of Cape Pigeon colonies at the Snares Islands, there was no evidence that they preyed upon Cape Pigeons. However, Pinder (1966) reported that Cape Pigeon eggs were common in Southern Skua middens at Signy Island. He also recorded indirect evidence for predation on chicks of all ages.

Nest site appears to be significant for the breeding success of Cape Pigeons. Birds with nests under rock overhangs and in caves are more successful than those using open ledges. Perhaps older, more experienced breeders establish their nests first and in more favourable sites than younger, less experienced breeders.

All banded adults from earlier seasons were nesting either under rock overhangs or in caves. Band recoveries suggest both a strong nest-site attachment and a low adult mortality. Even when the same nest site was not used, the same area was used. Pinder (1966) provided evidence for both a strong nest site attachment and a strong pair bond.

### ACKNOWLEDGEMENTS

The 1976-77 University of Canterbury Snares Islands Expedition was supported by a grant from the University Grants Committee. The Royal New Zealand Navy provided transport to the Snares Islands on the HMNZS *Taranaki* (Commander C. J. Carl), and F.V. *Sapphire* (Mr I. Leask) returned us to Bluff. Their help and interest in this expedition were most appreciated. I thank H. A. Best, Dr L. H. Field, Dr D. S. Horning and G. J. Wilson for constructively criticising the manuscript. G. D. Fenwick kindly identified the invertebrate food species.

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## SHORT NOTE

### NEW ZEALAND DOTTERELS CATCHING FISH

On a visit to Opoutere, eastern Coromandel Peninsula, on 6 February 1978, I spent some time watching a group of New Zealand Dotterels (*Charadrius obscurus*) feeding on the harbour flats at low tide. My interest quickened when I saw one of them flip over an empty shell with a sideways flick of its bill. After examining the spot thus bared and finding nothing of interest, the bird moved on to another shell where it stopped, cocked its head and seemed to listen intently. The shell was then flipped over in the same way as before, this time revealing a small 'cockabully' (*Forsterygion sp. varium?*). These little fish commonly spend low tide 'high and dry' below the single valves, concave side down, of such molluscan species as the Pipi (*Paphies australis*), Common Cockle (*Chione stutchburyi*) and the Wedge Shell (*Tellina liliana*).

The dotterel made a quick stab at the fish, then stepped back smartly as though afraid of it as it leaped about. After a short wait the bird stabbed again, then twice more. The fish was then taken in the bill and battered on the ground a few times before being swallowed whole, head first.

During the hour or so that I watched this bird it fed almost entirely in this way, catching and eating four fish. Three more of the twelve New Zealand Dotterels present were seen to catch fish in the same manner.

P. C. M. LATHAM, c/o Papamoa Beach P.O., via Te Puke, Bay of Plenty



# DISTRIBUTION OF THE CAPE PIGEON IN THE TASMAN SEA AND SOUTH-WEST PACIFIC

By NEIL CHESHIRE, JOHN JENKINS and PETER NESFIELD

## ABSTRACT

Observations of the Cape Pigeon (*Daption capense*) have been made during 16 years in the Tasman Sea and in New Zealand coastal waters, and for three years between New Zealand, Fiji, Tonga and Norfolk Island. Abundance and seasonal distribution have been plotted on four charts and a transect diagram. The relationship of abundance and distribution in the Tasman Sea and New Zealand is shown on three graphs. Between November and June (hydrological summer and autumn), few birds were recorded but during the rest of the year Cape Pigeons were widespread and abundant, even as far north as 24°S in September.

## INTRODUCTION

The Cape Pigeon (*Daption capense*) is one of the most familiar birds to seafarers in the southern oceans. It is an habitual follower of ships and is easily identified by the distinctive pattern of its black and white plumage. Records of its occurrence have been kept for many voyages in merchant ships on the New Zealand coast and trans-Tasman between 1959 and mid-1976. Good coverage has been obtained for all months in the Tasman and in New Zealand coastal waters. The area to the north of New Zealand toward Fiji, Tonga and Norfolk Island has been well covered during the four years from 1972 to 1976, many return voyages being plotted for each month.

Where possible the birds were counted three times each day, in the morning at 0800, at noon and around 1600 hours. When any peak in numbers was noticed outside these hours it was recorded. Since the Cape Pigeon is a faithful ship follower, no attempt was made to record by unit time or unit distance. It is rare to see a Cape Pigeon appear ahead of the ship even though quite large numbers may be following. They seem to join the ship by flying up the wake. Therefore the technique of recording birds appearing ahead of the ship was not practicable. Although it is known that *D. c. capense* and *D. c. australe* both occur in the area (Bartle 1974), it was found impracticable to separate the two under our conditions for observation. Therefore, any different patterns of dispersal that may occur in the two subspecies will be masked in our observations.

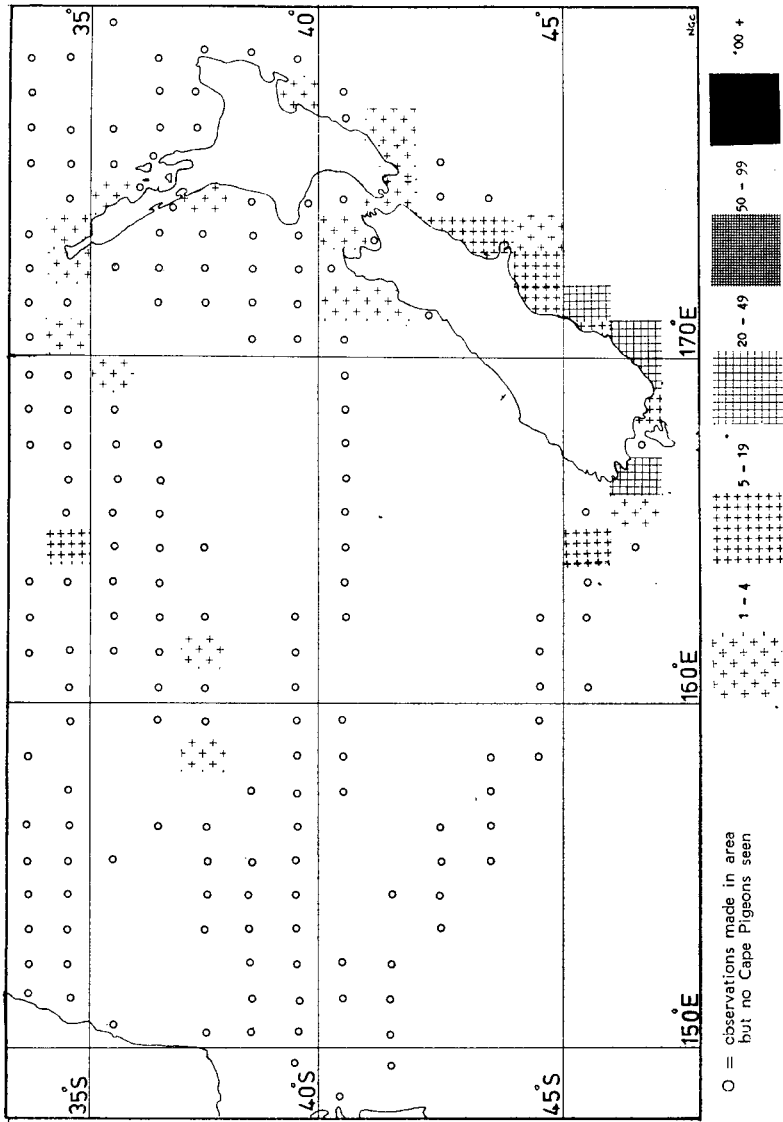


FIGURE 1 — Distribution of Cape Pigeon. December to March.

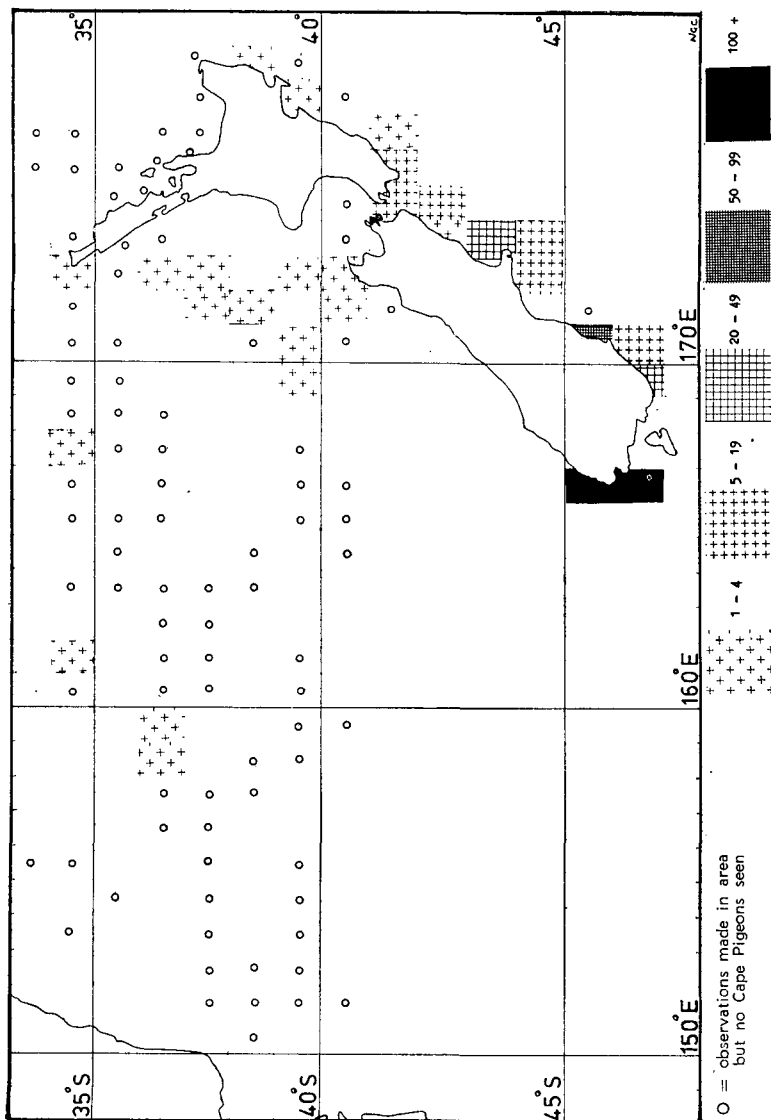


FIGURE 2 — Distribution of Cape Pigeon. April and May.

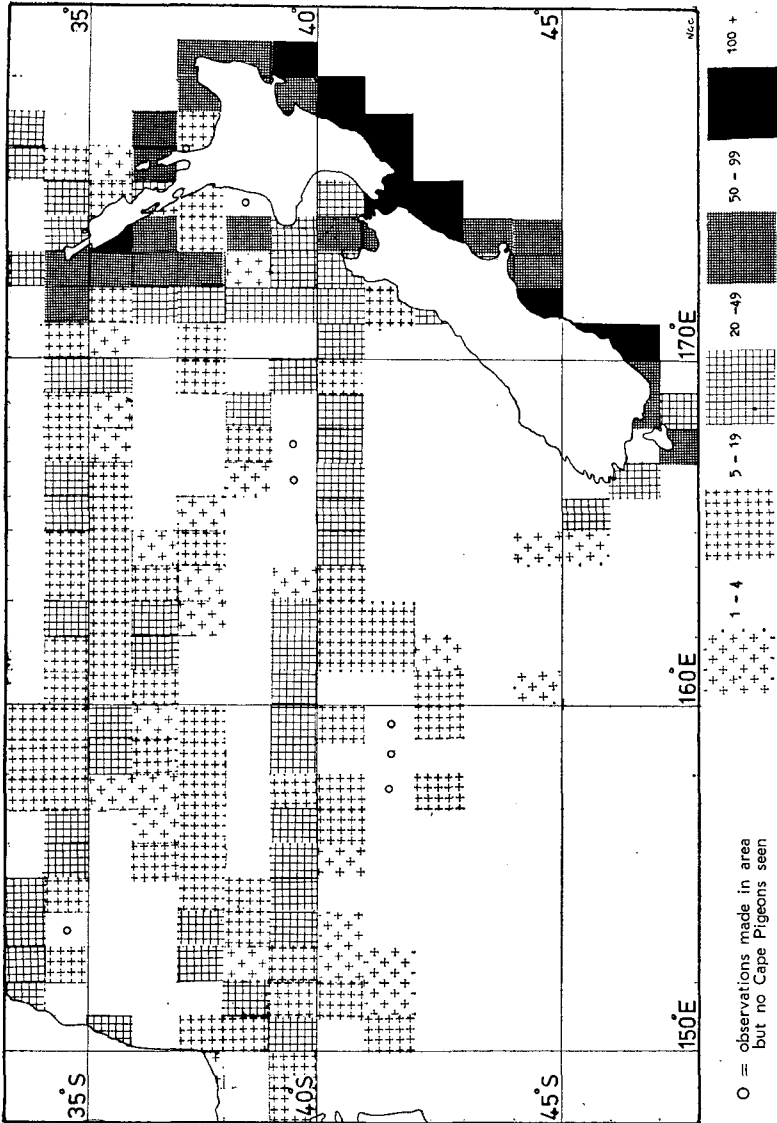


FIGURE 3 — Distribution of Cape Pigeon. June to October.

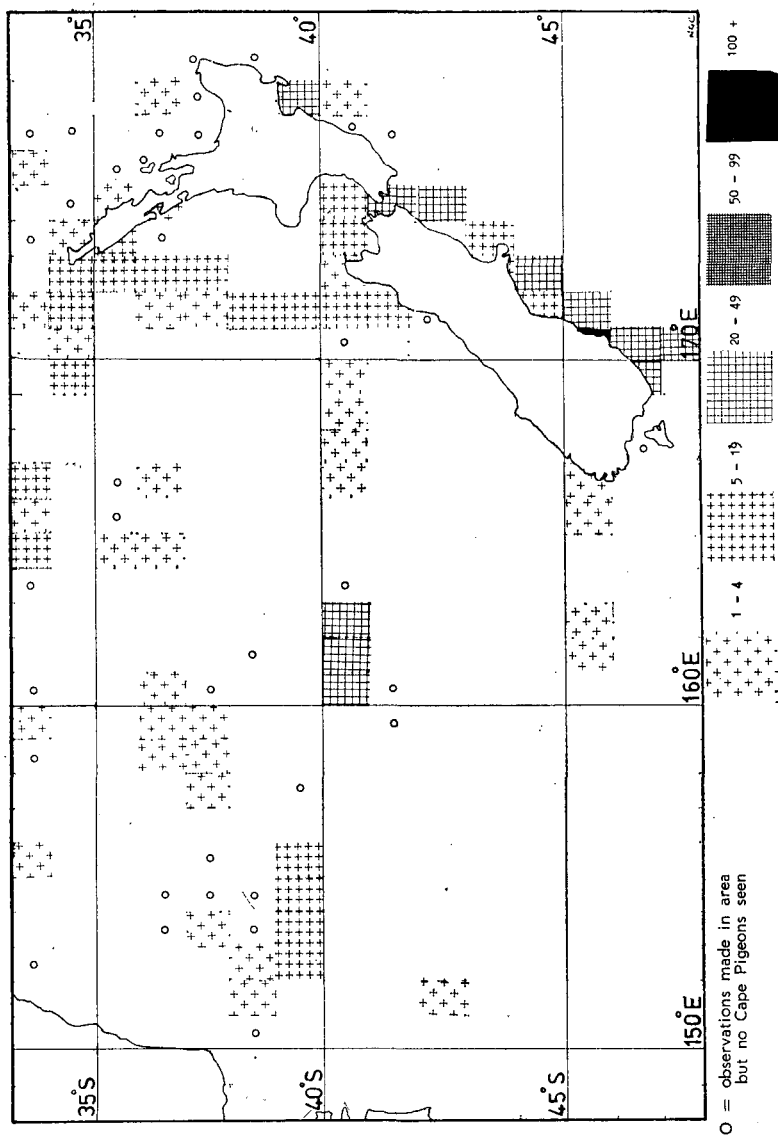


FIGURE 4 — Distribution of Cape Pigeon. November.

The records for the Tasman Sea and New Zealand coast were plotted on monthly charts for each 1° area of latitude and longitude. The numbers plotted indicate the maximum count obtained in any one degree area, at any instant. They do not represent a cumulative count or the total number of birds in the area. The monthly plots have been summarised into four periods during which there was little change in abundance and distribution (Fig. 1-4). The charts have some gaps as there are a number of 1° areas which we have not visited or have crossed at night. However, they do indicate the presence or absence of Cape Pigeons and give a reasonable indication of their relative numbers throughout the year.

In Figure 5, percentage distribution and average numbers per month are shown on three graphs covering the Tasman Sea 150° - 160°E, 160° - 170°E and New Zealand coastal waters. It should be remembered that these graphs cover a wide latitudinal range from 33°S to 48°S and should be used in conjunction with Figures 1-4.

#### DISTRIBUTION AND ABUNDANCE

*December to March.* In the western Tasman (150-160°E) single birds have been sighted in December, but from January until May no Cape Pigeons were seen. In the central Tasman (160-170°E) small numbers persist during December and through until February. There is an absence of birds here during March and April. In New Zealand coastal waters small numbers of birds remain throughout the summer months. Single birds have been seen as far north as North Cape (34° 20' S) during December. In the same month up to 30 birds have been seen off Otago and in western Foveaux Strait. These summer records off the east coast of the South Island may be related to fishing boat activity and the relative proximity of the breeding islands. Minimum distribution and numbers occurred during January and for this month we have no records north of Kaikoura (42° 25' S).

*April and May.* There is a complete absence of Cape Pigeons in the western Tasman. In the central Tasman a few birds (max. recorded 4) begin to reappear. South Island coastal waters show a considerable increase in distribution and numbers but even during May the birds are very scarce north of Cook Strait.

*June to October.* In the western Tasman there is a considerable expansion in range during June, birds being recorded in 70% of 1° areas compared with none during May. The actual number of birds remains low. Maximum 100% distribution is achieved in September with peak numbers in August.

In the central Tasman maximum 100% distribution was achieved in August with peak numbers in September.

