THE CAPE PIGEON, *Daption capensis* Linnaeus, AT SIGNY ISLAND, SOUTH ORKNEY ISLANDS

By R. PINDER

ABSTRACT. About 12,000 pairs of cape pigeon (*Daption capensis*) breed on the coastal cliffs of Signy Island. After a period of absence in winter, the birds return in mid-August or early September in an open year but not until late September or October if the island is surrounded by sea ice. Day-to-day observations of marked and sexed birds at 50 marked nests demonstrate that most pairs re-form at the nest used in the previous season. In the pre-laying period the male spends most time at the nest, and there is a total exodus of breeding females for the 2 to 3 weeks before eggs are laid. Despite wide fluctuations in the date of return from year to year and region to region, egg-laying is remarkably synchronous from year to year throughout the range of the species. The male takes over incubation within 24 hr. of laying and thereafter both parents alternate in incubation spells lasting about 4 to 5 days. Egg losses are fairly high during the first 8 days but diminish subsequently. The incubation period lasts about 45 days and hatching dates are nearly the same in all years and throughout the range of the species. Chicks are brooded for about 16 days and fed by both parents; their growth in weight is steady until after the end of the brooding period, when feeding becomes less regular. There is a decline in weight during the last week at the nest but the chicks are attended and fed intermittently right up to their departure. The mean departure dates for nestlings were 28 February and 1 March in two seasons. Overall mortality between egg-laying and departure is about 66 per cent. The brown skua is the only significant predator.

After departure of the chicks, breeding birds cease to visit their nests, and there is a total disappearance of cape pigeons from the island during the second week in March. A few breeders and pre-breeders return in late March and April, and some visit their nests. Final departure from the island depends on sea-ice conditions but it usually occurs in June. Banding returns are insufficient to give a clear picture of movements away from the island.

DESPITE its abundance and wide range, *Daption capensis* has received little detailed scientific study. Since the general synthesis of descriptive accounts, mainly from early expeditions and whaling voyages, by Murphy (1936), only the papers by Prévost (1953, 1958, 1963, 1964), and Downes and others (1959) have added much concerning the habits, life history and breeding biology of the species. The present study was designed to supplement this scanty information. It was undertaken between April 1960 and April 1962 as a part-time occupation for the author who for most of this period served as radio operator at the Falkland Island Dependencies Survey station on Signy Island. This station, at Factory Cove, Borge Bay, on the east coast of the island, was established in 1947 (Fig. 1) and since 1962 has been the main centre for biological research by the British Antarctic Survey. The two colonies of *Daption capensis* studied in detail are situated close to the station, but in the course of the study less detailed observations were made on other colonies farther away, and a census of the species on the whole island was carried out.

Distribution of Daption capensis. The cape pigeon is one of the most abundant and characteristic petrels of the Scotia Ridge and northern Antarctic Peninsula. It breeds in small numbers at South Georgia, abundantly in the South Sandwich Islands (personal communication from W. Vaughan), South Orkney Islands (Ardley, 1936; Clarke, 1906) and South Shetland Islands, and less frequently on the northern islands of the Palmer Archipelago and islands east of Hope Bay (Murphy, 1936). The species is truly circum-polar, in the outer or "maritime" Antarctic and the sub-Antarctic, with colonies at Peter I Øy (Holgersen, 1957), Îles Crozet (Falla, 1937), Îles de Kerguelen (Murphy, 1936), Heard Island (Downes and others, 1959), Macquarie Island (Falla, 1937), Bouvetøya (Holgersen, 1945), Snares Islands (Fleming, 1948), Antipodes Islands, possibly the stacks off Campbell Island, Bounty Islands (Bailey and Sorensen, 1962) and Balleny Islands (Dawson and others, 1965). There are small colonies on the Antarctic continent in MacRobertson Land and Enderby Land (Falla, 1937), Terre Adélie (Prévost, 1958, 1964), Windmill Islands (Orton, 1963) and Wilhelm II Land (Godman, 1907–10). The known breeding range is summarized in Fig. 2. Future research may confirm breeding for the Prince Edward Islands.

