

required, conversion factors for gut contents, calcareous skeleton, and alcohol solutes were not applied; it seems unlikely that these are of great precision, and it is clear that if the absolute values of organic material are required for productivity studies then a technique which involves ashing, after decalcification if necessary, must be used.

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The Northern Blue Penguin

(*Eudyptula minor Novaehollandiae*)

in Wellington Harbour

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The following is a summary of observations made on the northern blue penguin in the Wellington Harbour area during the 1954-55 nesting season and continuously from August 1956 to March 1958.

Somes Island, situated in the middle of the Wellington Harbour, was chosen for this study mainly because of its comparative isolation and its closeness to Wellington, and the fact that it was known to have a large penguin population. The island is used as a quarantine station, is closed to the public, no predatory mammals occur, and so the birds are virtually undisturbed throughout the year.

METHOD OF WORK

During the 1954-55 nesting season fairly regular day visits were made to the island and

only burrows occupied for nesting were observed at each visit. Notes were taken on incubation time, growth of chicks, and the time the chicks stayed in the burrows.

As insufficient data only could be assembled during that year, observations were repeated during the 1956-57 nesting period, by regular weekly day visits (interspersed with more visits if considered necessary). It was soon realised that because of the nocturnal habits of the birds no movement could be observed during day visits and therefore three nights were spent on the island during this nesting season. During the same season ringing of birds was started to facilitate recognition of individual adult birds, and all accessible chicks (21) were ringed. Adult birds and chicks were weighed as regularly as possible by means of spring balances and a cloth

bag, the weight of which ($\frac{1}{2}$ oz.) was disregarded with adult birds, but was subtracted when weighing chicks.

Starting from March 1957 and up to February 1958 regular weekly visits were made to the island, irrespective of weather, each lasting for at least one whole night and one day, and often these visits were extended to include two days and two nights.

Some intermediate visits were added when accurate data on individual nests or burrows could not be obtained from weekly visits only. During night visits at least one, sometimes two complete tours of the island were made, mainly on the areas near sea level, where more penguin traffic occurred and also mating and roosting places were more easily found. The remainder of the island was more or less ignored, but any nests found by chance further inland were subsequently followed up. The following day a complete tour of the island was made again to ascertain the number of birds which stayed on land.

From February to August all adult birds were ringed, and weighed whenever met with, and 35 chicks from accessible nesting burrows were also ringed. During the two years concerned, i.e. up to March 1958, 435 adult birds and 56 chicks were ringed.

The rings used were specially designed flipper rings, which were placed on the right flipper. The inscription on the ring is a serial number followed by "Send Dom. Museum N.Z." The rings used did not impede the birds in any way and did not even appear to be noticed immediately after their application. (Birds were observed preening shortly after ringing and not even at that stage did they try to pull the ring off, or peck at it.) The only dissatisfaction encountered with the rings was the actual material used (duraluminium) which does not withstand the corrosive effects of the sea water sufficiently and rings had to be exchanged at fairly short intervals.

The number of penguins on the island was estimated at 300 breeding pairs, not including non-breeders. All occupied nesting burrows and regular night-roosts found were marked with numbered pegs.

THE YEARLY CYCLE

The whole yearly cycle of the northern blue penguin can be divided into three parts:

(a) August to January (Breeding).

(b) December to March (Moult).

(c) March to September (Occupation of nesting burrows and pair formation).

AUGUST TO JANUARY (*Breeding*)

Nests of penguins can be found anywhere, from sea level to the top of the island. The places most frequently chosen are holes and crevices under and between large boulders, in caves, and nests were found also in and under clumps of flax, tottoi or rush and, where sufficient topsoil was available, in dug burrows.

Most burrows contain nesting material, and only very seldom are eggs laid on the bare ground. The material consists of dry grass, sticks or seaweed and the amount seems to depend on its availability in the immediate surroundings of the site chosen.

Courtship-display and greeting ceremony are very similar and are performed only within the nesting burrow. Copulation takes place on land only, and was observed in nesting burrows and night roosts.