Further east, in New Zealand coastal waters, there is also a wider distribution during June and again the number of birds reaches a maximum during August and September. From the graph (Fig. 5)

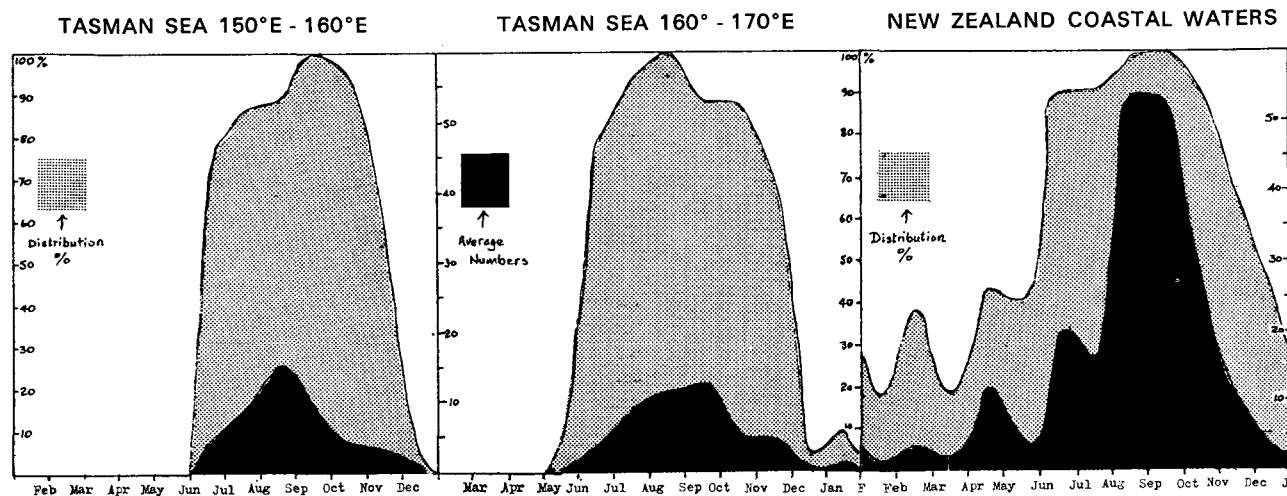


FIGURE 5 — Summary of monthly distribution and numbers of the Cape Pigeon.

$$\text{Distribution \%} = \frac{\text{Number of } 1^{\circ} \text{ areas where Cape Pigeons observed} \times 100}{\text{Total number of } 1^{\circ} \text{ areas in which observations made.}}$$

$$\text{Average numbers} = \frac{\text{Sum of maximum counts for all } 1^{\circ} \text{ areas.}}{\text{Total number of } 1^{\circ} \text{ areas in which observations made (incl. nil areas)}}$$

it can be seen that the actual numbers of birds recorded are much higher in New Zealand coastal waters than in the Tasman Sea. The maximum density of birds occurs in Cook Strait and off the east coast of the South Island and east coast of the North Island south of East Cape. Observations of large numbers include one on 6 September 1974 in eastern Cook Strait at 41°40'S 175°15'E when at least 300 Cape Pigeons were following the vessel. Off the west coast of Northland up to 100+ birds have been seen, yet to the east of Northland numbers are relatively low.

*November* is the month of transition. There is a marked decrease in abundance right across the Tasman Sea and in New Zealand coastal waters.

#### *Observations between New Zealand and Pacific Islands*

To illustrate the northward extension of the Cape Pigeons' range in this area, monthly latitudinal distribution has been shown by means of a transect diagram (Fig. 6, after Fowler 1973). The longitudinal limits of the diagram are 170°E to 175°W (15° of longitude).

Maximum northward extension of range occurs in September and on 17 September 1973 a Cape Pigeon was sighted six miles west from Cape Washington, Kadavu, Fiji (19°05'S 177°52'E). Also, on 16 September 1973, three birds were seen at 20°05'S 177°23'E, being 60 miles SSW from Kadavu. The sea surface temperature at the northernmost limit on 17 September 1973 was 25°C. Where there are cold north-flowing currents such as the Humboldt off the west coast of South America and the Benguela off South-west Africa, Cape Pigeons are recorded north to the equatorial regions.

Of particular interest are the quite large numbers of birds seen well to the north of New Zealand in September: 50+ birds to 29°13'S and 30+ to 24°08'S. The northward distribution of Cape Pigeons in the Tasman Sea in winter was noted by Summerhayes (1969), who also summarised earlier records.

#### AUTHORS' NOTE

This report was drafted in 1976. It is based on original material and is an attempt to present information collected by the authors between 1959 and 1976 and helped to a small extent by fellow seafarers. The number of references to Cape Pigeons in the South-west Pacific is legion; although we have taken them into consideration, we have not listed them because in most instances they concern single voyages or even isolated observations. Accordingly, they can have little effect on the interpretation of the observations which we have ourselves made on many voyages at all seasons.

Subsequent records are being lodged with the Australasian Seabird Mapping Scheme.



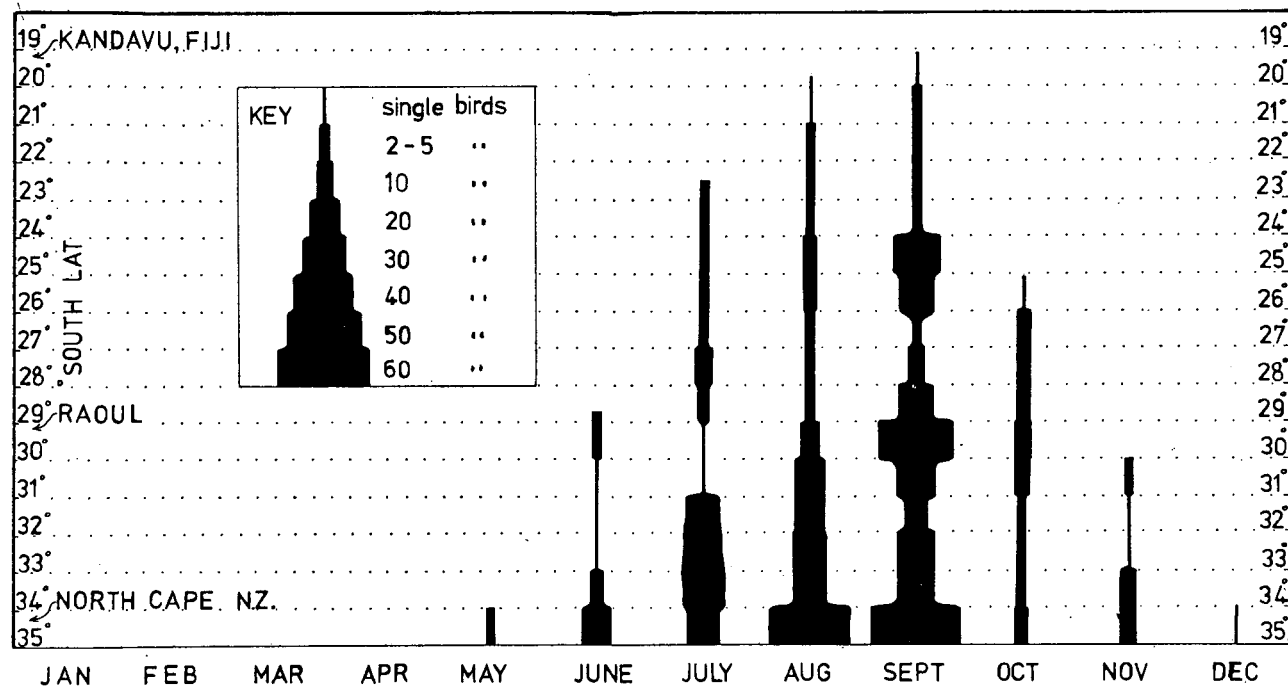


FIGURE 6 — Latitudinal distribution and abundance of the Cape Pigeon between New Zealand and Pacific Islands. Longitudinal limits, 170°E to 175°W (15° longitude).

## ACKNOWLEDGEMENTS

We should like to thank our seafaring colleagues Derek Smith and Rod Grout for providing extra material. Our mentor throughout this project, R. B. Sibson of Auckland, is sincerely thanked for his continuing assistance with our seabird recording.

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NEIL CHESHIRE, 140 Glamorgan Drive, Torbay, Auckland; JOHN JENKINS, 14 Lochiel Road, Remuera, Auckland; PETER NESFIELD, 8 Opuia Street, Belmont, Auckland.



## SHORT NOTES

## WHITE-FACED HERONS ON CHATHAM ISLAND

On 9 January 1978, while in the south-west of Chatham Island with David Crockett's successful 'Taiko' Expedition, my husband and I were traversing the coast from just north of the Little Awatotara Creek to north of the Durham Point area. While high on a bluff, we saw a White-faced Heron (*Ardea novaehollandiae*) fly out from a ledge below us, and we saw a nest.

The nest, some 10 m above sea-level, was in a small cleft. It contained a few pieces of driftwood and seaweed, and two sky-blue eggs. The rock face below was white with droppings.

On 21 January we revisited the site and flushed the bird — two eggs; and twice on the 29th — one chick and one egg. As we then had to leave the island no further observations were possible.

Could it be that this site was chosen because of the complete lack of trees more than 3 m high within a 1500 m radius?

AUDREY GORDON, 4 Lewis Street, Kamo, Northland.



## AN INTERESTING BAND RECOVERY

On 21 April 1978, I found a juvenile New Zealand Black-browed Mollymawk (*Diomedea melanophris impavida*) carrying a New Zealand band No. 22519, about 3 km north of Himitungi, on the Wellington west coast. The bird, which had probably died within 24 hours, had been banded by the Campbell Island meteorological party only seven days earlier, in its nest on Bull Rock, Campbell Island — 1470 km away.

HUGH A. ROBERTSON, No. 1 R.D., Aokautere Drive, Palmerston Nth.

# NOTES ON THE BEHAVIOUR OF VARIABLE OYSTERCATCHERS

By ALAN JONES

## INTRODUCTION

Buffalo Beach is a sandy beach exposed to the open sea, extending about 3 km northward from the narrow entrance to Whitianga Harbour, where the township of Whitianga is situated, to the settlements of Brophy's Beach and Ohuka Beach. The central 2 km are backed by a narrow belt of low sand dunes which separate the beach from the main road. At the mid-point of the beach are a small estuary and lagoon at the mouth of Taputapuatea Stream, known locally as Mother Brown's Creek (Fig. 1).

On the beach, large beds of the bivalve Tuatua (*Paphies subtriangulata*) extend from below low-tide mark to about half-tide mark; as the tide falls, live tuatuas are often exposed. Small green mussels, about 50 mm long, and larger green mussels attached to seaweed debris, are often washed up on the beach. These molluscs provide regular food for the Black-backed Gulls (*Larus dominicanus*), Red-billed Gulls (*L. novaehollandiae*) and Variable Oystercatchers (*Haematopus unicolor*) which frequent the beach.

A small population of Variable Oystercatchers, varying from 5 to 15, often accompanied by one or two South Island Pied Oystercatchers (*H. ostralegus finschi*), regularly occupies the lower part of Whitianga Harbour and the southern part of Buffalo Beach to a boundary about 800 m south of Mother Brown's Creek (Fig. 1). Two pairs of Variable Oystercatchers live and breed at the Ohuka Beach end and the central beach, at present occupied by two pairs, was from before 1969 up to December 1974 occupied by one pair whose territorial centre was the mouth of Mother Brown's Creek.

I named these birds Darby and Joan as they had been together so long. Joan's left leg was twisted inwards, causing her to limp, and she had a small smudge of white near her left leg. Darby was fully black. The following notes refer mostly to incidents I watched during many beach patrols on Buffalo Beach between June and December 1974. The names Darby and Joan are retained for simplicity. I could make no thorough study nor did I try to define the various calls and their function.

## TERRITORIAL AFFAIRS

During the period March to late June 1974, Darby was rather tolerant towards other oystercatchers on the beach to within about 200 m south of Mother Brown's Creek. As the breeding season approached, however, he would not tolerate them within 800 m to the north and 400 m to the south of Mother Brown's Creek.

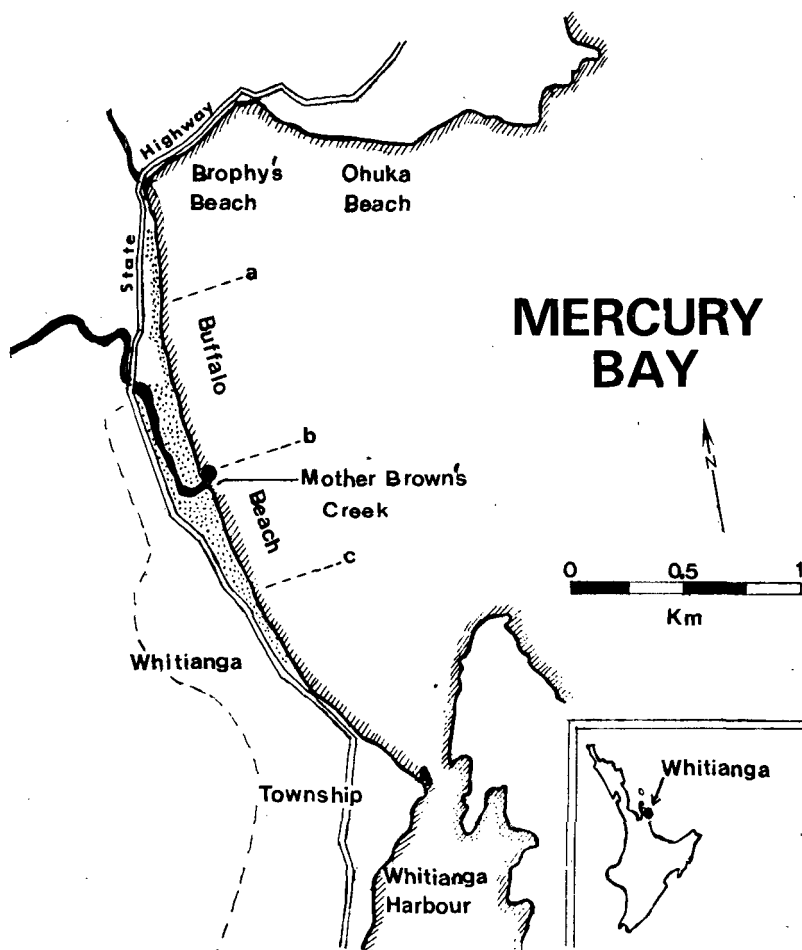


FIGURE 1 — Locality map. a: northern boundary; b: nesting site; c: southern boundary of Darby and Joan's territory. Stipple: recreation reserve (fore-dunes and/or grass).

In early June 1974, six of the Whitianga Harbour oystercatchers established themselves at the northern end of their Buffalo Beach territory (Fig. 1). As soon as they had arrived, Darby and Joan moved from their usual position on the northern side of Mother Brown's Creek to the southern side. They often visited the six, the encounters apparently friendly, with much head-tossing and the picking up and throwing away of sticks, seaweed and shell. However, if any of the six tried to cross the creek, Darby and Joan would sprint at them with

head down, beak open and held close to the ground, back feathers raised, accompanied by noisy piping. Joan was always on the left of and about a body-length behind Darby. I have seen this relative position of male and female in the territorial display of many pairs of Variable Oystercatcher on Buffalo Beach.

On one occasion (10 June), when one of the six approached the creek, Darby flew straight at it and soon they were striking each other with their beaks and at times Darby followed up his strike by jostling the other bird with his body until it fell over. The other five arrived and they all ran round and round anticlockwise, accompanied by noisy piping. A Black-backed Gull was attracted and stood as close as possible to the circle. The fight lasted 15 minutes and ended when the group returned to the harbour. Several days later, the group was back near its northern boundary.

On 13 June, a new pair of oystercatchers settled in on the beach about 200 m south of the creek. They were visited from time to time by Darby and Joan and there were the usual territorial displays. Once, when one of the birds came near the creek, Darby chased it to the water's edge and attacked it viciously, rolling it over and over in the water and then pecking it. After this attack, the intruding pair was not seen again.

On 23 October, a single bird challenged from about 30 m down the beach. Darby and Joan flew to within 20 m and began their territorial display. Then Darby took flight and began diving at the intruder, each dive more close until the intruder had to crouch on the sand at each pass. Darby was diving at about 45° angle, changing at the last moment to an upward glide, without landing. After five dives, the intruder started to move away. Darby then reduced the angle, each time hitting the intruder's back with his body and then bouncing along the beach on his feet for a short distance before flying up for the next dive. From the sound of the impact, it was obvious that the blows were hard. After about five such dives, the intruder crouched behind a small log. Darby then began hitting with his feet. After about 15 minutes of this, Darby rejoined Joan and they returned to their territory. The intruder was not seen again.

On 21 November 1974, an oystercatcher landed near Darby and Joan's nest on the north side of the creek, about two weeks before hatching. Both birds attacked it, pecking it and rolling it over and over on the sand. The intruder flew, closely followed by Darby and for 20 minutes the two were in the air, mostly over the sea, with Darby keeping to landward of the intruder which was forced to move seaward to avoid colliding with Darby flying closely alongside. Both then landed on the beach, some 600 m from the nest, where they carried out the territorial or visiting display for 10 minutes. The intruder flew again and the same sequence of shepherding away in the air and display on the beach occurred. This sequence occurred

four times altogether and ended after two hours with the intruder leaving the beach completely.

This was the first time I had seen Joan join Darby to attack an intruder, probably because she was sitting on eggs. From then on, it was she who attacked whenever the nest was threatened, while Darby attacked birds intruding on the general territory. The next day, when I came to within 2 m of the nest, she dived and hit me on the back with her wings.

On one occasion, just before the eggs hatched, she hit me very hard several times on the back, using both her feet and beak. Meanwhile, Darby merely stood by making a shrill noise (not piping). The same occurred the next day. On this day also a fairly large dog came too close to the nest. Joan began flying round the dog's head, while Darby arrived and stood nearby making his shrill noise. When the dog did not move away, Joan began hitting it on the back of its head and neck and it soon retreated, with Joan harassing it until it was well away.

When Darby and Joan had left Buffalo Beach in December 1974, two other pairs soon moved in, one on the north side and one on the south side of the creek. Their behaviour was little different, though perhaps less skilled and determined. One day a north bird flew over the creek and chased a south bird along the sand into northern territory. The pursuer extended its wings horizontally and bounced in pursuit along the sand like a small plane making a bumpy landing. When it had caught up, the pursuer folded its wings and for 15 minutes, in complete silence, slowly walked anticlockwise round the pursued, its beak almost touching the body of the latter which stood throughout as if mesmerised.

Among several similar incidents was an occasion on 1 July 1977 when five Variable Oystercatchers from the harbour, accompanied by a South Island Pied Oystercatcher, flew into Mother Brown's Creek and began bathing. Within a minute the pair from the northern side flew in and quickly chased the five out of the creek and along the beach toward the harbour. The five were at full sprint, followed by the two aggressors and, well to the rear, by the South Island Pied. Once all took to the air, the South Island Pied soon caught up to the others.

#### FAMILY AFFAIRS

To my knowledge, Darby and Joan lived on Buffalo Beach from before 1969. They hatched eggs every year up to and including 1974 but did not rear any chicks, mainly because of dogs. For example, in 1973 one chick was reared almost to the point of flying but was killed by a dog.

Their nest in November 1974 was a shallow depression in the sand very close to the high-tide storm level, near the northern bank of Mother Brown's Creek, within a few metres of the sites of the

previous five years. As is often the case, it was on the seaward side of a small log.

On 11 November, Joan was sitting on one egg and, becoming upset at my approach, flew and hit me on the back with her wings. On 12 November, there were 3 eggs. Darby spent most of his time sitting on a hump of sand about 1 m from the nest. From time to time, Joan would walk about or stand nearby for up to 15 minutes; Darby would wait for several minutes and then reluctantly sit on the nest. When Joan had had her exercise, she would walk back and Darby would move away to let her sit. Although I saw many of these change-overs, I saw no ceremonies with them. Nor did Darby bring food to Joan, even though he was often feeding on tuatuas while she was sitting. I did not see her feed while off the nest, although she may well have done so when I was not there.

If I walked quickly toward the nest, Joan would attack me but if, as on one occasion, I sat on the sand and slowly edged forward, I could reach to within 1 m of the nest. She showed no alarm while I stayed there and Darby even went down to the water to feed. In 1972, during a "Save the birds" project at Whitianga School, two pupils sat about 1 m from the nest every day after school and at weekends, to protect the nest from dogs and thoughtless children. Joan was not concerned but would attack anyone else who came near.