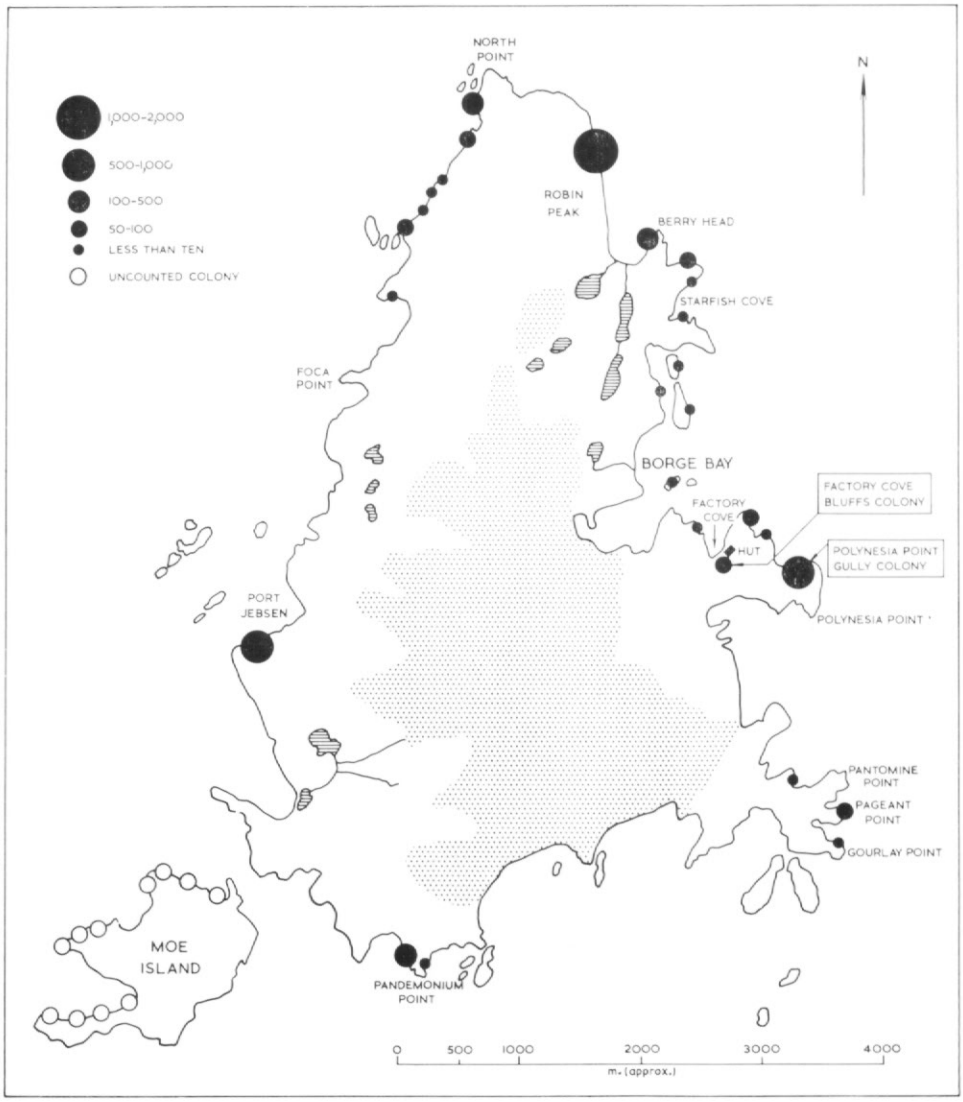

Fig. 1. The location of cape pigeon breeding colonies around Signy Island. Stippled areas are permanent ice or snow.

Cape pigeons range widely in the Southern Ocean. According to Murphy (1936), the species commonly migrates northwards to lat. 10°S. in the centres of the great oceans, while its northward distribution is extended still farther where cool currents or zones of upwelling flank the southern continents. Extreme records up to lat. 16°N. are cited for the west coast of South America. Although there are insufficient banding recoveries to permit definite statement, the migrations of the species probably have two components: a circum-polar drift in the west wind belt, and a broad northerly trend which is seasonally correlated. The population moves north during the southern winter and south towards the fringe of the pack-ice zone in summer. *Daption* does not generally feed in dense pack ice and its movements around Signy Island can clearly be correlated with those of the ice. These movements and the available information on the migration of the South Orkney Islands population are discussed later.