Clutches of one or two eggs are usual, very rarely do three egg clutches occur. The percentages of one and two egg clutches appear to remain fairly constant every season being in the vicinity of 30% and 70% respectively during the three breeding seasons observed. Egg laying began in early August and ended about the middle of November, the peak period was usually during the second half of August. Average measurements of 41 eggs from Somes Island were 56.36 x 43.08 mm.

Eggs are normally laid at an interval of 1-2 days, but intervals of up to 7 days were observed. Incubation began with the laying of the second egg and chicks hatched the same day, or one day apart. Variations occur in the start of incubation, and some chicks were observed hatching up to 5 days apart.

The shortest incubation time recorded was 33 days and the longest was in excess of 47 days. The usual incubation time appeared to be 35-38 days. Both male and female incubated, and in most cases the female carried the main share of incubation, although in some pairs this procedure was reversed. Usually the incubating birds were relieved during the early hours of the night, the partner carrying the main duties taking over again before daybreak, i.e., the bird (male or female) which had taken over the main incubation duties continued for approximately 16 to 17 hours in every 24 hours. Variations also occurred in this pattern and sometimes the

incubating bird was not relieved for 48 hours or more.

Chicks when hatched are very weak and are not able to lift their heads during the first 24 hours; in this time they are not fed. One or other of the parents remained with the chicks day and night for some time, this continuous attendance varying in length from 10 days up to three weeks. During this period chicks were fed regularly every night by the relieving bird, the exchange taking place early each evening, the guard bird then returning to sea until the following evening. Later, when the chicks are left alone, they are fed by both parents regularly every night, until they leave the nest.

The time taken from hatching to leaving the nest varies from 49 to 60 days. During the whole period in the nest chicks go through several conspicuous plumage changes, which make it possible to fix their age fairly accurately.

Nest losses on Somes Island were very high, and reached 42% during the 1956-57 breeding season and 53% during the 1957-58 breeding season; most of these losses occurred during the egg stage.

Only about 10% of the pairs which lost the first clutch re-nested, and the intervals between the abandonment of the first clutch and the laying of the second clutch varied from 22 to 50 days, indicating that a period of at least three weeks was necessary for relaying.

The hatching and fledging successes during the 1956-57 and 1957-58 nesting seasons were practically identical; 59% and 54% respectively of all eggs laid were hatched. The number of young fledged represented 51% and 50% of all eggs laid. The productivity in the two seasons was 0.9 and 0.8 chicks per pair respectively.

DECEMBER TO MARCH (*Moult*)

As soon as the chicks leave the nest adult birds start a period of intensive feeding to reach the physiological condition necessary to go through the moult. During this preparatory period they return to land only at irregular intervals for night visits, which they spend in burrows; they do not stay on land during the day.

When a bird arrives on land for moulting, it is in good physical condition, very fat, and weighs a good deal more than its normal weight. The average weight of 35 males weighed when arriving on shore to moult was 3 lbs. 13 ozs. and the average weight of 27 females was 3 lbs. 1 oz.,

i.e. 1 lb. 1 oz. and 11 ozs. more than their normal average weights respectively. This excessive weight appears necessary to enable them to stay ashore for the duration of the moult, without food. The time necessary for moulting varies from 12 to 18 days, with an average of 15½ days, during which time between 40% and 50% of the initial body weight is lost.

The interval between the time the chicks leave the nest and the return of the adult birds to moult varies from nought to eight weeks, with an average of four weeks, and seems to depend on the actual physical condition of the adult bird after the chicks have left the nest.

If a bird increased in weight during the nesting period, it returned for moulting sooner than a bird which lost weight during the nesting period. From weights taken on one bird during the pre-moulting stage, it was found that the weight increase was not a gradual but a very sudden one and that it occurred only during the last week before the bird settled down to moult. In this case the bird gained nearly 1 lb. within four days. After completion of the moult birds returned to sea, where they apparently regained normal weight in a comparatively short time.