Dogs were generally deterred by the combined noise of Darby and Joan, two pairs of Pied Stilts (*Himantopus himantopus*) and one or more of the male New Zealand Dotterels (*Charadrius obscurus*) that bred nearby.

On 3 December, there were three chicks, one still in the nest, giving an incubation period of about three weeks. From then on, the chicks were to be found in the soft sand at the top of the beach, by 5 December having moved about 400 m north along the beach to a less public area. Between 3 and 9 December, both adults found the chick's food, breaking it into small pieces which were dropped in front of the chicks. On 14 December, Darby started bringing opened tuatuas up from the wet sand. On 9 December, I first noticed a chick probing in the soft sand with the parents.

On 9 December, Joan had a broken wing which dragged on the ground as she walked; there was a large red patch under the wing, as though a dog had had the wing in its mouth. On the 11th, while Darby was at the top of the beach with the chicks, Joan was chased by a dog. Both Darby and Joan made a lot of noise but, although Joan with her broken wing was in danger, Darby was distracted by a passing oystercatcher and immediately flew up and did not reappear for 20 minutes. I had to intervene until his return.

There were two chicks on the 13th, one chick on the 17th and no chicks on the 21st, when Joan's wing was partially healed. She was seen to walk into the dunes and also parallel to them, giving

the short, quiet call she used with the chicks. Later, Darby brought an opened tuatua, seemed to look for a chick and finally left the tuatua untouched on the dry sand. On 23 December, Joan was listlessly standing near the nest site, often lifting her broken wing. Darby was busy chasing oystercatchers south of the creek. This was the last occasion when Darby and Joan were seen.

ALAN B. JONES, 34 Buffalo Beach Road, Whitianga.

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## SHORT NOTES

### A FURTHER GREY-FACED PETREL COLONY

Some years ago, Medway (1966, *Notornis* 13: 17 and 1967, *Notornis* 14: 223) recorded the presence of breeding colonies of Grey-faced Petrels (*Pterodroma macroptera*) on coastal cliffs and stacks at Pukearuhe and Tongaporutu, North Taranaki. At that time he postulated the existence of further colonies within the area. This present note records the occurrence of such a further colony, 10 km southward of the Pukearuhe sites.

On 23 January 1978, I was shown a small group of "mutton-bird" burrows by Messrs P. and J. Carr, Urenui, who had known of them for a number of years. The colony, about 2½ km north of the Urenui River mouth, consists, apparently, of about half a dozen mainland burrows and a smaller as yet unascertained number on a stack about 20-30 m off-shore. Several of the mainland burrows had been occupied during the previous breeding season and a few feathers were present at the entrances. The burrows are confined to a narrow (c. 3 metre) strip of taupata (*Coprosma repens*) and flax (*Phormium tenax*) atop 10-15 m mudstone sea cliffs.

This colony may well be the most southern mainland breeding colony of Grey-faced Petrels as it is near the limit of the coastal cliffs apparently favoured by the species in Taranaki.

R. E. LAMBERT, Taranaki Museum, P.O. Box 315, New Plymouth.

### GOLDEN PLOVER ON BOARD SHIP

Early on 12 September 1978, when *Marama* was at 24°50'S 177°45'W, a Golden Plover (*Pluvialis dominica*) was noticed flying around the ship and attempting to land on board. In this it was eventually successful, and it was seen a number of times during the day in various parts of the vessel. In the evening it was caught and placed in a bathroom for the night, where it was seen to eat finely chopped meat, and to drink fresh water. It was released at 31°26'S 178°22'E on 13 September. It flew around the ship twice before heading off southward. The weather on the 12th was heavily overcast with heavy rain and on the 13th was partly cloudy and fine.

JOHN JENKINS, 14 Lochiel Road, Remuera, Auckland.



# **A COMPARISON OF COUNTING METHODS TO OBTAIN BIRD SPECIES NUMBERS**

By A. V. RATKOWSKY and D. A. RATKOWSKY

## **ABSTRACT**

Stationary and walking counting methods to obtain numbers of bird species in survey work were compared under Tasmanian forest conditions. For short observation times, the stationary method was clearly inferior to walking at a brisk pace through the survey area. In unsheltered areas, windy conditions significantly reduced the number of species recorded compared with calm conditions in either fine or rainy weather. When time is short, a basic 10-minute walking unit will yield a reasonable percentage of the number of species present.

## **INTRODUCTION**

The impetus for the present study came during a stay in New Zealand between September 1976 and April 1977, where one of us (DAR) was employed by the DSIR Applied Mathematics Division, and the other (AVR) pursued her vocation of bird observation. We came into contact with people employed to survey birds in forest areas and who were using the stationary count method advocated by Dawson & Bull (1975). As we had used a continuous walking method previously (Ratkowsky & Ratkowsky 1977), we became interested in undertaking a comparison of the two methods, in which we would consider factors such as forest type and weather. In Australia, both the stationary counting method (Driscoll 1977) and the walking method (Pattimore 1977) have been used, but neither of those authors made comparative tests of the two methods.

The present study was carried out after our return to Tasmania. Although their dominant trees are very different, both Tasmania and New Zealand have an impoverished island avifauna and information obtained in the Tasmanian forest on bird counting methods could be of relevance to New Zealand forest conditions as well. One should bear in mind the important distinction between bird observations made by amateur ornithologists and those conducted by professionals employed by government or government-funded bodies to learn about bird biology or to study the effects of forestry practices on bird populations. Time is usually of little importance to the amateur bird-watcher who is pursuing a recreational interest. The professional, on the other hand, working at public expense, often has only limited study time. It is essential therefore that counting methods be chosen which return a maximum amount of information in the available time. With these

considerations in mind, the present study was directed towards obtaining information about bird numbers by considering time units of short duration, from five minutes to a maximum of thirty minutes.

An estimate of the number of birds in an area can be achieved either by counting individuals of given species, or by counting the number of different species. The counting of individuals can be achieved accurately with seabirds in a coastal seawatch situation where an unobstructed view is available (Marchant 1977), but it is our experience that this is virtually impossible in forest conditions where one must rely primarily upon aural, rather than visual, observation. In Tasmanian forest conditions, this difficulty has caused Pattemore (pers. comm.) to abandon the attempt to count individuals in favour of recording a complete species list in each 50 metre interval whilst walking along a transect length of 500 metres in wet sclerophyll forest (Pattemore 1978). The average species-frequency obtained from the ten counts was used as the basis for comparing different areas.

### METHODS

The present study consists of three trials conducted consecutively. The first compares the stationary and walking methods during five minute sessions, the second involves walking counts over three different time sessions and in three different weather types, and the third examines the different effects of sheltered versus exposed environments upon half-hour walking counts along fixed transects. All trials were carried out near Hobart in the Mt Wellington Range, very familiar to the authors as a result of previous surveys (Ratkowsky & Ratkowsky 1976, 1977). Mt Wellington is 1270 m high and has a variety of environments, including dry sclerophyll forest, wet sclerophyll forest, gully communities, high elevation woodlands and treeless upper regions. No attempt was made to assess the number of individuals of a given species. A species was recorded as being present once only in a time trial irrespective of whether a single bird or a large flock was involved.

In all three trials, mostly aural but also visual identification was used, and the walking pace varied between about 3-6 km/h depending upon terrain, but was usually in the range 4-5 km/h. The trials were carried out between October and December 1977.

*Trial 1:* A comparison was made between 5-minute stationary counts and 5-minute walking counts. The stationary counts were made while standing or sitting quietly. The pair of counts was taken in each environment in random order.

*Trial 2:* In different weather types, walking counts were conducted as sessions of fifteen minutes duration with subtotals taken every five minutes. During the first five minutes, the total number of different species seen or heard was recorded. In the next five minutes, only the additional species not recorded in the first five minutes were entered. Similarly, in the last five minutes, only species not seen or heard in

the previous ten minutes were entered. Results are reported as 5-minute, 10-minute and 15-minute counts. The weather was divided into three classes: (1) windy but fine (2) raining but not windy (3) calm and fine.

*Trial 3:* Three transects were chosen, each of which could be walked in approximately a half-hour. The first was in a dry sclerophyll forest under the lee of a mountain and thus sheltered from the prevailing westerly wind. The second transect was also in dry sclerophyll but was exposed to the prevailing wind, and the third transect was in a closed-canopy wet sclerophyll forest.

## RESULTS

*Trial 1:* Mean values for the number of species for the 5-minute stationary count, the 5-minute walking count, the difference between them and its significance using Student's t-test, and the percentage by which 5-minute stationary is less than 5-minute walking are given in Table 1.

*Trial 2:* Mean values for each of the three walking times, 5-minutes, 10-minutes, and 15-minutes, are presented in Table 2 for the five vegetational zones and the three classes of weather studied. The three weather categories were: windy but fine (W); raining but not windy (R); and calm and fine (C). Rainy days unaccompanied by wind were less frequent than the other two weather categories. The coefficient of variation (CV), i.e. the standard deviation expressed as a percentage of the sample mean, is given in Table 3 for all vegetational zones and for weather types W and C, but not for R because of the small number of trials.

TABLE 1 — Mean values for the number of species for the 5-minute stationary count S(5), the 5-minute walking count W(5), their difference, and the percentage by which S(5) is less than W(5), Trial 1.

Vegetation Zone	Number of counts	S(5)	W(5)	W(5) - S(5)	Percent diff.
Treeless upper regions	15	1.3	2.0	0.7*	35
High elevation woodlands	19	2.7	5.7	3.0***	53
Gully communities	15	5.8	9.5	3.7***	39
Wet sclerophyll	15	4.9	8.0	3.1***	39
Dry sclerophyll	15	5.3	8.9	3.6***	40

\*  $p < 0.05$ ;

\*\*\*  $p < 0.001$

TABLE 2 — Mean values for the number of species for three walking times in three different weather types, Trial 2.

Vegetation Zone	Weather	Number of counts	W(5)	W(10)	W(15)	E[W(15)]
High elevation woodlands	W	18	2.0	3.4	4.3	4.2
	R	6	6.0	7.8	8.8	8.9
	C	15	6.9	8.2	8.9	9.0
Wet sclerophyll ( <i>Eucalyptus delegatensis</i> )	W	17	5.5	7.6	8.9	8.8
	R	6	7.8	11.0	12.5	12.9
	C	15	9.3	11.1	12.6	12.2
Wet sclerophyll ( <i>Eucalyptus obliqua</i> )	W	16	8.3	11.3	12.9	13.1
	R	9	13.2	15.7	17.0	17.2
	C	15	12.7	15.7	17.3	17.5
Gully communities	W	15	9.0	12.0	13.3	13.8
	R	6	12.5	16.0	17.5	18.0
	C	15	12.6	15.6	17.3	17.4
Dry sclerophyll	W	15	7.3	9.7	11.6	11.1
	R	7	12.1	14.9	16.7	16.5
	C	15	11.1	14.8	16.0	17.0

*Trial 3:* Mean values for the number of species in each of the three transects are given in Table 4 for calm and windy weather, together with an assessment of the significance of the difference between means using Student's t-test.

TABLE 3 — Coefficients of variation (CV) for the results from Trial 2 for windy (W) versus calm (C) weather in the various vegetational zones.

Vegetation Zone	Weather	W(5)	W(10)	W(15)
High elevation woodlands	W	75%	54%	50%
	C	19	15	16
Wet sclerophyll ( <i>E. delegatensis</i> )	W	50	51	43
	C	28	24	20
Wet sclerophyll ( <i>E. obliqua</i> )	W	28	19	16
	C	16	18	20
Gully communities	W	28	20	21
	C	14	10	10
Dry sclerophyll	W	36	29	24
	C	16	16	12

TABLE 4 — Mean values for the number of species in half-hour counts in calm (C) and windy (W) conditions, and their difference C-W, Trial 3.

Transect number	Description of transect	C	W	C-W
1	Dry sclerophyll, open canopy, leeward	21.2 (9)†	20.2 (6)	1.0 (ns)
2	Dry sclerophyll, open canopy, windward	16.5 (8)	13.3 (7)	3.2 (*)
3	Wet sclerophyll, ( <i>E. obliqua</i> ), closed canopy	18.1 (7)	17.9 (8)	0.2 (ns)

† Number of replicates; \*  $p < 0.05$ ; ns = not significant

## DISCUSSION

The results of Trial 1 (Table 1) for all vegetational types show that the mean number of bird species recorded using the stationary method is significantly lower than when using the walking method. Even in the treeless upper regions where the mean number of species observed per 5-minute session was only 2.0 with the walking method, the percentage deficiency using the stationary method compared with walking is 35%. The deficiency is remarkably constant in gully communities, wet sclerophyll and dry sclerophyll, being about 40% in all these vegetational zones. The clear superiority of walking compared with stationary counting for obtaining the number of bird species is evident from these results.

Since Dawson & Bull (1975) reported no difference between the number of individuals obtained from walking versus stationary methods, it is of interest to re-examine their results. Their study compared three methods: in the first, the observer walked at a slow pace (0.8 km/h) for a period of two hours and took subtotals every 15 minutes; in the second, the observer remained stationary and recorded birds over a period of five minutes and then walked 200 m without counting to the new position; in the third, the procedure was the same as the second method except that each count was taken over a period of ten minutes. One can convert the mean number of birds per count reported in their Table 1 to the mean number that may be expected in a 2-hour session of counting, so that the results will reflect a constant effort in terms of total time allotted to counting. Dawson & Bull (1975) have estimated that the approximate number of counts that could be completed in two hours is eight sub-totals walking, ten five-minute stationary counts and seven ten-minute stationary counts, the last two methods requiring time to move between stations. Table 5 of the present work presents the converted mean numbers of

five species of birds that would be recorded, on average, for a two-hour effort.

TABLE 5 — Mean number of birds expected in two hours of counting, converted from Dawson & Bull (1975).

Species	Walking (8 counts)	5-minutes stationary (10 counts)	10-minutes stationary (7 counts)
Bellbird	16.5	17.4	15.0
Tit	9.6	5.3	5.6
Silvereye	13.4	10.3	10.4
Fantail	7.2	5.5	5.0
Warbler	18.8	11.7	12.1
Total (all species)	65.5	50.2	48.1

Two points emerge very clearly from Table 5. Firstly, excepting the Bellbird, the walking method yields more birds than either stationary method despite the fact that a very slow walking pace was used (less than one-fifth of the pace of the present study). Secondly, there is close agreement between the mean number of birds observed in a given total time for the two stationary methods. As 2000 m would have been traversed in two hours using 5-minute counts compared with only 1400 m using 10-minute counts, the agreement suggests that covering a greater distance tends to compensate for a shorter observation time. Thus, both distance and time are important and may be effectively combined in the walking method, thereby explaining the superiority of walking to stationary methods.

The results of Trial 2 (Table 2), show the effect of weather and time of walking upon the average number of species observed in each zone. A smaller number of species is consistently recorded under windy conditions than under calm but fine conditions, or in windless rain, these latter two conditions producing virtually identical numbers of species. Table 3 lists the coefficients of variation (CV) for the number of species recorded in Trial 2 for windy versus calm conditions and enables the internal variability within each sample to be examined in more detail. In calm conditions, the CVs are low and are contained within a rather narrow range (10-28%), reflecting the fact that bird species numbers can be obtained with greater precision in windless conditions. In wind, the CVs increase in all zones but are lowest in the more closed environments, i.e. the gully communities and the sclerophyll forest dominated by *Eucalyptus obliqua*. The dry sclerophyll forest, with its more open structure, is next highest in variability, followed by the wet sclerophyll forest dominated by *Eucalyptus delegatensis*, which is situated at moderately high elevation and is exposed to high winds. The upper woodlands, which have a fairly open structure and which are prone to the full force of the wind, have the highest CVs (50-75%).

The effect of shelter upon the results obtained in windy versus calm conditions was further examined in Trial 3, where a longer time period (approximately 30 minutes) was used. The results of this trial (Table 4) demonstrate that, in a sheltered forest, whether due to landform (Transect 1) or to a closed canopy (Transect 3), no significant difference in bird species numbers is obtained. In the open-canopy forest unprotected by landform (Transect 2), the effect of windy conditions is to reduce the number of species recorded, despite the half-hour observation period. Nevertheless, the observed difference of 3.2 species is smaller than that obtained in dry sclerophyll for the shorter counting times of Trial 2 (Table 2).

We now turn to the question of determining the optimum time to use for a counting session. Taking calm conditions as a standard for comparison, the results given in Table 2 show that the 10-minute walk session increases the number of species relative to the 5-minute walk session by an amount ranging from 1.3 to 3.7, depending upon the vegetational zone. Similarly, the 15-minute walk session brings about a further increase, but the range of the increase is only 0.7 to 1.7, indicating that successive extra five-minute sessions bring increases of decreasing magnitude. Previous workers have found a quantitative relationship between number of species recorded and time of observation. For example, Preston (1960) found that when the duration of observation periods was successively doubled, the number of breeding species added to the list with each successive doubling of time tended to remain constant. Caughley (1965) showed that this was generally true for birds irrespective of whether they are breeding or not. We can examine whether this finding applies to the results of Table 2 by predicting the expected mean value for 15-minute counts, denoted here by  $E[W(15)]$ , and comparing it with the observed mean value,  $W(15)$ . Following Caughley (1965), using the observed mean count for the first time unit,  $W(5)$ , and the observed increment in the count obtained by doubling the time,  $W(10) - W(5)$ , then the expected count for the third time unit, i.e. at 15 minutes, can be predicted from the following equation:

$$E[W(15)] = W(5) + [W(10) - W(5)] \lg 3,$$

where  $\lg$  signifies logarithm to the base 2.

Values of  $E[W(15)]$  are listed in the last column of Table 2 and the agreement between these predicted values and the observed values at 15 minutes,  $W(15)$ , are excellent. As the basic time period of five minutes in the present study is vastly less than the basic time period of one day used by Caughley (1965) for his bird counts conducted both in Australia and New Zealand, it appears that Preston's rule applies for widely different basic time periods.

Using the total number of species known from our previous study to be present in these zones (Ratkowsky & Ratkowsky 1977), an estimate can be made of the fraction the entries in Table 2 represent of the maximum possible number of birds that would be

recorded by devoting a very long time to counting. The maximum number of species recorded in each zone excluding very rare sightings, and the corresponding means from Trial 2 for calm weather expressed as a percentage of this maximum, are given in Table 6.

TABLE 6 — Maximum number of bird species present and estimated percentages of this maximum observed in Trial 2 in calm weather.

Vegetation Zone	Maximum Number of species (Earlier survey)	W(5)	W(10)	W(15)
Upper woodlands	20	35%	41%	45%
Wet sclerophyll ( <i>E. delegatensis</i> )	26	36	43	48
Wet sclerophyll ( <i>E. obliqua</i> )	40	32	39	43
Gully communities	22	57	71	79
Dry sclerophyll	37	30	40	43

The percentages in Table 6 show that gully communities are markedly different from the other vegetational zones. More than half of the 22 species regularly inhabiting the gullies can be observed, on the average, in a single 5-minute walking session through the environment. Use of a 10-minute interval increases the estimated percentage to 71%, a very high proportion of the total number of species present. This may be due to the uniformity of the gully communities, and to the relatively small area that they occupy. Given a fixed time interval, the remaining four vegetational zones are remarkable for the extent of the agreement between their recorded percentages of maximum observable species numbers. These habitats cover a much wider area of the Mt Wellington Range than do the gully communities, and are much more diverse. This could account for their much lower recorded percentages of species present.