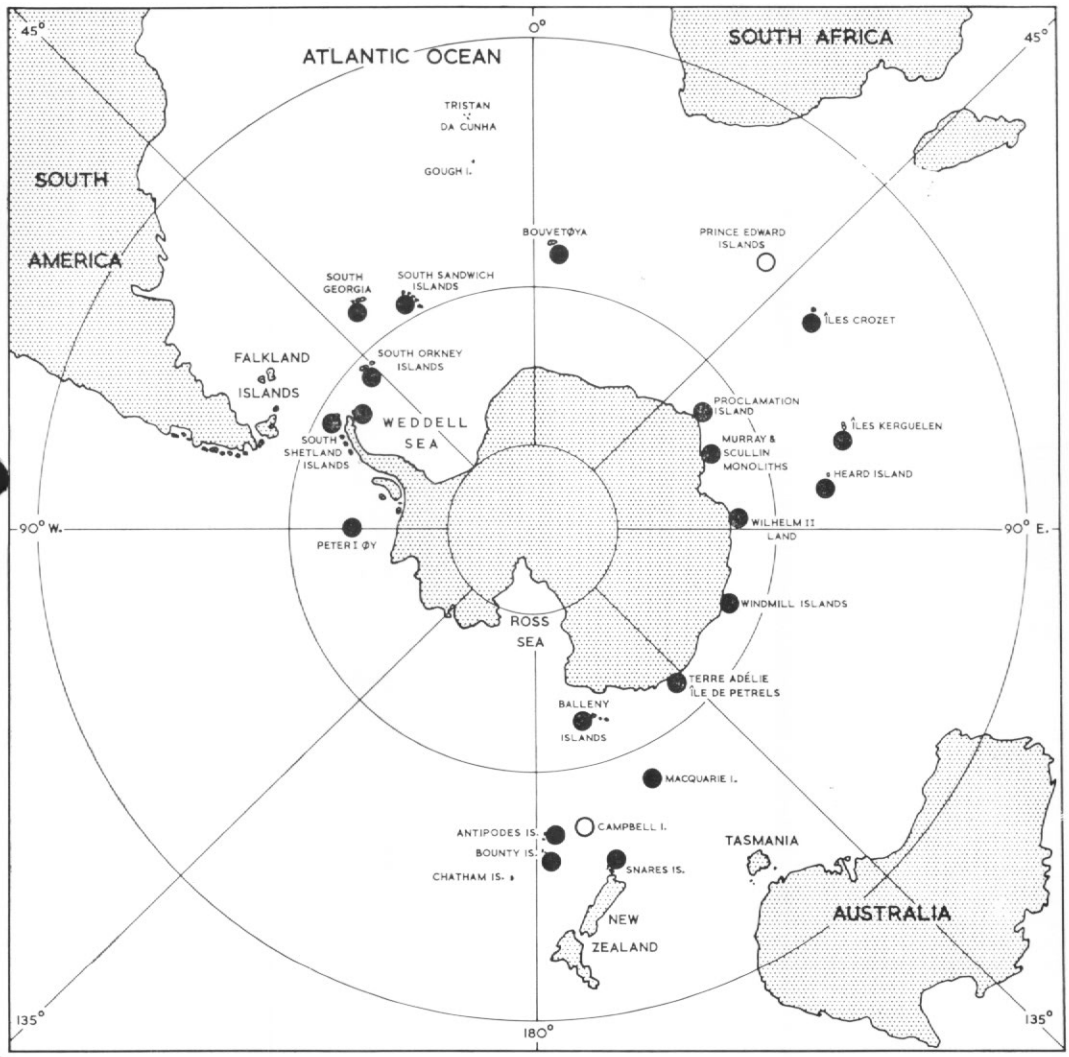

Fig. 2. The known breeding range of the cape pigeon. Breeding is confirmed from all sites marked by solid circles. Open circles represent possible breeding grounds awaiting confirmation.

Cape Pigeon Colonies of Signy Island

Distribution of colonies. Signy Island (lat. 60°40′S., long. 45°38′W.) is one of the smaller of the South Orkney Islands group. It measures approximately 8 km. from north to south and 5 km. from east to west, having a broadly triangular shape with the apex pointing north. The terrain is hilly, the central spine of the island reaching 250 m. at several points and a maximum elevation of 275 m. at Tioga Hill. Almost half the surface is covered by permanent snow and ice, but about the coast there are extensive tracts of ground that are snow-free in summer and support some vegetation (Holdgate, 1964). The steep rocky coastline is indented by numerous bays, and it provides many suitable sites for cliff-nesting sea-bird colonies. The climate is maritime-Antarctic, with a mean temperature slightly above freezing-point in two summer months (maximum monthly mean, $+1{\cdot}2$°C) and falling to about -12° C in the coldest month. Strong winds are frequent, westerlies prevailing, and cloudiness and precipitation are high.

The breeding sea-bird species have been listed by Tickell (1962) and the distribution of cape pigeon colonies on Signy and the adjacent Moe Island is shown in Fig. 1. From what is known, there is every reason to suppose that Signy Island is a truly representative sample area of the South Orkney Islands group but, because of the relative abundance of suitable nesting sites, it probably has an above-average bird population.

The cape pigeons generally nest communally. In the more densely populated areas, such as Polynesia Point gully, nests are spaced about 1 m. apart on rocky ledges at the sides of scree slopes, and as many as 30 nests occur on one ledge. In the less populated areas, such as Factory Cove bluffs and Berntsen Point, nests are spaced farther apart and in some areas solitary nesting birds are seen. The height above sea-level of the lowest nests on Signy Islands varies from 3 m. on ledges which are protected from the oncoming swell to 10 m. on cliffs which are directly exposed to the sea. The highest known nests are 90 m. above sea-level. From Fig. 1 it is evident that the main cape pigeon colonies on Signy Island are on the north and east coasts where shelter is readily available both from southerly winds and the strong prevailing westerly storms. Even where colonies occur on the west coast of the island (notably at Jebsen Point) the nest sites are protected from south and west. Such north-facing situations may also be favourable, because they receive in summer most of the available radiation, which can cause appreciable warming and accelerates snow melt in spring. At the time the breeding birds return after a normal winter, the south-facing cliffs are still snow-covered. On Bird Island, South Georgia, which is on the northern limit of the cape pigeon's breeding range, nests do face the south; the climate here, however, is less rigorous than that of the South Orkney Islands and the nesting ledges are to some extent protected by tussock grass. At both Signy and Bird Islands there is a difference in nest situation from the colonies in Terre Adélie described by Prévost (1964). There, cape pigeons occupy exposed sites high up on the coastal islets. But, as Prévost comments, this selection is related to climate since these sites are alone snow-free early in spring; in all cases the colonies appear to be located in the optimum locality available at the time the birds return in September-October.