During the whole moulting period, i.e. up to the middle of March, moulted birds spend all day and many nights at sea, returning to land only for irregular night visits. During this time they never enter burrows and are never seen to spend daylight hours ashore. No calling of any kind is heard at this time.

MARCH TO JULY (*Occupation of nesting burrows and pair formation*)

The quiet period described above changes suddenly during the second half of March, when birds return in large numbers in the early evenings to spend the nights on land. The birds return singly, in pairs, or in small groups (up to nine observed), calling continuously until actually coming ashore, just after darkness falls. From this time onward small numbers of birds often spend a whole day on land. For the first two weeks most birds spend the night sitting on beaches and between rocks, and do not enter caves or burrows, but by the beginning of April most have re-occupied burrows and very few are found spending the night in the open. The number returning to the island is fairly constant throughout this time (the winter), except during the second half of May, when a considerable decline in numbers was recorded.

Notes on this period (March–July) have not been worked out fully yet, but the following observations are of interest:

The northern blue penguin is more or less confined to the breeding area and returns to land throughout the year for regular night visits. Adult birds adhere strictly to the adopted territory and land always at the same place.

Pair formation is retained for several years, and possibly for life. Although one or other bird of a pair will keep company during the winter with another bird of opposite sex for a shorter or longer period, it will immediately accept its old mate as soon as it turns up.

Pairs will re-occupy their nesting burrows regularly from year to year, the sites being the meeting place of the pair. The partner first arriving occupies the burrow or any other nesting site and remains in occupation until the second partner arrives.

MOVEMENT (*Ringing results*)

Over 300 of the 435 "adult birds" ringed on Somes Island were seen again on the island, and many of them were met with regularly. One bird was found breeding under a boat shed on Petone foreshore, 11 birds were recovered dead, and only two of these were found outside the Wellington Harbour area.

From the results obtained through ringing it was found that adult birds which have established a home territory on land, will always return to this territory when coming ashore, and only in exceptional cases did birds land for a night on strange territory. Such exceptions were two birds ringed on Somes Island in April and June 1957, respectively, one of which was found breeding near Petone on 18/8/57, and one was found killed by a train near Ngauranga on 16/10/57.

When at sea birds will never wander very far from their home territory, and it is doubtful if Somes Island breeding birds ever leave the Wellington Harbour area. Ringed birds from Somes Island have been seen feeding off the Wellington wharves, near Days Bay, and off Petone foreshore, and can be seen returning to

the island during the early evenings from any direction. Birds at sea feed singly, in pairs, or in small groups, and apparently a strange bird sometimes gets caught up with such a group and will then be brought to the island and spend a night there. This association in groups and their return to the island will also explain the rare cases when birds, well known to be established in one area of the island, are to be seen on a different place one night, only to be found at their accustomed place during a subsequent visit. The strict adherence to the home territory may also be illustrated by observations made on Ward Island and Leper Island, which were visited at night, and although many birds were found on land, never was a Somes Island ringed bird seen there. In the case of Leper Island this is especially interesting, as this island is only about 150 yards distant from the northern end of Somes Island.

Over 100 of the birds ringed on Somes Island were never seen again on the island. Some of these nested further inland, and it is probably for this reason that they were not seen again, but many of them were probably sub-adult, non-breeding birds, which had not yet established a territory, and were still wandering.

Distances covered by such birds appear to be substantial, as can be seen from the two recovered birds outside the Wellington harbour area. One of these was a female, ringed in April 1957 and recovered only one month later east of the Wainuiomata river mouth, i.e. 12 miles from where ringed, and the other, a male ringed 26/4/57, was recovered dead on Hokio Beach, just south of Levin, about 80 miles from where ringed on 15/3/58, i.e. nearly one year later.

From 56 chicks ringed during the 1956 and 1957 breeding seasons, only one was recovered dead. This was found at Evans Bay about four months after leaving its nest on Somes Island. Only through further ringing of chicks and further observations, probably for several years, may something be learned about the wanderings of the northern blue penguins during the immature stage, the age at which they start breeding and whether they return to where they were hatched, or disperse to other areas.