The optimum length of time interval to use for observation depends upon a variety of circumstances and factors. Probably the most important is the time the observer has available to spend in the field throughout the course of the project. If a person lives close to the survey area, frequent excursions are recommended, as this increases the likelihood of recording a large number of species. However, a remote survey area or limited observation time will impose restrictions upon the survey method. The results of the present survey indicate that the 10-minute walking count is the basic unit to be considered. The number of such 10-minute counts to use per area, zone or environment would have to be determined after consideration of local factors such as steepness and roughness of the terrain, the extent of the area to be surveyed, and personal factors such as the ability and fitness of the observer. The reason for choosing the 10-minute walking count as the basic unit comes about from examining Tables 2 and 3.



A survey party committed to perform a study in a limited number of days will have to make allowances for the vagaries of weather. Under windy conditions, the CV is generally less the longer the counting time, and this argues in favour of a longer count to give a greater measure of reliability to the results obtained. It has already been remarked that in calm weather the 5-minute count gives a surprisingly high percentage of the maximum bird species present. The 10-minute count increases the percentage and at the same time increases the reliability by reducing the CV. Increasing the observation period to 15 minutes is probably not justified because of the relatively small increase in bird species numbers.

### CONCLUSIONS

- 1) Walking methods are clearly superior to stationary methods for the short times of observation and the conditions considered in this study.
- 2) Windy conditions significantly reduce the number of bird species recorded in time intervals of up to 15 minutes. Rainy calm conditions yield as many observations as are obtained under fine calm conditions.
- 3) Longer time sessions for observation can reduce the difference between the numbers of species obtained in windy and calm conditions in exposed environments, and can even eliminate it in sheltered environments.
- 4) In calm conditions, the coefficient of variation for the recorded number of bird species is low and does not depend markedly upon the nature of the environment. In windy conditions, the variability is lowest in closed or sheltered environments and becomes very much higher in situations exposed to the full force of the wind.
- 5) Where limited time is available to conduct a survey, the 10-minute walking session is recommended.

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## RED-HEADED PARROT FINCH COPULATION

Little seems known about the mating displays and copulation of the Red-headed Parrot Finch (*Erythrura cyanovirens pealii*). Bahr (1911: 51) noted "vigorous pairing" by his captives but did not elaborate.

I have twice seen wild Red-headed Parrot Finches copulating in Suva, Viti Levu, Fiji.

At dusk on 11 December 1972 I saw one parrot finch, presumably the male, pursuing another in flight, the two birds breaking off the chase to perform an undulating display flight in which they rose and fell repeatedly in concert over a height of some 70-80 cm, at least one bird calling loudly. They then landed side by side on a branch 3 metres above the ground, locked bills for a second, then broke apart as the female swung to hang upside down beneath the branch, the male perching upright above her. She swung upright to perch on the branch again, whereupon the male mounted her, seizing her nape in his bill. After a brief copulation the birds fell off the branch, parting as they fell and flying back up, to perch 15 cm apart. The male sidled up to the female, calling "zip zip zip zip," and they locked bills violently once more, separating to let the female swing upside down beneath the branch again. When she swung upright they locked bills for a moment before flying off together.

A similar display followed by copulation was seen on 7 September 1975, but this time the female persisted in repeatedly hanging upside down from the branch, the male bending over and apparently attempting to seize her with his bill to pull her upright.

A preliminary pursuit followed by a copulation in which the male grasps in his bill the feathers of the back of the female's neck seems typical behaviour for the genus, this being recorded for *E. psittacea* (Morris 1958: 432) and *E. trichroa* (Immelmann 1971: 79).

Groups of up to eight Red-headed Parrot Finches are frequently seen performing the undulating display flight and pursuing one of their number, presumably female. This could well be involved in preliminary pair formation.

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# AN ARCTIC TERN AT THE TARAWERA RIVER MOUTH

By P. C. M. LATHAM

A small, slim, whitish tern was seen at the mouth of the Tarawera River, in the Bay of Plenty, on the afternoon of 10 June 1978. It was roosting on the beach in a mixed flock of Black-fronted Terns (*Chlidonias albobriatus*), White-fronted Terns (*Sterna striata*), Red-billed Gulls (*Larus novaehollandiae*) and Black-billed Gulls (*L. bulleri*).

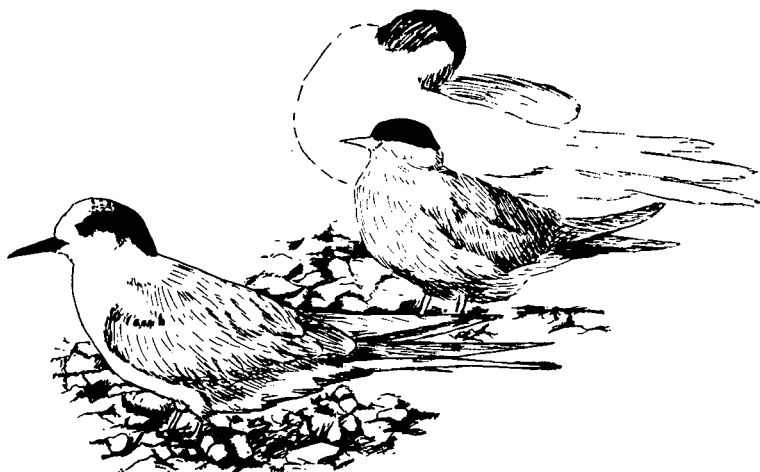


FIGURE 1 — Arctic Tern (foreground) at Tarawera River mouth, from colour slide by P. C. M. Latham. Bill somewhat distorted against disruptive shingle background. Black-fronted Tern in centre (head turned slightly, foreshortening bill); preening White-fronted Tern (out of focus) behind, included for comparison of size.

**Body size:** That of a Black-fronted Tern, but appearing slimmer and longer because of its long tail streamers. My first impression was of a rather small White-fronted Tern.

**Forehead:** White from base of bill right back to forepart of crown.

**Crown:** Fore-crown white, mid-crown streaked with black, hind-crown and nape a shiny, black cap down to the mantle.

**Lores:** White.

*Ear coverts:* Black. The black of the nape came forward in a broad line to surround the eye.

*Underparts from chin and cheek to under tail-coverts:* White.

*Mantle and back:* Pale pearly grey, slightly darker than *striata*.

*Rump and upper tail-coverts:* White.

*Tail:* White, except for dark grey outer edges of the outer tail streamers. When the bird was at rest these long, slender tail streamers projected a little beyond the wing tips.

*Upper wing surface:* Grey, darker than mantle and back; i.e. darker than that of *striata* but not as dark as that of *albostratus*. When the wing was folded a mottled, blackish-grey edging showed at the carpal joint. This was not a bold marking but indistinct and difficult to see at any distance.

*Underwing:* White with dark grey primary tips.

*Bill:* Black with a small, dull red patch at the base of the lower mandible, noticeable only at close range in good light; longer and slimmer than that of *albostratus*, shorter but the same shape as that of *striata*. Inside the mouth was bright, blood red.

*Legs:* Red, very short, making the bird look as though it was almost lying on the ground; compared to those of *albostratus* (average tarsus length 16 mm — Oliver 1955), appearing not only shorter but sligher.

During the half hour or so that I watched, from a distance of about 14 metres, the tern showed no alarm at my presence nor was it harried at any stage by any of the birds about it. When last seen it was flying out to sea, in easy, buoyant fashion, in the company of three Black-fronted Terns.

Though this description more or less fits the non-breeding dress of four similar species of tern which occur in or close to the New Zealand region, the Common Tern (*Sterna hirundo*), the Roseate Tern (*Sterna dougalli*), the Antarctic Tern (*Sterna vittata*) and the Arctic Tern (*Sterna paradisaea*), only *paradisaea* matches it exactly.

The eastern race of the Common Tern (*Sterna hirundo longipennis*), the race most likely to reach New Zealand as it annually visits eastern Australia, has, until very recently, not been recorded here. It can however be eliminated on a number of points. The bill and legs are black at all times (Slater 1970); the average tarsus length is 20 mm and the tail streamers do not project beyond tips of the folded wing and the bill is more robust than that of the White-fronted Tern (Serventy *et al.* 1971). The last three points apply to all races of the Common Tern. In his description of the immature *longipennis* Slater (1970) says it has dusky secondaries, pale grey rump and broad carpal bar particularly obvious when the bird perches. Serventy *et al.* (1971) add that it has brown barring on the mantle.

The Roseate Tern, which has not been recorded in New Zealand, has an average tarsus length of 19 mm (Serventy *et al.* 1971) and has entirely white tail streamers very much longer than the folded wing tips (Slater 1970). As an immature, *dougalli* has black legs, lacks a white forehead, and mantle and back are coarsely scaled, almost barred and often show some buff colouring (Grant & Scott 1969).

The New Zealand race of the Antarctic Tern, *Sterna vittata bethunei*, though breeding at the South Cape and Snares Islands, and at Port Pegasus in Stewart Island in 1977-78 (R. B. Sibson pers. comm.), has yet to be recorded from mainland New Zealand. Murphy (1938) gave the average tarsus length of *bethunei* as 18.9 mm. Watson (1975) described the outer tail streamers of the Antarctic Tern as "... white or only lightly washed with pale grey on the outer web." He also says the immature and nonbreeding adult have black bill and feet, and "The Antarctic Tern has a more robust body and heavier bill than the Arctic Tern, ..." The last point, however, is valuable only in a situation of direct comparison.

The Arctic Tern, though breeding in the sub-arctic and arctic zones of the northern hemisphere, migrates south to spend the northern winter in the Antarctic off the continental pack ice, particularly in the Weddell Sea (Watson 1975). It is known to have occurred in New Zealand several times and indeed may pass through annually (R. B. Sibson, pers. comm.). The dark grey outer edges of the outer tail streamers and the very short tarsus are important distinguishing features of *paradisaea* when they can be seen to advantage. Both Murphy (1938) and Watson (1975), when comparing *vittata* with *paradisaea*, drew attention to these features. Murphy (1938) gave the average tarsus length as 15.8 mm. He also said, "The plumage of *paradisaea* is of a lighter and more pearly grey, particularly on the ventral surface, than that of the palest race of *vittata* . . . the tail streamers are relatively longer and more slender in *paradisaea* than in any form of *vittata*." Watson (1975) mentioned the tail streamers as projecting beyond the folded wing tips and Serventy *et al.* (1971) stated that the ends of the primaries are grey.

The following is taken from Grant & Scott's (1969) description of the immature Arctic Tern. References to the Common Tern have been omitted as they apply to the European race (*S. h. hirundo*). "... bill . . . appears all black, although some older individuals actually have at the base of the lower mandible a little red which is rather difficult to see in the field. Legs orange, usually redder-orange . . . in older birds. General plumage coloration is black, grey and white, lacking buff or brown. The mantle lacks any strong scaling and is virtually uniform grey, especially in older individuals. When on the ground, the less extensive dark carpal bar is usually only just visible on the folded wing as it is largely hidden by the overlap of the mantle feathers. Except in very newly fledged birds, which

retain some feather down, the forehead is always pure white and the cap is jet black, even glossy. From below, against the light or in bright sun, the undersides of the primaries appear very white and translucent, and have a thin clear-cut black line along the tips. The secondaries are also translucent . . . ."

A final relevant point regarding the sub-adult *paradisaea* is that "first- and second-year birds retain white foreheads all year and have a dark cubital bar on the ulnar portion of the upper wing" (Watson 1975).

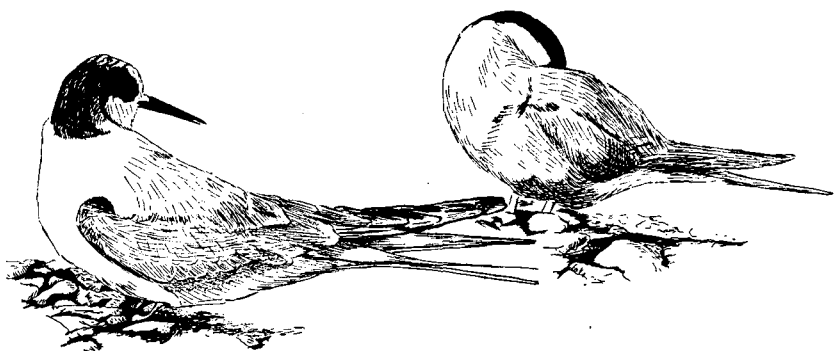


FIGURE 2 — Arctic Tern (foreground) with resting Black-fronted Tern at Tarawera River mouth. Bill on slide strongly distorted by movement. Note short, thin legs.

Having been fortunate enough to see the tern on land and with other species for direct comparison I found its identification far less formidable than if it had been flying. The very short legs, with *albostratus* for comparison, are in themselves diagnostic (Fig. 1 & 2). When this point is backed by the dark grey outer edges of the outer tail streamers, the streamers extending beyond the folded wing tips, slim bill, dark grey primary tips, indistinct cubital bar and white rump, the bird can safely be identified as an Arctic Tern.

It seems likely that the tern was sub-adult, as it was not in breeding plumage in June. Its description too, is consistent with that of an older immature, i.e. second summer bird. Campbell (1977) states, "Immature birds may stay south for their first summer or longer; breeding usually begins at three years old."

It should be noted that the guide to distinguishing *vittata* from *paradisaea* in the Antarctic, by M. C. Downes (*Emu* 1952: 307) and reproduced by Falla *et al.* (1970: 164), should be used with caution as it is primarily applicable to birds seen in the austral summer, e.g. the leg and bill colours may well be reversed in the southern winter.

Most sightings and/or recoveries of Arctic Terns in the New Zealand region have been at river mouths and harbour entrances on the mainland or at outlying islands:

Waikanae River Mouth, Dec. 1929; a single live bird, collected (Oliver 1955).  
 Waimakariri River Mouth, 1939; a single live bird, collected (Oliver 1955).  
 Kaipara Heads, 1939 (O.S.N.Z. Checklist 1970).  
 Auckland Islands, 1943; a single live bird, collected (Oliver 1955).  
 Waikanae River Mouth, Oct. 1952; two live birds (Downes 1954).  
 Manukau Harbour, Mar. 1961; four live birds (Edgar 1961).  
 Auckland Islands, 1963 (O.S.N.Z. Checklist 1970).  
 Foxton, Nov. 1963; a single dead bird (Imber 1965).  
 Manukau Harbour, May 1968; a single dead bird (Frew 1969).  
 Oreti Estuary, Southland, Jan. 1969; a single dead bird (Muller 1969).  
 Aramoana, Dec. 1972; a single live bird (Hogg 1975).  
 Chatham Islands, Jan. 1975; a single dead bird (Veitch 1975).  
 Campbell Island, 1936, 1960 & 1962; all sightings of live birds but there appears to be some doubt about these records (Kinsky 1969).

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## PROLONGED INCUBATION BY LITTLE SHAGS

During the current OSNZ shag census a colony of 60-80 Little Shags (*Phalacrocorax melanoleucos brevirostris*) in Hobson Bay, Auckland, which includes pied, white-throated, and smudgy individuals, was closely watched throughout its breeding season, September 1977 to April 1978. The progress of 56 nests was followed and from 35 of these, young fledged successfully, with an average of just under two per nest. Other nests failed due to wind damage or desertion.

The nests in the outer branches of pohutukawa were visible from below but out of reach, so that hatching and fledging times could be judged only roughly. Pied Shags in the Auckland area have been shown to incubate for 30 days on average (Millener, P.R., 1972, unpubl. M.Sc. thesis. *The biology of the New Zealand Pied Cormorant*. Univ. of Auck.), and it is unlikely that Little Shags require longer. Visits to the colony every few days revealed that if hatching does not occur the pair may prolong incubation considerably. One pair which built during November finally deserted the nest in April. This nest was clearly in view and from 28 November 1977 to 31 March 1978 (123 days), one or other bird was sitting whenever I visited. Both were involved as the individuality though not the sex of the sitter was readily checked, one bird being pied and the other white-throated. The nest was finally deserted probably because of disturbance by close neighbouring birds which had built during January and which by April were feeding a large nestling. The period of 123 days is remarkable, being more than four times the expected incubation.

Another pair, this time both white-throated, deserted on or about 21 March 1978, without obvious reason, after sitting since November for about 100 days. This nest was occupied during all my inspections until 16 March, unoccupied on 18 March, occupied again on 19 March but not on 21 March or subsequently.

A third nest proved particularly interesting in that one of the birds was inclined to sit as if on remaining eggs, during the growth of its one successful chick. Incubation of this nest began on or about 3 February and the small nestling was first seen four weeks later on 5 March. On 18 March the pied adult was sitting closely with the one nestling alongside, but left on the arrival of the partner (a bird of smudgy plumage). This bird spent some time peering into the nest before turning its attention to the chick and feeding it. On 23 March the pied adult was seen to fly in, feed the chick (now aged about three weeks), then settle to incubate whatever the nest still held. The successfully reared young bird left this nest between 3 and 5 April at approximately five weeks, by which stage it had assumed the white breast and yellow bill of the pied form of Little Shag although the head and neck were still covered in dark down. Young of the white-throated form are wholly dark at this stage.

More work on the plumage development of the young birds is planned for the 1978-79 breeding season.

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## SEASONAL MOVEMENTS OF BLACK-FRONTED TERNS

By CHRIS LALAS

The Black-fronted Tern (*Chlidonias albostratus*) breeds along the shingle riverbeds of the South Island of New Zealand east of the Southern Alps (Stead 1932; Oliver 1955). In common with the several wader species which inhabit inland waters of the South Island, the Black-fronted Tern moves locally within New Zealand. Most terns disperse to coastal regions, including some to the North Island, after the completion of breeding (Wodzicki 1946; Sladden 1953; Oliver 1955).

I studied Black-fronted Terns between December 1974 and February 1976 along the Waitaki River system and around Otago Harbour. Numbers of terns given in this paper are from a monthly census taken during this period. Martin Heine, a Mount Cook National Park ranger, assisted with tern counts in the Tasman Valley. The distribution of the Black-fronted Tern, together with the position of my study areas, is shown in Figure 1.

Black-fronted Terns returned to the upper reaches of the Waitaki River system from their wintering grounds during August. Numbers along the 8 km of the Ahuriri River between the bridge for State Highway 8 and the mouth at Lake Benmore (study site C) reached an annual peak of 200-300 in late September, remained constant through October and November (the incubation period), and then declined to 50-65 during late December and January. Most terns had left the area by late March. Equivalent numbers along the 12 km of the Ohau River between the bridge for State Highway 8 and the mouth at Lake Benmore (study site B) were 100-150 and 35-40 respectively.

Seasonal fluctuations in tern numbers in the upper reaches of the Tasman Valley (study site A) differed from those on the Ahuriri and Ohau Rivers. Terns first appeared there in late August or early September but numbers increased only gradually (15-20 in mid-September, 20-25 during October and November, 25-35 from December to February) and reached an annual peak of 35-50 during March. Numbers then decreased relatively rapidly and no terns remained by late May. Numbers in the Tasman Valley therefore increased during the months (December-March) that they decreased along the Ahuriri and Ohau Rivers. Although this influx was not large, it indicated that not all terns which leave the lower altitude rivers immediately migrate to coastal regions.