Interaction with other petrels. The three medium-sized petrels breeding on Signy Island do not compete with one another for nesting sites. The dove prion (*Pachyptila desolata*) burrows in scree slopes and peat banks (Tickell, 1962); the snow petrel (*Pagodroma nivea*) prefers deep recesses and sheltered holes in the cliffs, whilst the cape pigeon nests on open ledges. On Coronation Island and, apparently, in the South Sandwich Islands the southern fulmar (*Fulmarus glacialoides*) occupies similar ledges but generally prefers more sheer and inaccessible cliffs than the cape pigeon. Here, detailed observations may show that there is some competition with the cape pigeons for nest sites, but the absence of *Fulmarus* from Signy Island made it impossible to study this subject. The two species do not have the same nest site preferences in Terre Adélie (Prévost, 1964). There are insufficient observations for detailed analysis of the feeding habits of these and other species but there is an obvious separation of species feeding preferentially in open water (*Daption*, *Pachyptila*) and others commoner in the pack ice (*Pagodroma* and *Thalassoica antarctica*). *Fulmarus glacialoides* falls into neither group, being common both in the pack and the open sea. Future research will probably demonstrate differences in food preferences between all these species, like that shown to exist in molly-mawks by Tickell (1964).

Census of Daption capensis on Signy Island. During the two seasons, 1960–61 and 1961–62, all parts of Signy Island were visited by the author in mid-February, and the number of chicks present in each colony was either counted or estimated. In the second season all accessible chicks were banded. In 1962–63 a comparable survey was made by F. Topliffe who also banded most accessible chicks. Total populations have been computed from these surveys, using the colony in the main study area (Polynesia Point gully) which normally produces about 450 chicks as a standard sample. Mortality rates determined in the main study area were used in calculating the total of breeding pairs from the total of surviving chicks.

For the majority of the colonies, which are small and accessible, counts and close estimates are fairly easy and the majority of the chicks can be banded. The colony at Jebsen Point, however, is difficult to reach and count, and the very large colony on the east face of Robin

Peak can only be estimated by extrapolation from a small counted sample to a total based on the total area of the colony. These inaccuracies make the total of fledged chicks reliable only to within an estimated ±10 per cent (i.e. ±400). Moe Island was omitted from the population count but it supports at least 14 colonies which probably total about 2,000 pairs.

Table I summarizes the figures obtained for each colony, and colony size is also shown diagrammatically in Fig. 1. A total cape pigeon population of about 24,000 breeding birds emerges as a reasonable figure for Signy Island, these producing approximately 4,000 fledged chicks each year. It is considered that the inaccuracies inherent in all techniques make the apparent year-to-year variation in the numbers in the various colonies of no real significance.

TABLE I. NUMBERS OF FLEDGED OR NEAR-FLEDGED CHICKS IN CAPE PIGEON COLONIES ON SIGNY ISLAND

	1960–61		*1961–62*	
	Estimated Chicks	*Banded Chicks*	*Estimated Chicks*	*Banded Chicks*
Polynesia Point gully	500	276	600	468
Berntsen Point	25	3	35	13
Factory Cove bluffs	40	10	35	35
Billie Rocks	10	—	10	—
Thule Islands	40	15	40	36
Knife Point	6	6	5	5
Starfish Cove	8	—	11	11
Tern Cove	100	26	90	62
Berry Head	150	113	160	156
Robin Peak	2,000	—	2,000	226
North Point	200	159	200	172
West coast	100	—	140	89
Port Jebsen	500	—	500	—
Pandemonium Point	150	—	150	—
Gourlay Point	7	—	10	—
Pageant Point	50	—	60	28
Pantomime Point	10	—	12	—
Total	3,896	608	4,058	1,301

Factory Cove bluffs colony. The first colony of *Daption capensis* to be studied on Signy Island occupies a prominent broken cliff rising for about 50 m. immediately south of the present British Antarctic Survey station (Fig. 1). It contains approximately 50 pairs. Sporadic work was done on this colony between 1948 and 1959. In the latter year, F. A. O'Gorman and the author banded 89 adults at marked nests, and these included several pairs. Some incubation-routine and egg-hatching data were obtained. In 1960–61 these studies were expanded and numerous nests and individual birds were marked and observed daily. Although ideally close to the station hut, this colony was found unsuitable for detailed study because nests were

difficult to observe and were prone to disturbance; therefore, in 1961–62 it was used only for general observations. After the first cape pigeon had been seen, in September, the nests were checked at frequent intervals throughout each day, every effort being made to identify the breeders which had been banded in the previous two seasons as early as possible after their return. After these arrival data had been obtained, the colony was left undisturbed until after hatching when as many adults as possible were recaptured and identified, new occupants were banded and nest markers were re-painted where necessary. The records of this colony, while indicating a considerable longevity in adult cape pigeons and pair-bond tenacity, form too small a sample for separate discussion.