Numbers in the Ahuriri-Ohau region varied between six and 15 during April to July. Therefore only a small number of Black-

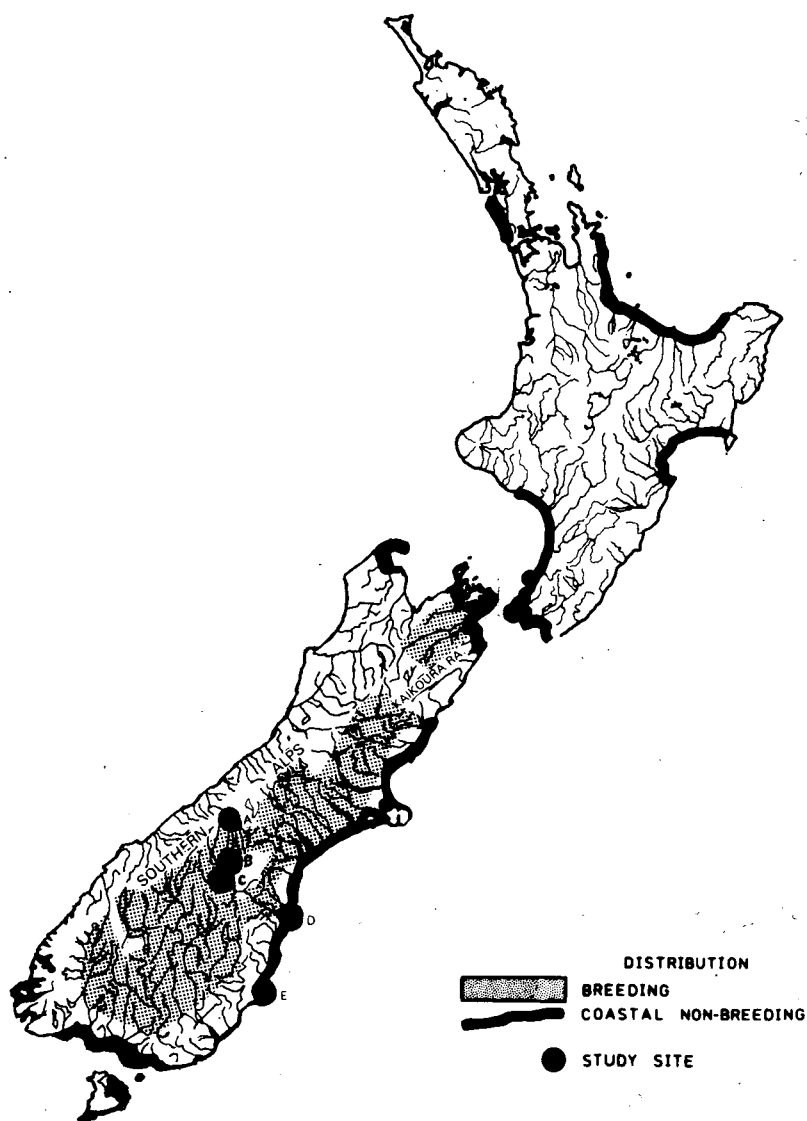


FIGURE 1 — Study sites and Black-fronted Tern distribution (taken from OSNZ records and Oliver 1955). Study sites: A: Tasman Valley, B: Ohau River, C: Ahuriri River, D: Waitaki River mouth, E: Otago Harbour.

fronted Terns, possibly five percent of the spring population, over-wintered along these rivers. Movement of terns to and from Central Otago, a region further south than the Waitaki River, occurs during the same months as outlined above for the Ahuriri and Ohau Rivers but no over-wintering has been recorded (Child 1970).

Black-fronted Terns are present in coastal regions, particularly river mouths, estuaries and harbours, from January until the end of July, with occasional sightings in December but few in August (OSNZ Recording Scheme). The only recorded sightings away from the New Zealand mainland are from Chatham Island and The Snares (Oliver 1955). Records of tern numbers at coastal sites show relatively great fluctuations over brief periods. However, most records are of numbers seen resting and these numbers vary with time of day, weather conditions and tide. Between 50 and 70 Black-fronted Terns over-winter in the Otago Harbour region (study site E) where they roost on the Aramoana tidal flats at the harbour mouth. Larger numbers, up to almost 200, have been recorded there occasionally, especially soon after the birds first arrive (January) or during winter (May-July) (Hamel & Barr 1974).

The movement from coastal regions to the rivers is more synchronized throughout the tern population than the reverse movement after breeding. They leave the coast during August but the timing of their return to the coast is more staggered and extends primarily from December to March but may continue into April and possibly May. Sibson (1948) suggested that some Black-fronted Terns may spend their first summer north of the breeding grounds but this suggestion was based on one record of a juvenile seen near Auckland in November. First-summer terns, distinguishable from both adults and juveniles by plumage differences, are common in the Waitaki River system at this time, so that it seems unlikely that a sizeable fraction of this age group spends the summer in the North Island.

The Black-fronted Tern is at present classified as a subspecies of the Whiskered Tern, with other subspecies widely distributed throughout Eurasia, Africa and Australia. The relegation of the New Zealand tern from species to subspecies status was made after recommendations by Sibson (1948) but recently this alteration has been seriously questioned by Mees (1977). It is therefore appropriate to compare seasonal movements of the Black-fronted Tern with those of Whiskered Terns.

Whiskered Terns are migratory and generally show a movement into the tropics after breeding is completed. Notable examples are the subspecies in Europe, *C. h. hybrida*, which migrates to equatorial Africa and the Australian subspecies *C. h. fluviatilis*, which breeds in south-eastern Australia then moves north, sometimes into Indonesia (Mees 1977). In contrast, Black-fronted Terns tend to scatter towards coastal regions and a small percentage of the population remains within the breeding range. The northern limit of over-wintering is Kaipara

Harbour, north of Auckland, but many travel east and south to the coast of the South Island. Some travel as far south as Paterson Inlet, Stewart Island.

Within their breeding distributions Whiskered and Black-fronted Terns have a similar diet, mainly aquatic insects and small fish, but their habitats differ. Whiskered Terns build floating nests in swampy localities and feed mainly over shallow lakes and slow-flowing rivers. In contrast, Black-fronted Terns nest in shingle on bare riverbeds and feed mainly over fast-flowing rivers.

Whiskered Terns over-winter generally around inland waters similar to those of their breeding quarters and their diet is essentially unchanged. Although Voous (1960) reported that the diet of *C. h. hybrida* in Africa consists mainly of terrestrial insects (locusts), this observation has been questioned by Bannerman (1962). Whiskered Terns rarely feed on marine prey except during migration. An exception has been reported from Indonesia where large numbers gather along the muddy coast of north-western Java (Mees 1977).

Most Black-fronted Terns over-winter along the coast where their diet consists mainly of planktonic crustacea (Lalas, in prep.). They forage not only over sheltered waters, such as harbours and estuaries, but also at sea. They are seen regularly up to 6 km off the Otago coast, often in association with White-fronted Terns (*Sterna striata*), a habit presumably typical of the whole winter range. Black-fronted Terns, therefore, differ from Whiskered Terns in their selection of wintering quarters.

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## SHORT NOTE

### GREAT SKUA MOBBED BY GREY-FACED PETREL

At 1200 hours on 16 July 1978 at 26°04'S 176°32'E a very dark Great Skua (*Stercorarius skua*) was seen flying northward and being mobbed by six Grey-faced Petrels (*Pterodroma macroptera*). The skua did not attempt to return the attacks but appeared to be flying quickly to get away from the petrels. The mobbing was seen for about five minutes, when five of the petrels left. The remaining one continued the attack, still without provoking a response, until both birds had passed out of sight.

JOHN JENKINS, 14 Lochiel Road, Remuera, Auckland.

# FEEDING AND ROOSTING BEHAVIOUR OF SOME WADERS AT FAREWELL SPIT

By H. A. ROBERTSON and M. D. DENNISON

## ABSTRACT

The feeding and roosting of the Banded Dotterel (*Charadrius bicinctus*), Turnstone (*Arenaria interpres*), Eastern Golden Plover (*Pluvialis dominica fulva*) and Far-eastern Curlew (*Numenius madagascariensis*) were studied for six days on Farewell Spit. Five habitat zones are defined and the use of these zones by the four species and their behaviour in them are given.

## INTRODUCTION

Although there is now a large body of information on the numbers and distribution of waders in New Zealand, published information on the behaviour of waders, their use of habitat and their daily routines has been mainly incidental to description of species and census counts.

With this in mind, a visit was planned to Farewell Spit in February 1978 to study the feeding and roosting behaviour of selected species. Unfortunately, permission could not be obtained for the ten days planned, so that in the six full days allowed, only a small beginning could be made. No census was planned or attempted. Wildlife Service/Ornithological Society parties have visited Farewell Spit irregularly since 1961. Edgar (1974) summarised census results and listed 95 bird species recorded during these visits. A summary of census results since 1974 will appear separately (Dennison & Robertson, in prep.).

The party, consisting of W. F. Cash, A. Palliser and the authors, was on the Spit from 7 to 12 February 1978 inclusive. All but W. F. Cash had visited the Spit before during a course for young ornithologists in January 1977. As the spring tides (maximum 4.1 m at Nelson on 10 February) were at their peak around midday the activities of birds could be followed at both high and low tides.

The species studied were the Banded Dotterel (*Charadrius bicinctus*), the Turnstone (*Arenaria interpres*), the Eastern Golden Plover (*Pluvialis dominica fulva*) and the Far-eastern Curlew (*Numenius madagascariensis*).

## HABITAT ZONES

Farewell Spit is a slightly curved finger of consolidated sand extending 25 km eastwards from the north-west tip of the South Island (Fig. 1). It is a Nature Reserve administered by the Abel

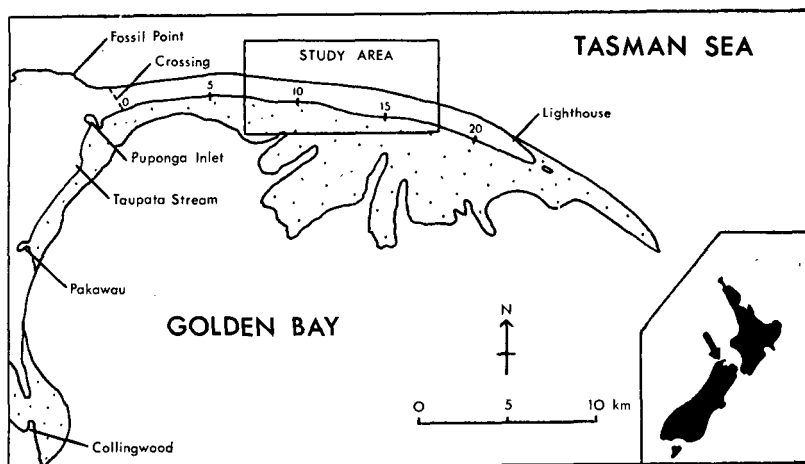


FIGURE 1 — Farewell Spit and Golden Bay, showing places mentioned in the text. The stippled area shows the extent of sand-flat at low tide.

Tasman National Park Board. At high tide the Spit is about 1 km wide, but at low tide sand-flats extending southwards widen the Spit to 8 km in parts. For the present study, the Spit was divided into five distinct zones: Ocean Beach, Ocean Dunes, Central Flats, Bay Dunes and Bay Flats (Fig. 2), in which 'Bay' refers to the Golden Bay side of Farewell Spit. Previous workers have called the Ocean Beach the 'Outer Beach,' the Central Flats the 'Inner Flats,' and the

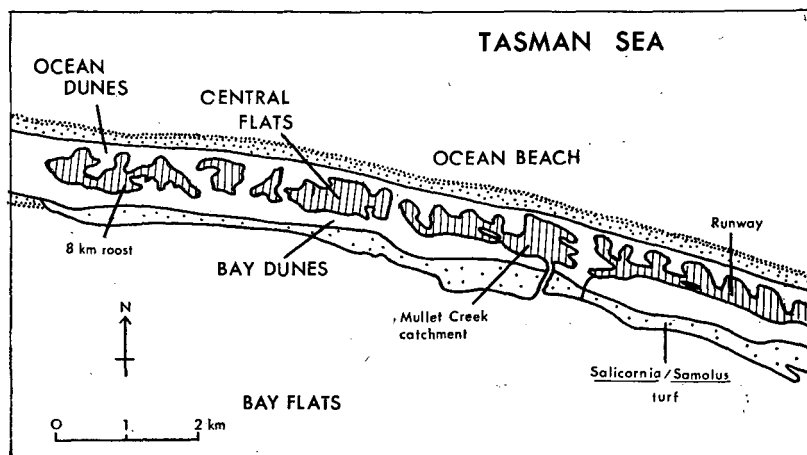


FIGURE 2 — Study area (between 7 km and 18 km) on Farewell Spit, indicating the five habitat zones and places mentioned in the text.



FIGURE 3 — Looking eastwards along Farewell Spit from the 10 km mark. The Ocean Dunes in the left background, the Central Flats in the middle, showing the vegetated southern edge flanked by the Bay Dunes on the right.

Bay Flats the 'Inner Beach.' We feel that the new names are less confusing. All distances have been converted to metric (e.g. the 5 mile mark now becomes the 8 km mark).

The Ocean Beach is normally smooth, hard sand. During the study, however, it was very soft and small pools were left behind at low tide in the lower regions of the beach. This was the result of a long period of unusually dry, settled weather.

The Ocean Dunes (Fig. 2 & 3) are a chain of bare, shifting sandhills often reaching 20 m in height. Gaps in the chain allow spring tides to flood the Central Flats.

The Central Flats (Fig. 2 & 3) are a series of vast, stable sand-plains, some of which are up to 100 ha in extent. These are separated from one another by bare or vegetated sandhills which extend inward from the Ocean Dunes. Vegetation on the Central Flats is confined to its southern edge and primarily consists of raised patches of *Samolus repens*, *Salicornia australis*, *Selliera radicans* and rushes (*Juncus* sp. and *Leptocarpus* sp.). Heavy rains or spring tides can flood the Central Flats to a depth of 40 cm, though the areas of vegetation are usually not fully submerged.

The Bay Dunes (Fig. 2) form an almost continuous line of well vegetated sandhills, up to 10 m high, broken only by Mullet Creek and an associated smaller creek feeding the Runway, a long, narrow sand-plain (Fig. 2). Vegetation is dominated by lupin, marram grass, blackberry, gorse, flax, *Coprosma acerosa* and *Cassinia*. Among these dunes there are shallow basins which were open lagoons previously when the Spit was grazed by sheep, cattle and deer, but which are now largely overgrown with rushes.

The Bay Flats (Fig. 4) stretch southwards from the Bay Dunes, forming an extensive zone of sand-flats at low tide, estimated to have an area of 2000 ha (McLay 1976). From the Base to 7 km, a firm shelly beach separates the dunes from the sand-flats. Beyond 7 km the Bay Dunes are flanked by rushes, with further out a 200 m wide carpet of glasswort (*Salicornia*) and shore pimpernel (*Samolus*) which is interspersed with shallow, unvegetated channels. At low tide levels, this carpet gives way to sand-flats sparsely covered with eelgrass (*Zostera muelleri*).

At each end of the Spit, near the Base and near the lighthouse at 22 km, the zones become indistinct, the Central Flats merging into low scrub-covered sandhills.

The most favoured wader habitat, with a good variety and number of birds, lies between 7 km and 18 km from the base of the Spit. Observations were made in and en route to this area, but most time was spent at the 8 km roost and its adjacent sand-flats, and in the Mullet Creek catchment (Fig. 2), sites reasonably within cycling range of the Base each day.





FIGURE 4 — Looking south over the Bay Flats at 8 km, showing *Juncus* sp. and the *Salicornia*/*Samolus* turf, at mid-tide.



FIGURE 5 — 8 km roost, showing the hide, centre left.

The 8 km roost (formerly called '5 mile'), at Grid Ref. 257222 (NZMS 1, S1 & S3), is a favoured place for Banded Dotterels and Turnstones. This roost (Fig. 5) is a stretch of *Salicornia/Selliera/Samolus* turf, enclosed by a semi-circle of dunes and a low spit of consolidated sand and rushes, which acts as a windbreak in rough weather. Most of the flat is bare, dry sand which is flooded in heavy rain, or at very high tides, but which remained dry during the study.

Mullet Creek catchment, which becomes an extensive lagoon at high tide, is the major roost of Farewell Spit. Immediately west of Mullet Channel, a 0.5 ha flat of *Salicornia* and *Samolus*, only partially covered at high tide, is a roost for Banded Dotterels, Turnstones, Eastern Golden Plovers, Sharp-tailed Sandpipers (*Calidris acuminata*) and Red-necked Stints (*C. ruficollis*). The rest of the catchment is bare sand, interspersed with sand-hummocks, which is used as a roost by large flocks of Bar-tailed Godwits (*Limosa lapponica*) and Knots (*C. canutus*), and a few Far-eastern Curlews and other species.

A hide was erected at each of these roosts.

#### BANDED DOTTEREL (*Charadrius bicinctus*)

The Banded Dotterel is the second most numerous endemic wader at Farewell Spit, following the South Island Pied Oystercatcher (*Haematopus ostralegus finschi*). Summer counts given by Edgar (1974) are: January 1961, 1088; January 1967, 930 and 1458; March 1974, 1134 and 1624. Previous census data indicated that most of the Banded Dotterels on Farewell Spit roost between 7 km and 18 km, our study area. In the January 1961 census (Bell *et al.* 1961) about 70% were within this region, and in January 1977, 64% (pers. obs.).

Most of the 1458 birds in January 1967 (Andrew 1967) were in various stages of juvenile plumage or post-nuptial adult moult, but at least two pairs were still displaying territorial behaviour. In February 1978, nearly all adults seen were in post-nuptial moult. By contrast two pairs still on territory, with flying young nearby, were in full breeding plumage.

Banded Dotterels at Farewell Spit probably come mostly from South Island riverbed breeding grounds. R. B. Sibson (pers. comm.) considers that Farewell Spit may be a major staging site for Banded Dotterels before trans-Tasman migration, which begins in February. A census from 10 km to 20 km in April 1965 yielded only 200+ Banded Dotterels (Bell 1966). However, in late May 1962, Edgar (1962) recorded 1255, which he considered an under-estimate. Whether most January-March birds migrate and a different set of late migrants or winter residents arrives later, could only be shown by a series of counts in the autumn and winter of the same year. Stidolph & Fleming (1941) found that by May, the exceptionally large North Auckland flocks had given way to a lower but steady wintering population. Edgar (1976) recorded a large influx of Banded Dotterels to Parengarenga Harbour in the Far North in May 1976, and results of monthly

counts at the Manawatu Estuary (MDD, HAR) indicate that Banded Dotterels are "on the move" until May. These migratory movements need much closer study.

### *Ocean Beach*

Even though Banded Dotterels occur on sandy coastlines elsewhere in New Zealand, they were not seen on the Ocean Beach during our study. Only Edgar (1962) has recorded them (2 birds) in accounts of previous visits.

### *Central Flats*

All Banded Dotterels used the Central Flats over high tide and small numbers remained even at low tide. They were among the first to arrive at the roosts, some being there at least three hours before high tide. Up until two hours before high tide more would fly in, low, over the Bay Dunes from the Bay Flats feeding grounds, alone or in small groups of less than ten. They quickly settled and rarely moved to another roost, unless disturbed. On arriving at the roost or after a period of inactivity, birds often preened.

The exception to this pattern occurred in the Mullet Creek catchment where Banded Dotterels fed in the region of damp sand just ahead of the incoming tide, being slowly forced up the catchment until the tide turned, when they fed in the region of wet sand just above the falling tide.

Loose flocks of 5-100 birds were scattered throughout the length of the Central Flats at high tide. They clearly preferred the southern edge where sheltered pockets extend into the Bay Dunes (e.g. 8 km roost) and where the *Samolus/Selliera* turf occurs. Here they roosted beside flocks of Turnstones, Golden Plovers and Sharp-tailed Sandpipers. They were not seen with the large South Island Pied Oystercatcher, Godwit and Knot flocks which generally roosted towards the northern edge of the Central Flats. Most dotterels foraged during high tide, and at any instant only a small percentage of a flock would be sleeping. This behaviour differed from that at the Manawatu Estuary, for example, where all Banded Dotterels stop feeding at high tide.

Banded Dotterels foraged on the dry sand-flats near their roosts with a regular sequence of actions: (a) running or walking quickly a variable number of paces, (b) stopping and standing upright, (c) looking around, (d) taking another pace or two, before (e) pecking\* at the substrate, sometimes several times in quick succession. We

\* One important feature of feeding behaviour is how deeply the bill is inserted into the substrate, if at all. In this study the two depth classes given by Baker & Baker (1973) were used:—

(1) Pecking — bill inserted less than  $\frac{1}{2}$  of its length into the substrate, or taking food from the surface. Visual feeding.  
(2) Probing — bill inserted for more than  $\frac{1}{2}$  of its length, normally down a burrow. Tactile feeding.

abbreviated this pattern as "run-and-stop, look, step, peck." Evidently the short run disturbs prey, the bird stops to see it move, then runs a couple of paces to secure the prey. Several times MDD saw a dotterel fly a couple of metres into the air in pursuit of a small insect that had been disturbed by its running, follow it to the ground and step forward to pick it up. There was no definite pattern to where birds foraged; they seemed to wander randomly over a large area of sand, sometimes doubling back over an area previously searched, or crossing paths of other individuals.

In the tidal regions of the Central Flats, e.g. Mullet Creek catchment, some Banded Dotterels moved from the dry sand to feed in the area of damp sand left as the tide receded. In this region, presumably in response to a less mobile prey, they changed to the method described by Heather (1977) as "run-and-stop, peck." This differed from the behaviour on the dry flats in that the bird pecked upon stopping, rarely running forward again before feeding. Banded Dotterels shared this damp sand zone with Turnstones, Red-necked Stints and Sharp-tailed Sandpipers.

There was considerable interchange of feeding and sleeping birds. Sleeping birds stood or more often sat facing into the breeze, with their head tucked under one wing and, on hot days with back and flank feathers often raised. On one particularly windy day most dotterels stopped foraging and sheltered behind clumps of vegetation.

### *Bay Flats*

About one hour after high tide, small flocks of Banded Dotterels began leaving non-tidal areas of the Central Flats, but they were forced to return, until the Bay Flats became exposed. The birds could not see the tide level from their roosts, and it is of interest that they had apparently not adjusted their roosting time to the spring tides, continuing to leave prematurely at a time appropriate for lower tides.

Shortly after the carpet of *Salicornia/Samolus* on the Bay Flats near the Bay Dunes became exposed, small groups of dotterels began feeding. They arrived in flocks of up to 20 birds which quickly broke up into groups of three to six birds. These smaller groups moved from area to area as a compact unit but spread out to feed in each area.

On the *Salicornia/Samolus* turf the dotterels foraged in a different way from on the Central Flats. In a carpet of vegetation about 10 cm high, prey is less visible, and dotterels cannot run quickly as they do on the open sand. Instead, they walked slowly, with their heads down, pecking at the substrate as they moved through the vegetation. In vegetation, the prey is probably not as active as in clear, dry areas, so that birds could peck at it as it was encountered. This foraging method of "walk-peck-walk" is similar to that of Turnstones.

As the tide dropped still further, clear mud/sand patches and runnels were exposed in the *Salicornia/Samolus* carpet. On moving into this new zone most dotterels used the same "run-and-stop, peck"

technique as in damp areas of the Central Flats. A further change noted was that, while foraging, the dotterels now walked more often than ran, and probed much more often than pecked, behaviour we termed "walk-stop-probe-walk." Thomas & Dartnall (1971) found that Curlew Sandpipers (*Calidris ferruginea*) and Red-necked Stints in south-east Tasmania, pecked more often in dry zones furthest above mean low water, with probing progressively more common as the substrate became wetter near mean low water.

Quite often Banded Dotterels on Farewell Spit entered shallow water (lower than a bird's tarsal joint) while searching and feeding.

Towards low tide Banded Dotterel groups spread out over the whole of the Bay Flats. Most moved from the *Salicornia/Samolus* turf to the damp, low-lying, *Zostera* sand-flats. This seemed to be the preferred low-tide feeding ground. Unlike godwits, Knots and South Island Pied Oystercatchers, the Banded Dotterels were not seen to move any great distance along the Spit. Instead, they fanned out on the Bay Flats straight out from their high-tide roosts. As a result few dotterels were encountered between 7 km and the base of the Spit.

Single dotterels flying out late to the Bay Flats from the Central Flats, well after the majority had started feeding, would call repeatedly until this was answered by a feeding bird. The new arrival would quickly settle into the feeding group. Several times individuals or small parties were noted returning to the Central Flats after several hours' feeding on the Bay Flats.

Foot-trembling (see Heather 1977) was not observed even though Dunn (1975) recorded this behaviour, especially in very damp sand, among 150 dotterels over-wintering at Aramoana, Dunedin. Heather (pers. comm.) has found no other record of it in Banded Dotterels, and so Aramoana birds may have been responding to some unidentified, locally abundant food.

#### TURNSTONE (*Arenaria interpres*)

Large flocks of Turnstones spend the New Zealand summer at Farewell Spit, and only the Southland lagoons have permanent summer populations of similar size (Muller 1969). In the last complete census of the Spit (January 1977) 1635 Turnstones were counted, the fourth largest wader population behind godwit, Knot and South Island Pied Oystercatcher. Previous summer counts, 808 (January 1961) and 700 (January 1967), suggest that Turnstones may be increasing at Farewell Spit and Veitch (1978) noted a similar trend in Turnstone numbers on Manukau Harbour and the Firth of Thames.

Within the study area Turnstones frequented three zones: Ocean Beach, Central Flats and Bay Flats. Most birds occupied the last two over a tidal cycle and a smaller, apparently separate group kept to the Ocean Beach.

### *Ocean Beach*

A small population of Turnstones fed and roosted in the Ocean Beach/Dunes zone. In 1961, 62 of 808 birds (7½%) were on Ocean Beach and a similar proportion was noted in 1977 (MDD).

Turnstones are well known for their technique of flicking over tidal wrack when fossicking. In January 1977, they were seen working at large storm-washed clumps, particularly of *Macrocystis pyrifera*, which were ringed with their tracks and with disturbed sand where birds had probed and dug underneath. Fresh debris is ignored until animals such as amphipods and isopods have taken shelter beneath it. The settled weather prior to and during our visit had produced less tidal debris than usual. Turnstones were ignoring recently stranded pieces of *Ulva lactuca* and were only occasionally seen to upturn sticks. Instead, they were fossicking on the wet sand left after each wave.

From about 3 km onwards, small groups of two or three but more commonly single birds were scattered along the Ocean Beach. Most fed progressively along the beach but often others worked a single area back and forth, gradually being forced up the beach as the tide rose. They avoided the surf, running up the beach as each fresh wave broke, returning promptly to the wet sand as the wave receded. It is likely that they were feeding on small annelids and crustaceans disturbed from below the surface by each wave. Their feeding action was reminiscent of the "run-and-stop, peck" style of a dotterel. They dashed forward to peck or probe, at times up to three-quarters of the bill length. It was common to see birds running almost continuously as they foraged, covering the beach rapidly. A single bird might feed along more than 100 m of shoreline in two to three minutes. Turnstones must have acute eyesight, for they were undoubtedly seeing their scuttling prey before dashing to pick it up.

Ocean Beach Turnstones fed for as long as there was wet sand, ceasing only when the tide lapped the first sand hillocks (Ocean Dunes). They roosted just above the high tide line on these first low dunes. Suitable hummocks were covered with Turnstone tracks and up to 33 birds would rest on a single rise. Birds arrived to roost in singles or pairs, flying along the dune edge.

These birds were spending considerably more time feeding before high tide than those which frequented the Bay Flats and roosted on the Central Flats. It could not be determined whether these birds fed and roosted solely on the Ocean Beach or whether some were moving across from the Bay Flats feeding grounds, instead of going to roost.

### *Central Flats*

In the January 1977 census of the Spit, 1015 of the 1635 Turnstones counted were on roosts between 7 km and 18 km, our study area. Most of the detailed roosting observations were made at the roost at 8 km, where between 115 and 132 Turnstones normally rested over high tide.

Although Turnstones arrived on the roost about 2½ hours before full tide, they were among the last, as the large flocks of godwit, Knot and South Island Pied Oystercatcher flew to roost about 3½ hours before high tide and Banded Dotterel were generally already present on the roost. Small Turnstone groups, usually of 2-5, flew from the Bay Flats across the Bay Dunes to the Central Flats. Occasionally birds flying to the roost were seen chasing one another aerobically. The swift, twisting flight, also seen as Turnstones left the roost, involved pairs or trios of birds. Bent (1929), reporting similar behaviour among Turnstones on their breeding grounds in Greenland, suggested they were courtship flights.

On landing at the roost, birds preened vigorously for up to ten minutes before settling on the edge of the roosting group. They roosted in a tight flock, quietly standing or sitting on the bare sand. In a wind they sheltered behind *Samolus* clumps and in the lee of a small spit on the roost. They always roosted facing into the wind, a habit common to all waders. Although Banded Dotterels were present in relatively high numbers they did not associate closely with the Turnstones. However, Golden Plovers and Sharp-tailed Sandpipers often roosted on the edge of a Turnstone flock, and occasionally Knots were found with them. The association of Golden Plovers with Turnstones has been noted elsewhere (Sibson 1946; Wall 1953).

Turnstones seldom fed while on the roost. On one occasion, however, 20 birds fossicked over dry sand at the edge of the roost, dashing forward to pick up prey, probably the fast-moving isopod *Ligia novaezelandiae*. They fed as a tight group, often on a front, but it was not urgent feeding and lasted less than 20 minutes.

Turnstones were the last birds to leave the roost and resume feeding after the tide had dropped. They, and the Golden Plovers and Sharp-tailed Sandpipers with them, always preened before leaving. Turnstones from the 8 km roost dispersed over the Bay Flats feeding grounds directly opposite the roost. This habit of roosting close to the feeding areas was noted elsewhere on the Spit, in contrast to most godwit, Knot and South Island Pied Oystercatcher flocks which flew long distances up the Spit to their roosts.

Although Turnstones preferred to roost in the smaller, sheltered Central Flat areas with other small waders, some flocks were found on the larger roosts such as in the Mullet Creek catchment. 140+ birds roosted on the *Salicornia* area on the eastern side of Mullet Creek (see Fig. 2), but kept apart from the huge aggregations of Bar-tailed Godwit, Knot and South Island Pied Oystercatcher.

### *Bay Flats*

All the Turnstones from the study roost at 8 km, and probably most of the Spit's population, fed on the Bay Flats. This vast area of sand-flats is the major feeding ground on Farewell Spit where 45 000+ waders and many thousands of Black Swans (*Cygnus atratus*)

disperse at low tide. Godwits, Knots and South Island Pied Oystercatchers feed over an area extending from beyond the Tip to the flats opposite Puponga and Pakawau. Turnstones, however, were more restricted in their feeding habitat on the Bay Flats, and were not encountered until the stretch of *Samolus* and *Salicornia* turf beginning at 7 km.

Turnstones did not appear on the Bay Flats till about 2½ hours after high tide, an hour later than godwit, Knot and South Island Pied Oystercatcher, and coinciding with the stage when the marsh turf was becoming exposed. The small groups which had flown across the Bay Dunes to the feeding grounds remained together as "feeding parties," at least initially. They foraged first over the *Samolus* and *Salicornia* clumps, a preference which probably accounts for the Turnstones' absence below 7 km. A feeding party fed close together, often on the same clump, searching the vegetation by peering beneath the canopy as they walked, in a manner reminiscent of groups of Starlings (*Sturnus vulgaris*) foraging on a lawn. The *Samolus* clumps had a layer of decaying vegetation below the canopy, providing both shelter and food for sand-flat invertebrates. A feeding bird would thrust its head below the canopy, probing beneath the litter layer or turning debris in its search. They fossicked through these clumps more commonly on the falling than the rising tide, probably taking drowned animals trapped in the clumps or prey concealed beneath the litter.

The Bay Flats are mostly bare sand with a thin covering of *Zostera* grass. As the tide receded, feeding parties progressed from the marsh turf zone to runnel edges on the sand flats. Here *Zostera* growth is noticeably denser and a mat of living and dead grass traps tidal debris as well as harbouring animals. Feeding birds would insert the bill at an angle of 45° under *Zostera* strands or debris, with the head tilted to the side. When the head was raised and straightened the object was lifted, flicked over and the substrate exposed. As well as this characteristic sideways flick of the head to dislodge small debris, a "bunting" action was also used for large or stubborn objects. This technique involved a direct rather than sideways, probe and lift. The bill was inserted under the object, feet braced and the bird pushed forward and up with the head and breast to up-end the debris. If nothing was disturbed by either method, the Turnstone quickly withdrew its bill and the object fell back in place. If prey was disturbed, the object was flipped out of the way for the bird to feed.

On the incoming tide Turnstones fed mainly on the open sand runnels between *Samolus* clumps. The crab *Helice crassa* is particularly abundant in these sheltered channels, which are riddled with their angled burrows. Turnstones were seen to prey on *Helice* crabs only on the incoming tide, chasing them on the surface or taking them from their burrows. Most commonly, birds probed into a burrow, sometimes



right to the base of the bill, often side-stepping around the hole to work the crab loose and extract it. Once successful, the Turnstone used a modified bunt to expose the crab's softer underparts, wedging the bill under the crab to flip it "head over heels" on the sand, before striking. One Turnstone was seen to flip a crab six times before it could strike. Birds sometimes struck a crab under the carapace from the side, but normally the crab was upturned and the Turnstone struck powerfully straight downwards to open up the ventral surface. Turnstones on rocky coasts feed on barnacles and molluscs in a similar way to birds feeding on crabs at Farewell Spit, delivering one or two sharp blows to the barnacle (Groves 1978), and its technique of dealing with crabs may be modified from this. One bird, apparently with a method of its own, dug at the burrows, inserted its bill and catapulted the crabs out with a vigorous sideways flick of the head. In one case a stream of sand flew from the hole as the bird worked feverishly to get at the crab. Three crabs taken in this way were left after a brief inspection, suggesting that the size of crab was important. Birds also ignored larger crabs moving on the surface and would chase after only small crabs.

Aggression among feeding birds was seldom seen except when they were feeding on crabs. At this stage feeding parties were loosely associated, not compact as on the receding tide. One bird would dash at another, forcing it into hasty retreat, often with the crab in its bill. Displays were seen when one bird encroached on another's feeding area, or when a bird attempted to poach prey. Groves (1978) recorded two common aggressive postures in Turnstones on their North American wintering grounds, a tail-level posture and a tail-depressed posture, the latter being of greater aggressive intensity. On the Bay Flats only the tail-depressed display was seen, and it was always used during short, vigorous chases between two birds. The tail of the aggressor was depressed till nearly touching the sand and the rectrices spread to display an alternating pattern of black and white. Three terminal white spots were exposed, resembling "eye-spots." The head was dropped close to the ground, bill pointing skyward, and the feathers of the mantle and scapulars were raised to form a hackle. This threatening posture was maintained only as long as the aggressor chased the other bird.

The increase in aggressive displays at this stage is probably related to the breaking up of the feeding parties as the birds spread out on the sand channels and sand flats, where crabs and other prey are scattered. With larger and more conspicuous prey taken on the incoming tide, feeding becomes more active; birds dashing across the sand flats, chasing crabs and infringing on other feeding birds. Feeding seems to become urgent as the time of roosting approaches, perhaps further intensifying the reaction of one bird to another.

### EASTERN GOLDEN PLOVER (*Pluvialis dominica fulva*)

Farewell Spit seems to provide only marginal habitat for the Golden Plover, the number being remarkably low compared with other New Zealand wader localities. Andrew (1967) noted this, suggesting a lack of true estuarine mudflat or drier sand flats as the cause. It has been noted by many observers (e.g. Sibson 1946) that at some harbours flocks fly a short distance inland to marshes, ploughland and to pastures with thin or short vegetation. This may partly explain the low number of Golden Plover at Farewell Spit. The maximum count has been 49 in January 1977. We saw at least 27 but they were difficult to study because of their irregular movements at all stages of the tide. It would be interesting to know why the Farewell Spit flocks are so mobile.

#### Central Flats

Golden Plover roosted on the Central Flats, loosely associated with flocks of Banded Dotterels and of Turnstones. Occasionally single birds were encountered, but normally there were flocks of 4 to 17 birds. These flocks were very mobile over the high tide period and had no regular roost. Tight groups flew from roost to roost throughout the study area for no apparent reason. Flocks would split up or combine with other flocks over the course of high tide. This restlessness may be due to the large number of roosts available. By comparison, Golden Plovers at Manawatu Estuary, for example, remain on one roost over high tide. On the roosts Golden Plovers were not seen to forage; they either stood erect and alert, or, in a wind, sat preening or sleeping. They did not form compact flocks but were scattered, usually slightly apart from the other waders.

Times of movement to or away from the Central Flats roosts could not be precisely noted.

#### Bay Flats

At low tide Golden Plovers fed on the Bay Flats but again groups moved about continually, making observation difficult. Some birds were seen feeding in the region of the *Samolus/Salicornia* flats with Banded Dotterels about two hours after high tide. They were not seen on, but may well have used, the extensive wet sand flats beyond this zone.

### FAR-EASTERN CURLEW (*Numenius madagascariensis*)

Farewell Spit is one of the main feeding grounds for Far-eastern Curlew in New Zealand with more than half the New Zealand population in some years. A flock of 37 in September 1962 (Bell & Zumbach 1963) is the largest recorded yet. A flock of 15 was seen during the present study. Like Andrew (1967), we found them too wary to be watched closely while feeding. Some of their behaviour could well be studied from a hide set up on the *Samolus/Salicornia* flats near Mullet Creek.

### *Ocean Beach*

On several occasions single birds or groups of up to 7 roosted near the high-tide mark of the Ocean Beach between 5 km and Mullet Creek. As the tide dropped, some resumed feeding on the Ocean Beach near the tide line. Others remained resting for several hours after high tide before flying across the Spit to the Bay Flats.