Polynesia Point gully colony. East of the British Antarctic Survey station a ridge of high ground culminating in Observation Bluff (109 m.) extends eastwards as a prominent headland, whose south-east corner is named Polynesia Point (Fig. 1). Just before its termination, the rather regular north face of this high ridge is gashed by a prominent gully falling at about 40° almost from the summit to the coast, a vertical distance of about 80 m. The west flank of this gully is a sheer cliff, the ledges of which are mostly inaccessible, but its eastern wall is more gently inclined and broken, and it has many ledges which can easily be reached. Cape pigeons breed in numbers on both walls of the gully and the section of the colony on the east side is ideally disposed for study. From a single vantage point on the west tip of the ravine the whole upper east wall is in full view and birds can be observed through binoculars without disturbance. The nests themselves are easy to reach, yet the colony is far enough from the Survey station to escape most of the disturbance caused by visitors. For these reasons it was selected as the main sample area in 1961–62. Earlier work had been done on it in 1952–53 by A. W. Mansfield who marked a number of nests (using painted numbers) and banded 103 of the occupants and 93 nestlings. By 1961 nearly all of Mansfield's markers had disappeared and it was not possible to trace the nests. Between 1954 and 1960 the gully was visited periodically and some breeding adults were banded but no systematic observations were made. Nestlings were banded in 1957–58 (113), 1958–59 (100) and 1960–61 (276). At the end of the 1960–61 season, following the decision to transfer detailed observations from Factory Cove to this area, 50 nests were marked and other preparations were made for the investigation described below.

Detailed Study of the Polynesia Point Gully Colony

Methods

The 50 nests selected near the top of the gully and on its east wall at the end of the 1960–61 season were all marked with paint. Flat stones about 20–30 cm. across with smooth faces were selected and a white or cream disc was painted on the face as a background. The nest number was then painted on this disc in a strongly contrasting colour. The markers were propped or wedged close beside the nest, but as a further precaution wherever possible the nest number was also painted on the solid outcropping rock near the nest. Painted nest numbers of this kind have proved satisfactory provided that they are located and re-painted every three years.

Marking of breeding birds. At the beginning of the 1961–62 breeding season, before egg-laying began, as many as possible of the occupants of the 50 marked nests were caught and banded or re-banded with B.T.O. 7 mm. monel bands. Coloured plastic bands were also put on, in individual combinations, so that birds could be more readily recognized from a distance. Because leg bands are generally hidden when the bird is on the nest, at Factory Cove bluffs in 1960, combinations of small cellulose paint dots were also applied to the head of each bird. However, these proved difficult to identify without very close approach and disturbance. Observation showed that once the eggs have been laid, birds only visit their own nests, and consequently it is only necessary to provide a means of discrimination between two individuals at any one site. In 1961–62 blobs of paint of two colours only, white and yellow, were applied. These paint marks were clearly visible from a distant observation point. As a result of these systems of marking, individual breeding birds in the study area were readily distinguishable.

Sexing of breeding birds. The standard method of sexing small petrels by feeling the egg in the abdomen was used. Inspection revealed that for about 24 hr. after laying the female had an enlarged cloaca and sometimes blood was present. Copulation was observed on only four occasions and in all cases the top bird proved to be the male. Another useful guide is provided by nest records of birds sexed either by feeling the egg or by cloacal inspection, which show that the male bird invariably takes the first long incubation shift. They also show that the female is absent from the breeding area for about 14 days before the egg is laid; all birds seen at the nests during this period proved to be males. Assuming consistency of behaviour within the population, these observations permit the sex of birds which could not be caught to be deduced.

Frequency and timing of observation

At the very beginning of the 1961–62 season the marked nests were visited when time and weather permitted. After the birds began to return, in September, the colony was examined daily and a record kept of the number of birds present at each of the 50 marked nests. Once most of the birds had been caught and marked, visits were made daily generally between 18.00 and 19.30 hr. local time. Not only did this fit in with the normal base routine, but it was noted that the non-breeding skuas and sheathbills were less active at this time of day. As most of the birds were marked in the pre-egg-laying period, there was very little disturbance of incubating birds, and once the last egg had been laid no approach was made to within 20 m. of the marked nests until the chicks were due to hatch.

Other colonies were visited from time to time during the breeding season and a look-out kept for any banded birds or unusual occurrences such as double clutches. These visits to areas immune from persistent disturbance of any kind provided useful control data.