### *Central Flats*

On the Central Flats, curlew were seen only in the Mullet Creek catchment. Andrew (1967) also noted that a flock spent most of its time near Mullet Creek. On 10 February 1978, WFC made detailed notes on the movements of a flock of 11 over high tide. The curlews were the last waders to arrive, about 1½ hours before full tide. Instead of roosting on dry land, they stood in shallow water. As the tide rose to belly-level, the flock was forced to seek shallower water, until finally, just before high tide, they joined a large flock of godwits and Knots on the dry sand on the northern side of Mullet Creek catchment. While roosting, the curlews stood, sometimes preening, in a loose group slightly apart from the other waders. About one hour after high tide the flock returned to the Bay Flats to feed.

### *Bay Flats*

When the curlews arrived after high tide, the *Samolus/Salicornia* flats were covered with water to a depth of 20 cm. Birds waded "knee-deep," probing for crabs (*Helice crassa*), which were very common in this zone. Most of the curlews remained feeding in this zone even after the sand-flats had become exposed. In this area a few White-faced Herons (*Ardea novaehollandiae*) and Bar-tailed Godwits were feeding alongside them.

Twice WFC noted aggressive behaviour by a curlew towards another species. One feeding curlew chased a godwit when it ventured too close. Another curlew, with neck and head outstretched, ran after a Red-billed Gull (*Larus novaehollandiae*), vigorously sparring at the bird as it flew off.

## DISCUSSION

Farewell Spit is an important wader habitat, both in terms of numbers of birds and richness of species. Because it is a Nature Reserve human disturbance is at a minimum, enabling studies to be done under natural conditions. Also, there now exists a good base of census data, particularly from summer months, on the bird species inhabiting the Spit (Edgar 1974). Similar data bases are now available for other New Zealand estuaries (e.g. Manukau Harbour/Firth of Thames, Manawatu estuary).

This study was only a preliminary look at aspects of the feeding and roosting behaviour of a few wader species. The behaviour patterns described can relate only to periods of spring tides and to the time of year we were at Farewell Spit.

More detailed, quantified studies are needed at Farewell Spit, and at other New Zealand estuaries, to clarify movements and increase understanding of the non-breeding biology of New Zealand's endemic waders and those migrants for which New Zealand is a major wintering area.

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# ESTABLISHMENT OF A NEW GANNETRY

By SYLVIA REED

In 1975 a new gannetry was begun on a flat-topped stack, known locally as the Sugarloaf Rock (Fig. 1), which lies about 30 m offshore from coastal cliffs between Maori Bay and the flat fishing-rock at the south end of the main Muriwai Beach, some 30 km west of Auckland. For many years the Australasian Gannet (*Sula bassana serrator*) has bred on Oaia Island (Fig. 2 & 5), just under 2 km to seaward of the mainland at this point; the breeding population in 1946-47 according to Fleming & Wodzicki (1952, *Notornis* 5: 60) was 338 pairs, plus about 168 roosting birds.

The Sugarloaf was a fairly regular breeding place of White-fronted Terns (*Sterna striata*) until 1973 when gannets began to prospect (Fig. 3 & 4). The rock has a shelving top sloping towards the mainland with a clump of pohuehue (*Muehlenbeckia complexa*) forming a central peak on the seaward side. Most of the top of the stack can be overlooked from the mainland which provides an excellent vantage point for observation.

On 22 October 1975, one gannet was seen to land on the rock, carrying seaweed which it used for the first stage of nest-building. Two days later up to 28 birds were present, performing greeting ceremonies, gathering nesting material and mating. Numbers rose rapidly during the next two weeks, up to 120 on 7 November, with at least 12 nests completed, 3 of them containing eggs. Birds from the colony were seen collecting seaweed below the stack throughout November. By 22 November, 28 nests were occupied, spread over most of the top of the rock (Fig. 5). Many birds used the grass growing on the rock as nest material until this was exhausted. The nests were then raised with surrounding earth.

The first chick was noted on 24 December 1975. On 7 January 1976, 3 fluffy chicks and 60 adults were counted. The following April, two young members of OSNZ managed to climb the rock — a very hazardous undertaking — and banded 16 juveniles.

In the early part of the season, some 50 White-fronted Terns had attempted to nest on the ledges on the sides of the rock, but gave up before any eggs were laid. The terns have appeared, settled a short while, then left, each year since.

The next season (1976-77) nesting began much earlier. On 1 October 1976, 130 gannets and 30 nests were observed. 78 White-fronted Terns were present but they very rarely landed on top near the gannets. One pair of Red-billed Gulls (*Larus scopulinus*) nested in the pohuehue. In March 1977, 61 juvenile and 83 adult gannets were counted.

Earliest observations for the next season (1977-78) record 50 birds on 7 August, taking up nest territory, performing sky-pointing





FIGURE 1 — Sugarloaf Rock, looking south towards Maori Bay from the fishing platform, Muriwai. Photo: Olaf Petersen



FIGURE 2 — Gannets on Oaia Island, January 1957, showing crowded conditions. Photo: Olaf Petersen



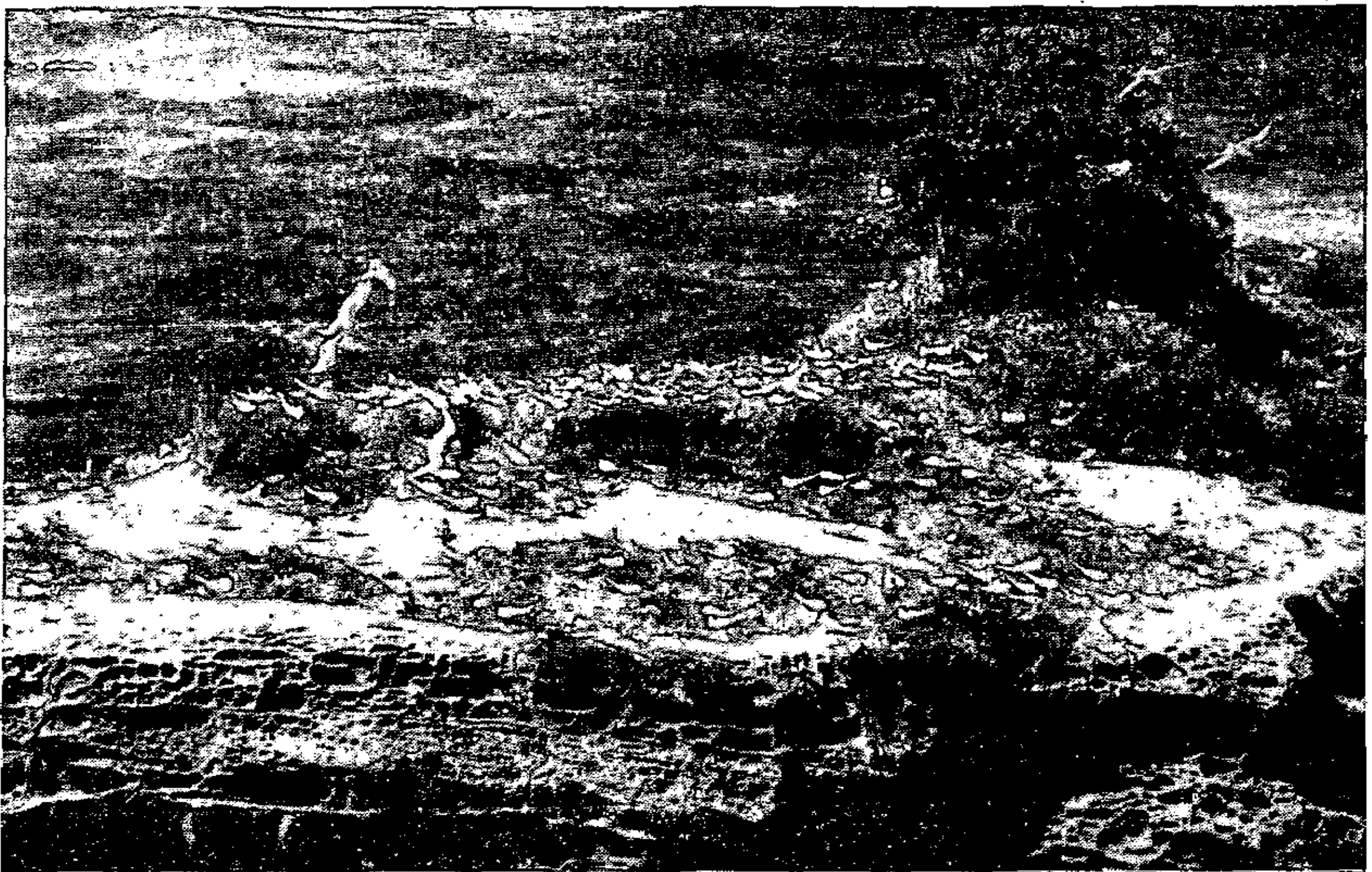


FIGURE 3 — White-fronted Terns breeding in the 1960s.

Photo: Olaf Petersen



FIGURE 4 — Gannets beginning to take over but not nesting in 1973.

Photo: Olaf Petersen



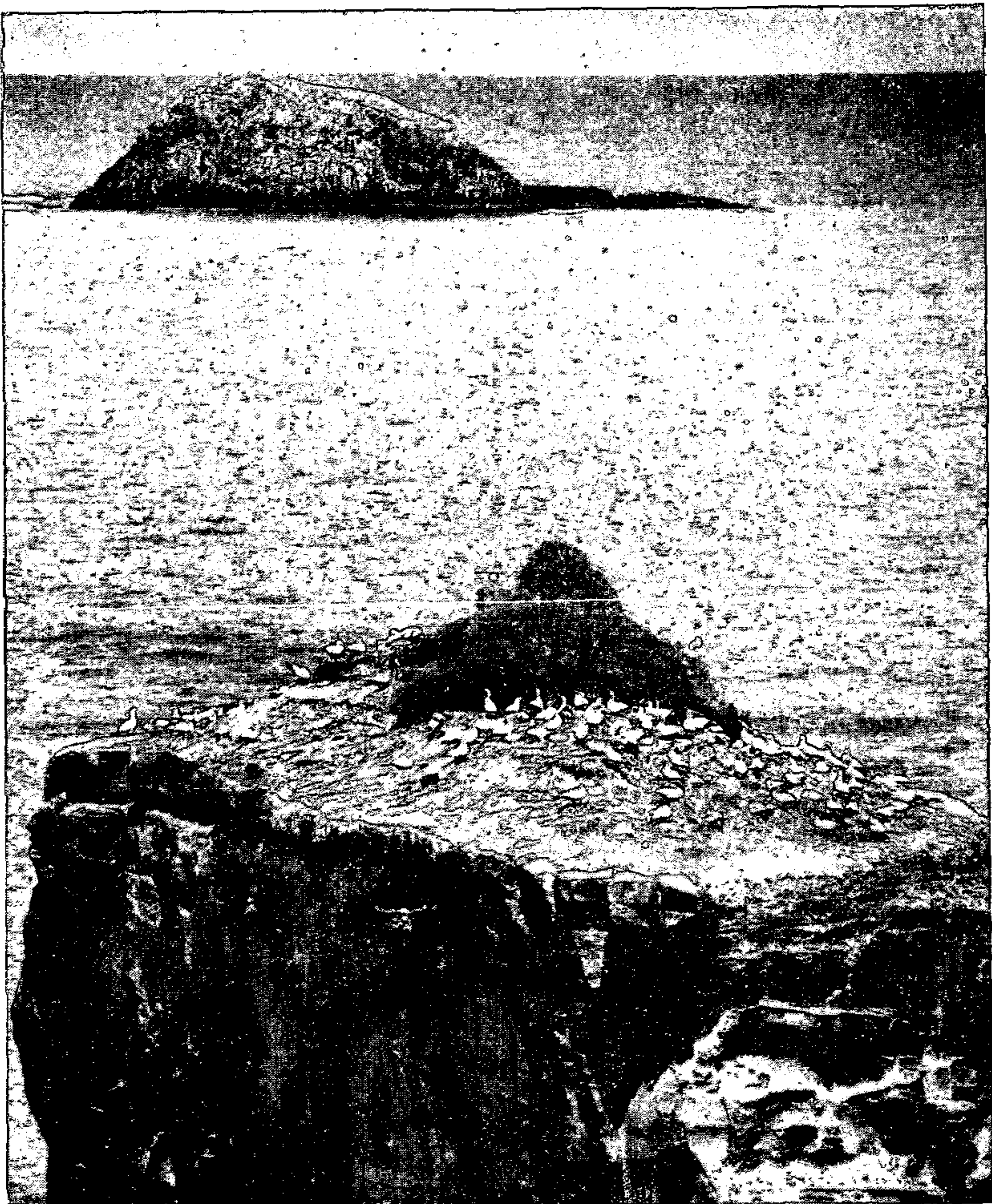


FIGURE 5 — Gannets nesting 1975-76. First season on the rock. Oaia Island in the distance. Photo: Olaf Petersen

and making nest-building movements, and a little sparring going on. The colony on 27 November is shown in Figure 6. 93 chicks were present on 23 January 1978. Most on the upper platform were in juvenile plumage and exercising their wings. Many chicks in white down were in nests on the outer slopes, while small chicks and unoccupied birds were on outermost edges (B. D. Heather, pers. comm.). On 12 March 1978, 60 chicks, including 4 still in down, were seen, together with 51 adults. On 9 April only 12 mottled juveniles remained but approximately 150 adults were present.



There were 55 birds on 8 August 1978, with some ceremonial displays in progress; no nests had yet been built. On 20 September, there were 156 birds and 80 nests (no eggs); also 27 White-fronted Terns on ledges on the south side of the rock.

Since its beginning, the colony has increased rapidly until all available space on the top of the rock has been occupied. The accompanying photographs show how the vegetation has been modified. The sides are too sheer to accommodate gannets. During the season, birds often alight on two adjacent platforms on the mainland, but have not so far attempted to nest there.

The rock is conveniently situated for viewing from the mainland, no disturbance occurs and, although the base can be reached at low water, the height and steepness deter all but the expert climber.

It is hoped that this gannetry will continue to thrive. It is both an object of study for local ornithologists and an attraction for the interested public.

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FIGURE 6 — The colony on 27 November 1977.

Photo: Olaf Petersen

## SHORT NOTES

### DOUBLE BREEDING SEASON IN PIED SHAGS ON STEWART ISLAND, FROM RECORDS BY ROY TRAILL

The Pied Shag (*Phalacrocorax varius varius* Gmelin, 1789) has a discontinuous distribution within New Zealand (Bull *et al.* 1978) and there has been some uncertainty about its breeding seasons in different parts of its range. According to Stonehouse (1968): "Laying seasons vary; in the South Island most eggs are laid between July and September, but in the North Island birds lay throughout the year with peaks of breeding activity in spring and autumn." There is equal intensity of egg-laying in spring and autumn at Lake Pupuke (Falla *et al.* 1966). The Australian subspecies *P. v. perthi* has a similar double breeding season in marine environments (Serventy *et al.* 1971). Continuous nesting has been recorded in the South Island from Marlborough Sounds (Soper 1972) and records suggest a similar trend on Stewart Island.

Roy Traill, who has lived on Stewart Island for most of his 86 years, kindly permitted me to inspect his more recent bird diaries in order to calculate annual nesting periods for shags. This account is based on his visits between 1970 and 1977 to a Pied Shag colony at Little Kaipipi (46°54'S 168°04'E), a small bay in Paterson Inlet. Descriptions of Pied Shag nesting behaviour in this area were given by Guthrie-Smith (1914) and Gillham (1965). This species nests at Little

TABLE 1 — Numbers of occupied Pied Shag nests at Little Kaipipi. Observations by Roy Traill.

Year	J	F	M	A	M	J	J	A	S	O	N	D
1970	-	2	-	5	+	-	2	+	5	5	-	4
1971	-	7	6	-	4	3	-	-	12	+	-	0
1972	-	0	3	-	-	-	2	+	-	-	-	-
1973	0	2	3	4	-	6	+	5	7	5	-	-
1974	0	3	4	-	5	7	5	+	6	5	+	-
1975	-	-	3	7	-	7	6	10	10	+	+	-
1976	+	5	6	+	-	5	5	+	-	+	2	-
1977	+	6	6	-	-	-	-	-	-	-	13	-

+ nests occupied but no count made.

- colony not visited.

#### Notes:

September 1971: nests with all stages from egg to large chick.

May and November 1974: all nests with large chicks.

Kaipipi in several Southern Ratas (*Metrosideros umbellata*) on branches which overhang the water. Nests are re-used from year to year and the number occupied per month is shown in Table 1. Roy Traill's records from other Pied Shag colonies in Paterson Inlet are relatively infrequent but show similar trends.

The Little Kaipipi colony was occupied almost continuously during the eight years recorded except for either December, January or February of some years (range 0-7 nests for these months). Nests were re-occupied during January/February in 1973 and 1974 and February/March in 1972. Numbers of occupied nests were fairly constant from March to July (range 3-7) and maximum annual numbers occurred from August to November (range 5-13). Roy Traill suggested that these birds have two annual egg-laying periods: summer and winter. These two periods overlap in winter but not always in summer. Pied Shags in Paterson Inlet therefore have breeding cycles similar to those recorded in the North Island, except that more nests are occupied in spring than in autumn. Without banding, it cannot be known if the same birds breed more than once in a year.

The other three shag species common on Stewart Island have extended but apparently not continuous breeding seasons. The Little Shag (*P. melanoleucos brevirostris*), which often nests in association with the Pied Shag, lays eggs in mid-winter, with most young fledged by September (Guthrie-Smith, 1914). Roy Traill has seen chicks as late as December but Richdale's report from Stewart Island (*in* Oliver, 1955) of eggs in January and chicks in May appears exceptional. The breeding season for the Stewart Island Shag (*Leucocarbo carunculatus chalconotus*) is not fully documented but probably extends from August to February in Foveaux Strait (Guthrie-Smith, 1914; Oliver, 1955; Watt, 1975). Nesting of the Blue Shag (*Stictocarbo punctatus stadi*) coincides with that of the Little Shag. Roy Traill has recorded mating plumage in June and July; eggs in July and August; chicks usually fledged by October, but occasionally as late as December. This contrasts with Oliver's record for eggs from November to January, but the latter dates from a period when Blue Shags were relatively rare (Stead, 1948) and did not nest in or near Paterson Inlet.

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## THE STARLING: A POTENTIAL BROOD PARASITE ?

On 15 December 1977, in an orchard at Havelock North I found in a Myna nest box three Myna nestlings which from their primary feather length and general development I estimated to be 15-17 days old, together with one Starling nestling approximately 18-19 days old. All were healthy, and only adult Mynas carrying food visited the nest — no Starlings were seen.

At 0045 hrs on 17 December 1977 I saw the brooding female Myna leaving the nest box, and at this time the Starling and all three Myna nestlings were still present. When D. G. Cooper checked the nest box again after dark on 19 December 1977, only the three Myna nestlings remained. The next day (20 December) a fledgling Starling was seen a few metres from the nest box and an adult Myna was nearby, but nothing in their behaviour indicated a parent/fledgling bond; there were no other Starlings nearby. The Myna nestlings fledged between 21 and 25 December, and were observed with their parents several times over the next few days, but the Starling fledgling was not seen again.