After the 1961–62 breeding season, and after the author had left Signy Island in April 1962, the gully was visited on several occasions by F. Topliffe and a few of the post-breeding birds were identified. Topliffe also visited the gully three times in October 1962 and made notes on the number of birds present at the marked nests. Marked nests were visited in January 1963 to count the number of chicks and in February to band the remaining chicks, and a few recoveries of adult breeders were made on these visits. In January 1964, R. W. Burton made a thorough check of all the marked nests in the gully and recorded details of the occupants. These observations subsequent to the main study have considerably enhanced the value of the results.

Breeding Cycle of the Cape Pigeon at Signy Island

Arrival at the breeding area

Base records over the years, together with observations made in the two main colonies and daily counts in Borge Bay during the present study, suggest that the date of arrival of the cape pigeon at the breeding ground is dependent on local sea-ice conditions (Table II). The first of the Signy Island breeding birds are normally in the vicinity of their breeding grounds by the end of August and, if the area surrounding their colony is ice-free, they may occupy their nest sites during the early part of September. A greater influx occurs towards the end of the month and virtually the whole population is present by mid-October. However, should the island be surrounded by fast ice or pack-ice, nests are not visited until the beginning of October and the peak is reached at the end of that month. The typical pattern of return is well exemplified by events in 1960 when there was little sea ice around Signy Island and an early break-up, and in 1961 when the ice persisted into November (Fig. 3).

It is interesting to compare the results of counts of the number of occupants of marked nests in the Polynesia Point gully colony in 1961 with those for the same dates in the very open ice season that followed in 1962. In 1962 the first bird seen at a nest in the gully appeared on 7 September (7 October in 1961). On 4 October 21 birds were at marked nests (none in 1961), on 7 October there were 36 (none in 1961) and on 25 October, 26 (28 in 1961, following ice break-up).

Analysis of the arrivals of known breeding birds shows that they return to their nests individually and at 13 out of 18 nests studied during the first part of the season the first arrival

TABLE II. DATES OF RETURN OF CAPE PIGEONS TO SIGNY ISLAND IN RELATION TO BREAK-UP OF SEA ICE

Date of First Arrival	*Date of Ice Break-up*
11 August 1953	18 August 1953
12 August 1960	27 August 1960
15 August 1954	29 October 1954
18 August 1955	19 August 1955
31 August 1956	19 August 1956
1 September 1947	17 September 1947
1 September 1958	28 September 1958
7 September 1962	31 August 1962
8 September 1952	19 September 1952
9 September 1957	23 September 1957
19 September 1961	9 November 1961
22 September 1949	18 November 1949
29 September 1959	12 January 1960

was the male (Table III). Visits to nest sites seem to be spasmodic, variable in duration and without any regular pattern, so it is quite possible that some may have visited the nest before the date shown in Table III. This irregularity, and the predominance of males in this period, is well brought out in Fig. 4, in which the birds present at the Polynesia Point gully nests in the pre-breeding phase are recorded diagrammatically. The preponderance of male "first arrivals" is thought to be genuine, although it could be exaggerated if males tend to spend longer at the nests at this period. The time lapse between the arrivals of the male and female may suggest that mated birds do not keep company when away from their breeding grounds, as has been suggested by Richdale (1952) for the royal albatross.

Pre-egg-laying activities

Complete observation of all activities during this part of the season was made impossible by adverse weather, snow and ice glaze on the cliffs, and the wary and irregular behaviour of the birds. However, 3 female and 45 male birds were caught and colour-marked at 46 nests before incubation started, and Fig. 4 therefore shows the trend of activities fairly accurately during this period.

In 1961 the first of the breeders arrived at the marked nests 51 days before the egg was laid, and the build-up of the breeding population was gradual. By 25 to 35 days before the mean date of laying almost all nests had been visited by both birds. Records show that the male bird spends the greater amount of time alone at the nest, especially during the latter part of the period, when there is a total disappearance of the breeding females.

Arrival at the nest. The incoming bird usually circles around the area, passing its nest several times before alighting. In gale-force winds it is noticeable that birds have much greater difficulty in landing on their narrow ledges. No flight display resembling that of the snow petrel was seen in this species. Sometimes, but not always, a short harsh call is given just before landing. If the bird lands at its own nest and its mate is in residence, a greeting ceremony takes place, this being similar to the "courtship" display described below but generally not so