The Starling nestling may have fledged from a nest nearby, and then entered the Myna nest, as frequently happens between Starling broods (Johnson & Cowan 1974). However, although some Starlings would be capable of flight at 18-19 days old, in New Zealand undisturbed nestlings usually leave at about 23 (19-26) days (J. E. C. Flux, pers. comm.). A more likely explanation in my opinion is that the nestling had been reared from a Starling egg laid in the Myna nest and incubated along with the Myna's clutch. Dumping of eggs in another pair's nest is not unknown in Mynas (pers. obs.) and quite common in Starlings (Yom-Tov *et al.* 1974). Judging by the age of the nestlings, incubation of both the Myna eggs and the Starling egg would have begun together, and, as Starlings incubate for 12 days and Mynas for 14 (Wilson, 1975) the Starling chick would have hatched first.

During a 7-year study of Myna breeding biology in Hawkes Bay (Wilson 1973, and unpubl.), over 400 clutches of Myna eggs were observed. None contained Starling eggs and no Starling nestling was found with a Myna brood. Clearly any laying by a Starling in a Myna nest is a rare event, but one with interesting evolutionary possibilities.

Both the Myna and the Starling are introduced to New Zealand and their ranges overlap north of 40°S. The feeding niches of both overlap (pers. obs. and Moeed 1975). Both take insects on the surface, though Starlings also probe for subterranean invertebrates and Mynas feed more fruit to their young. Both are hole nesters and lay very similar eggs; the breeding seasons overlap considerably; and the larger Myna can reduce Starling breeding success to very low levels by destroying eggs or nestlings in accessible nests. At inaccessible nests they even kill Starling nestlings by calling them to beg at the entrance (Wilson, 1973).

Brood parasitism will evolve only in species where it results in more offspring than would have been produced by ordinary breeding (Hamilton & Orians 1965), and is rare in birds as there are only seven families or sub-families where it is practised and only one of these contains more than a dozen species (Lack 1968). It follows that there must be unusual and special reasons for its evolution, and it is possible that the severe effect of Mynas on Starling breeding success could be sufficient. Certainly the incubation period of the Starling, being 2 days shorter, would give the Starling an advantage in brood parasitism.

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### WHITE-NECKED HERON NEAR MATAMATA

On 12 July 1978, while motoring south of Matamata, eastern Waikato, near the junction of highways 27 and 29 at about 0915 hrs, I noticed an unusual heron in flight. At first I thought it to be a White-faced Heron (*Ardea novaehollandiae*) but as I approached, I realised it was much larger, with a full white neck and darkish beak. It was flying higher than is usual for the White-faced.

The wings and upper parts of the body looked a darkish grey-blue, perhaps navy blue, and the body a lighter dull grey below. The wing beats were powerful, deep and slower than those of the White-faced.

As I turned into highway 29, the bird had passed me, flying south towards Tirau but, by the time I had turned back on to highway 27, it had swung west. It finally disappeared from view westward across open farm land. By its size and the whiteness of its neck, the bird could only have been a White-necked Heron (*A. pacifica*), which is widespread in Australia but has been recorded in New Zealand only once before, near Methven in April-July 1952 (Stidolph 1952, *Notornis* 5: 38).

In the frantic confusion of the occasion, I did not see more detail, particularly the white at the angle of the wing. A further search on the following days was unsuccessful.

A. R. LACEY, 3 Burwood Road, Matamata.

## SHAGS ON SHIPS

The two following notes contain further evidence of the crossing of the Tasman Sea by shags. Both were made by friends of Captain John Jenkins who in his absence asked me to prepare them for publication.

The first note, from a diligent diarist, indicates that some Black Shags were crossing the Tasman in the spring of 1976.

R.B.S.

6 November 1976. *Marama*. Sydney to Wellington. Two Black Shags were seen flying around the ship in the morning. By the afternoon, 12 Black Shags were about, mostly sitting on the radar mast. At noon the vessel was 659 miles (1061 km) from Sydney, about in mid-Tasman.

P. BRAE

On 26 November 1977, M.V. *Karepo* was steaming north off the west coast of New Zealand on a voyage from Westport/Greymouth to Portland (Whangarei). As we passed about 50 miles (80 km) off Kahurangi Point we were joined by a group of shags. I put the number at 13, but others gave differing figures from 10 to 18. When I first saw them, they were following in the wake. I did not recognise them as they were soaring as gracefully as any other seabird and were not using the cumbersome flapping flight I associate with shags. Towards evening, they came aboard and roosted overnight on the hatches and rails just forward of the bridge, despite heavy spray which at times was sufficient to dislodge them.

I am familiar enough with New Zealand shags to say that these were definitely shags. At first I thought they were young as I was sure they were slightly smaller than usual, but then I realised that they were all-black, with no white patches at all, a type of shag I had not seen before.

Next morning, 27 November, they were flying early and the numbers steadily dwindled. They kept flying and roosting during the day but, although I watched as much as I could, the group over the wake just seemed to decrease. The last vanished when we were 20 miles (32 km) to seaward of Reef Point.

B. M. COMMONS

We regret to announce the death on 23 February 1979 of Sir Robert Falla, a founder, the first President and a long-serving Council member of OSNZ. Sir Robert was a world figure in ornithology and a guide and friend to many ornithologists. An appreciation will appear in the next issue.

## LETTERS

The Editor,  
Sir,

6 October 1978

I have long had a grave disagreement with the 1970 *Annotated checklist of the birds of New Zealand*.

As an osteologist and systematist, I cannot agree with the relegation of Dieffenbach's Rail to a sub-species of the Banded Philippine Rail. The two are as distinct as the Takahe and Pukeko — a distinction which the 1953 *Checklist* maintained.

While I have no doubt that both rails had a common ancestor, Dieffenbach's Rail had diverged so widely in its isolation in the Chatham Island that I consider it not only specifically but generically distinct, and retain *Nesolimnas* for the genus. That, however, is a matter of personal preference and, if others use *Rallus*, it does not matter: what is important is that the two are specifically distinct. Apart from the decurved bill in *Rallus dieffenbachii* compared with the straight one in *Rallus philippensis*, *dieffenbachii* lacks a rostrum on the sternum and instead has a deeply incurved notch. The same distinction is found between *Notornis*, which also has no rostrum but instead has a similar incurved notch, and *Porphyrio* which has a pronounced sternal rostrum.

The pelvis of *dieffenbachii* is also more curved along the ilia in lateral aspect than is *philippensis*, but this and the much greater size of *dieffenbachii* are of less importance.

I admit the plumage similarities between both rails, but then Takahe and Pukeko also share plumages that are much alike. As the immortal Huckleberry Finn replied when Tom Sawyer quoted "Birds of a feather flock together," "No indeed they don't, Tom. There ain't two birds more alike than a crow bird and a jay bird, and them two birds don't flock together not no how."

This seems an appropriate place to correct a serious misprint in the 1970 *Checklist* in Appendix C. *Euryapteryx gravis* (Owen 1870). The locality list should be "N.Is. (rare) S.Is. Stewart Island."

R. J. SCARLETT

*Osteologist, Canterbury Museum.*

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The Editor,  
Dear Sir,

5 January 1979

Despite the risks of offending Archie Blackburn, for whom I have the greatest respect, and of defending jargon, for which I plead guilty, I feel a response to Blackburn (*Notornis* 25: 256) is required.

Jargon is, unfortunately, an accepted and often necessary part of the language of science. Its function lies primarily in streamlining

technical communication between specialists in a field. In a journal of such general readership as *Notornis* its use should certainly be avoided wherever possible. There are times, however, when jargon terms become increasingly accepted in laymans language — an acceptance which is justified by the usefulness of the terms. "Evolution" and "territory" are two such terms which, despite extremely wide use and acceptance, do not yet have definitions that are totally acceptable to all biologists. That a term is jargon is not good enough reason, of itself, for outright rejection of its use.

The term "strategy" has gained increasing acceptance in the biological literature in recent years. References to foraging strategies, growth strategies, breeding strategies, evolutionary strategies, etc., abound, and I submit that popularisation of the term by North Americans is not a reason for its rejection. Traditional meanings of "strategy" are those given by Blackburn, but in recent American dictionaries the term is also defined more generally: "a plan or technique for achieving some end" (Funk and Wagnalls, 1974); "the art or skill of using stratagems in politics, business, courtship, or the like" (Heritage, 1973); "a stratagem, plan, etc.", with stratagem defined as "any tricky ruse" (Websters, 1977). Changes in meanings of words in the English language are a part of our cultural evolution. Outright rejection of such changes, as implied by Blackburn's use of the term "absurd," can only stultify an evolution which is essential in a rapidly changing society.

A major problem with "strategy" in the biological literature is the overtones of teleology in its meaning. Thus Blackburn asks "are birds capable of planning . . . ?". In fact, end directed behaviour can, and must, be a part of an animal's existence. Reproduction, which ensures survival of genes through generations, is the classic example of this. All animals exhibit behaviour for which the end product is reproduction, even if this is a simple release of gametes. This behaviour need not, however, result from conscious selection of behaviours from a series of alternatives. Behaviours leading up to reproduction are a direct result of natural selection acting on preceding generations. The "end" is maximal production of reproducing offspring. In a sense, this is compatible with definitions of strategy involving war, since animals compete for resources as a part of their strategy.

I am prepared to argue that if eminent British biologists such as J. Maynard Smith and Richard Dawkins (see the evolutionary stable strategy, or ESS, in Dawkins, *The Selfish Gene*, 1976, Oxford University Press) are happy to use the term, then it is acceptable in *Notornis*.

Yours faithfully,

IAN G. McLEAN

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Albert, Edmonton, Alberta, Canada*



## REVIEWS

*The Sulidae: Gannets and Boobies* by J. Bryan Nelson (with a foreword by V. C. Wynne-Edwards). 1978. Oxford University Press. 1012 pp.; 404 figures, maps, photographs and field sketches; 14 col. and 18 b. & w. plates; 19 appendices; bibliography; 275 x 195 mm. £40.

To review critically a monograph as vast as this in a single *Notornis* page is patently impossible: I shall merely try and give some idea of the book's scope and of its relevance for the New Zealand ornithologist. The work is one result of Bryan Nelson's 19 years' devotion to the task of unravelling the biology of the world's gannets and boobies during which he worked in Britain, The Galapagos, Peru and Christmas Island (Indian Ocean). One might have concluded that Dr. Nelson would have exhausted his subject: not so — at the time of writing (December '78) he and his wife were taking a long hard look at our Cape Kidnappers' birds. . . .

Each of the nine sulids is dealt with under four main headings — (1) Nomenclature (external features, morphology, moult and voice), (2) breeding distribution (numbers and other aspects of population), (3) breeding ecology and (4) breeding behaviour. Apart from historical aspects (mostly deliberately ignored), the coverage is very extensive if not exhaustive and reflects the author's personal experience and the published work of others. For instance, the account of the North Atlantic Gannet covers 154 pages, that of the Cape Gannet 25 pages, that of our Australasian Gannet 33 pages. This last section is based mainly on the work of Wodzicki, Stein, F. H. Robertson, Probine and McMeeking in New Zealand and of your reviewer at Cat Island, Tasmania, with some recent data from C. J. R. Robertson. There are notes on all the Australasian gannetries (the colonisation of Norfolk Island was perhaps too recent to be included), maps of Australian recoveries of N.Z. birds, diagrams of the changes at the Cape Kidnappers colony and of the age structure of the population there, etc., etc. The result is that this chapter provides an excellent account of our gannet which is especially interesting for the comparisons of the ecology and behaviour of the three forms of *Sula bassana* — summarised in a table extending over four pages. Nelson points out that the Australasian Gannet is the second rarest sulid (after Abbott's Booby) and has a very restricted breeding distribution.

In the final chapter — virtually a book in itself — many strands are drawn together in comparing the nomenclature, evolutionary relationships, morphology, distribution and numbers of the nine species.

Throughout the book, attractive and relevant sketches support the text and photographs have been used lavishly. Although most are printed by offset, the majority have reproduced well.

This is a long, well written work of scholarship. It is reminiscent of James Fisher's *The Fulmar* in that virtually every gannet and booby colony is described but *The Sulidae* is a more balanced book, with behaviour and breeding ecology occupying a major part of the text. Despite the high price it is good value for money, and Dr Nelson gets no royalties on sales. Everyone undertaking serious work on sulids will need to own or to have access to a copy.

— J. WARHAM

*Rails of the world*, by S. Dillon Ripley, with illustrations by J. Fenwick Lansdowne. 1977. Pp. xx + 406. David R. Godine, Boston. \$US 75.00.

This extremely handsome book continues a recent trend towards large, expensive and well-illustrated books on comprehensive reviews of different families of birds. One result is that they all have rather similar titles; for example, Forshaw and Cooper's recent *Parrots of the world*. However, for those with fragile coffee tables, this volume weighs less than half.

The author is well known and so, too, is Storrs L. Olson who has contributed the chapter on fossil rails. Readers may remember that Olson, not long ago, made a contribution to the fossil rails of New Zealand. I must confess that the artist was not previously known to me, but perhaps he should be, as the 41 colour plates he has contributed are magnificent — a difficult standard to achieve, perhaps, when rails are generally rather drab birds. Although the dust-jacket says that all species are illustrated, in fact this is not so: six are missing by my count, at least two of them common species, and their absence cannot be excused on the grounds that there are no specimens available or that plates have not already appeared elsewhere. Perhaps this claim could be corrected in any future edition. There are a few black and white photographs (which in my opinion have only marginal value) and a series of maps and text figures which are very useful indeed.

When a reviewer reads a book of this wide range, it is natural to look most critically at those sections which most closely concern his own country or those species of which he has particular knowledge. Generally, one may assume that mistakes are typical of other sections too, the net result being such a compounding of errors that the book could not be regarded as highly authoritative. In this regard, Ripley has done a satisfactory, though not outstanding job on the living rails of New Zealand. However, it is obvious that, in his self-imposed task of reviewing the family in its world context, he has not been able to keep fully up-to-date, even with the local literature. For example, in his discussion on the Weka he has made some errors: over-emphasising its crepuscular character, being obviously not too familiar with its calls, and over-stating the extent to which wekas have adapted to the urban environment. He even says that wekas have "adaptability to habitat which, as I have pointed out elsewhere, has great survival value." Surely a truism if ever there was one!

His article on the Takahe (which he calls *Porphyrio mantelli*, I think rightly) gives too much emphasis to the species' preference for marshy habitat. Furthermore, he makes such incorrect statements as "no more than two eggs are laid," "no more than one chick is ever reared" and he certainly has incorrect data on the survival of chicks hatched at Mount Bruce between 1972 and 1976. Incidentally, it is gratifying that he has chosen the Takahe as his frontispiece. My main reservations about this fine painting are that the legs are too massive and their colour far too light.

Olson's chapter on fossil species is good and for the New Zealand region he recognises six genera and seven species. His treatment of the fascinating fossil rails of the Hawaiian Islands is too tantalisingly brief. One useful and instructive matter which Olson

discusses is the etymology of the scientific names of the fossil rails; it is a pity that Ripley did not follow him in this, especially as the introductory chapters show that he is not only well read, but writes well.

The book is well designed, well printed and well bound. Although expensive, it is worth buying by those who have \$75.00 to spare; not only for its information and the beauty of its illustrations but also for the rather materialistic reason of a good investment. New Zealand ornithologists should at least try to examine this book; I doubt if the more dedicated could then resist buying a copy if they can get one, which won't be easy.

— G. R. WILLIAMS

*Sounds of New Zealand birds, Vol. 8.* 1977. McPherson Natural History Unit, P.O. Box 21083, Edgeware, Christchurch.

A 45 rpm record of calls of 10 species of wader. All are on the New Zealand list but two (Bristle-thighed Curlew and Upland Plover) are barely so. A third, the Pacific Golden Plover, is represented by tape recordings from Manatoba (*sic*), presumably Manitoba Province and therefore of the American Golden Plover (*dominica*) and not the subspecies (*fulva*) that migrates to New Zealand, though some of its calls seem alike.

The quality is high, with only rare blemishes due to irrelevant background sounds and "blasting" from too high a recording level or too close a microphone, hardly the fault of Mr McPherson. The recordings are bound to intrigue the New Zealand wader-watcher, even if tapes made on boreal breeding grounds have mainly academic interest in the south.

The Eastern Bar-tailed Godwit, recorded at Heathcote Estuary: a lively chorus of flocked birds, presumably at a high tide roost — a nostalgic sound but it does go on and on! Asiatic Black-tailed Godwit: a selection of fascinating, well-recorded calls made on nesting territory, not stated where (French Institut Echo collection). Hudsonian Godwit: calls of male at nest, Fort Churchill, Manitoba; a monotonous series of simple notes so undistinctive that they might be anything (Cornell University). Japanese Snipe: a variety of grating calls against quite a strong background of small passerines and a cuckoo, a veritable "spring cantata" (Radio Japan). Turnstone: an excited sequence of rapidly repeated notes, some of which can, I think, be heard in New Zealand flocks, but the tape was made in June in South Finland.

"Asiatic" Whimbrel: song, calls and alarm notes near nest, recorded in Finnish Lapland and Sweden in June; glorious sounds, beautifully recorded, surely the most exciting passage on the disc. American Whimbrel: recorded on 8 March in Massachusetts, flying over a marsh, presumably on passage, though the date seems too early. The two whimbrels differ strongly but, as the recordings were made at quite different times in the annual cycle, the difference may not be significant. Bristle-thighed Curlew: in flight at Oeno Island (88 km NW of Pitcairn), thus in winter quarters; a musical *tee-a-wee* call echoed apparently by others in the distance. Upland Plover: recorded in New

Jersey in June; strident whistles, sometimes repeated as a chatter, but calls of other species in the background make identification somewhat hazardous.

Naturalists who regularly observe waders may benefit from having these tapes on tap but their value would have been increased by more documentation (of other bird calls in the background and of behavioural setting). Ideally, each species should be represented by song on breeding grounds, flight calls, alarm calls, and calls in winter quarters, all identified as such. This should soon be possible, to judge by the tape resources Les McPherson has been able to draw upon already.

— C. A. FLEMING

*Australian bird calls. Series Two: Western Australia*, by John N. Hutchinson. Available from author, Balingu 6253, Western Australia. \$Aust 8.00 per cassette or disc, post paid.

This stereo cassette contains the songs or calls of 25 Australian birds and three atmosphere or habitat recordings and is the equal of the earlier disc by this author.

The only complaint I have is that there is no verbal introduction to each species but this is offset to some degree by the use of a data sheet which comes with the tape and indicates precise times when a given species starts its song or call. Other information on the sheet includes the background sounds per channel, the date of recording, locality, time, temperature and the cloud type and wind.

One of the most striking recordings is of a Kangaroo hopping past the recording station from left to right, together with a strong background chorus from four bird species, three of which feature as soloists later in the recording. The only species that was on Mr Hutchinson's first disc and appears again is the White-tailed Cockatoo, a species over which there is much discussion at present. The early disc gave an example of song from the Long-billed, while the new one gives an example from the Short-billed variety.

This cassette is by far the most superior I have heard so far. There is none of the background rumble so common to pre-recorded cassettes of natural sound these days. Mr Hutchinson is to be very highly commended for this fine-quality recording.

— L. B. McPHERSON

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## SHORT NOTE

### TUIS FLYING WITH BILLS OPEN

On 27 January 1978, a very hot day, the temperature being about 30°, flax at the Mt. Bruce Bird Sanctuary was still in flower and about a dozen Tuks were feeding on the nectar. In every instance when the birds were seen in flight they had their bills open, apparently as a cooling action.

R. STIDOLPH, *Masterton*