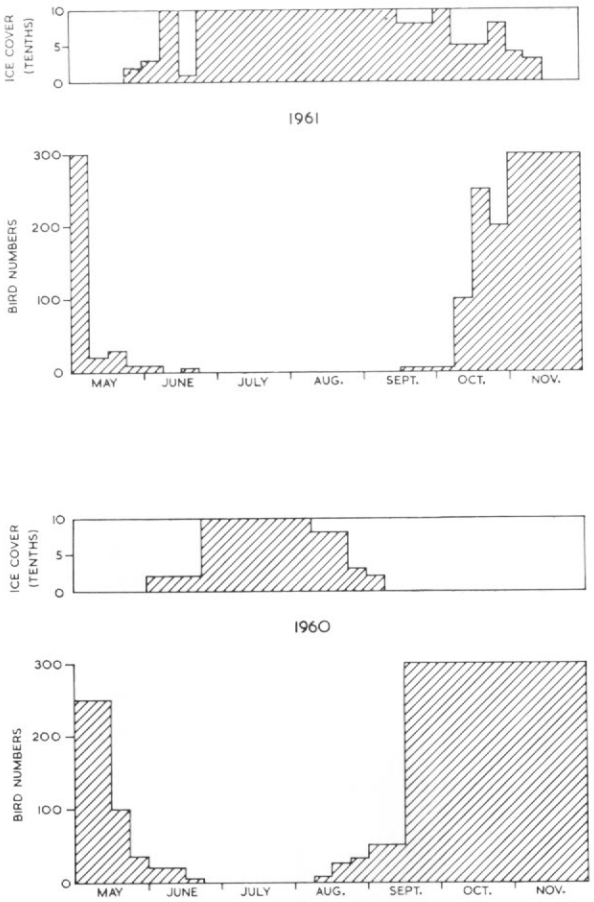

Fig. 3. Ice cover and cape pigeon numbers in the Borge Bay area, Signy Island, during the winters of 1960 and 1961. Numbers in excess of 300 birds were not estimated.

prolonged. If a bird lands at or near a nest other than its own, the greeting call is not reciprocated, and the sitting bird takes a defensive attitude and usually ejects a stream of oil at the intruder.

Nest clearing. Although the summer thaw has usually begun by the time the first arrivals appear, a certain amount of excavating is needed before some birds can occupy their nest sites. The male appears to be mainly responsible for this work and for guarding the nest against any intruders. Heavy showers of snow during October and November often result in nests being covered once again with up to 3 ft. (0·9 m.) of snow, and whenever this occurs birds can be seen busily clearing it away. Nests are cleared of snow with the beak, a rapid sideways movement with the partly open beak disposing of the softer snow and helping to break up the more tightly packed layers. Any small lumps of snow or ice are picked up and thrown to one side. Having gone through this laborious task, the bird generally leaves the nest, often to return and find it covered up again the following day. Although the snow cover never affects this species as much as it does burrowing birds such as Wilson's petrels and dove prions, cape pigeons seem just as adept in locating their own nests when many nearby topographic features are obscured.

Nest visiting. The precise elucidation of this interesting phase in the breeding cycle of the cape pigeon has so far proved impossible, since every bird at a colony cannot be banded and

TABLE III. RETURN OF BREEDING BIRDS TO NEST SITES AT FACTORY COVE BLUFFS

Nest Number	*Date First Bird Seen*	*Sex*	*Date Second Bird Seen*	*Date Both Birds Seen Together at Nest*
7	9 October 1961	M	14 October 1961	14 October 1961
8	18 October 1961	M	24 October 1961	25 October 1961
9	18 October 1961	F	20 October 1961	20 October 1961
10	16 October 1961	M	28 October 1961	28 October 1961
11	9 October 1961	F	15 October 1961*	15 October 1961
12	12 October 1961	M	15 October 1961†	15 October 1961
17	23 October 1961	M	25 October 1961	25 October 1961
20	13 October 1961	F	18 October 1961	18 October 1961
21	9 October 1961	M	13 October 1961	18 October 1961
22	15 October 1961	M	16 October 1961	16 October 1961
23	18 October 1961	M	21 October 1961	21 October 1961
25	12 October 1961	M	20 October 1961	20 October 1961
27	9 October 1961	M	16 October 1961	16 October 1961
28	9 October 1961	M	17 October 1961	17 October 1961
32	9 October 1961	F	15 October 1961	19 October 1961
35	18 October 1961	F	20 October 1961‡	20 October 1961
36	10 October 1961	M	19 October 1961	19 October 1961
38	11 October 1961	M	16 October 1961	16 October 1961

* *Nest 11.* The female at this nest had bred here in the previous year. She was first seen at the nest on 9 October 1961 and on the 15 October she was present at the nest with an unbanded bird. An unbanded bird was caught and marked on 18 October 1961 and later bred at this nest.

† *Nest 12.* The female at this nest was not recaptured early in the season but a banded bird (probably the female) was seen at this nest on 15 October 1961.

‡ *Nest 35.* An unbanded bird, present at this nest on 20 October 1961, was caught and marked, and later bred here.

colour marked. Whenever possible, visiting birds were captured and marked but unless they happened to be known breeders from another marked nest it was not always possible to trace their subsequent movements.

Up to 38 days before the mean date of egg-laying, several breeding birds were recovered at nests which were not their own. Such visiting by known breeding birds covers a fairly limited period. Visiting breeders usually also restricted their movements to the nests in the vicinity of their own and no case of inter-colony visiting was noted. It was found that birds of both sexes visit other nests and that birds of the same sex may be found together "keeping company" at a nest which belongs to neither of them. Visiting between known breeders becomes less marked once both birds of a pair have returned to the colony and have met at their own nest. It was noticeable during the first two weeks after their arrival that breeding birds were very tolerant of other birds and little activity in the way of nest defence was seen. Throughout the pre-egg-laying period, unbanded birds were found at marked nests, but daily observations were not sufficient to show exactly how many non-breeding or pre-breeding birds were present, because they appeared to spend much less time at any one nest than the breeders. The amount of time spent at a particular nest is probably limited by the return of the male occupant who apparently has no difficulty in ousting any intruders.

Nest records show that there must be a proportion of pre-breeders amongst the first arrivals

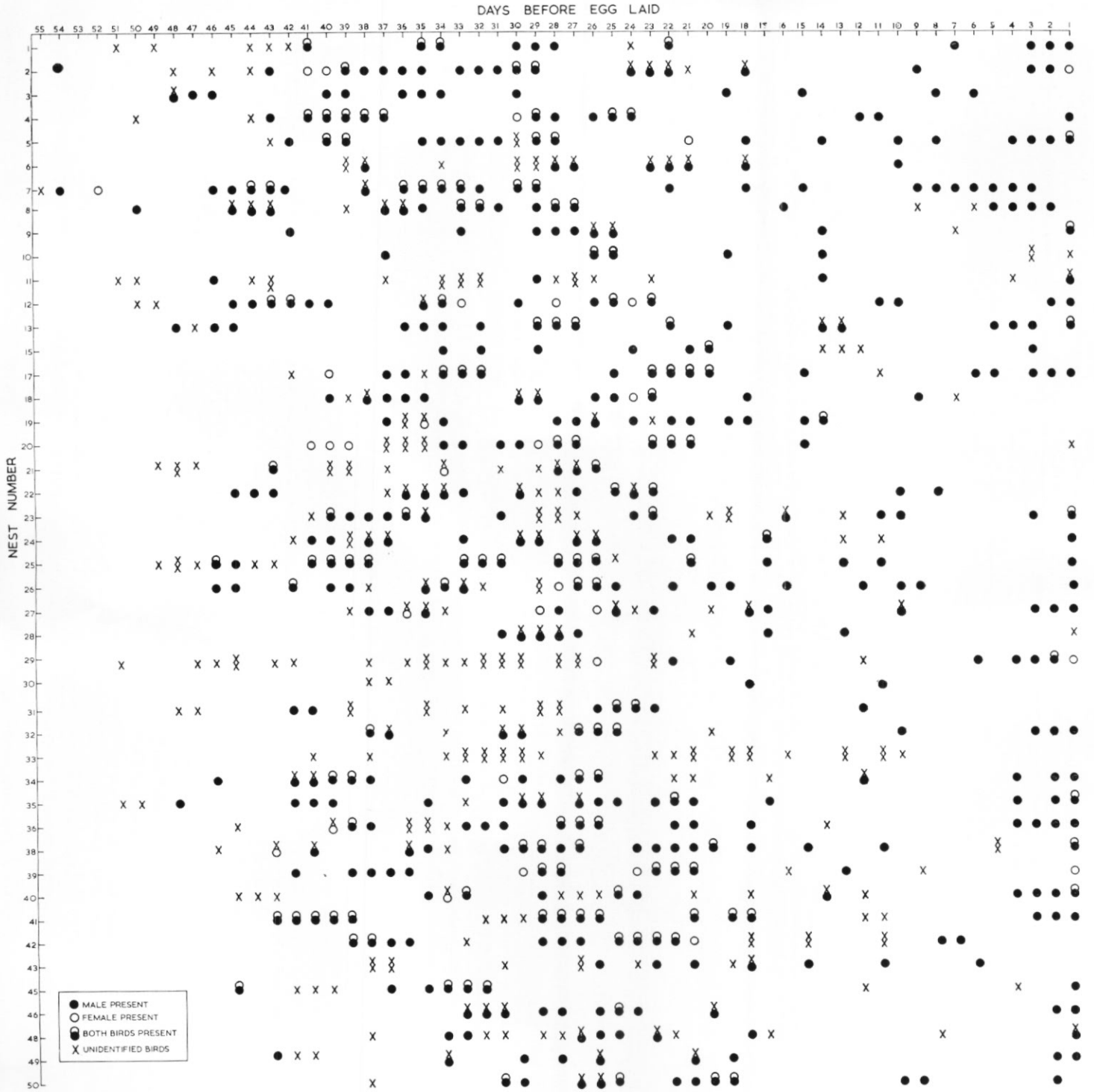

Fig. 4. Birds present at the 50 marked nests in the Polynesia Point gully colony during the pre-laying period.

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and, should one bird of a pair fail to return to its nest, the surviving bird (whether it is male or female) has no difficulty in re-mating, though in some cases it may have to leave its own nest in order to do so. The lost mate is replaced either by a bird in similar circumstances or by one that is breeding for the first time. The general statistics for the re-formation of pair bonds at Factory Cove bluffs and Polynesia Point gully are shown in Table IV. It has been noticed

TABLE IV. SITE AND PAIR-BOND TENACITY IN THE CAPE PIGEON

	Occupied by the Original Pair	*Occupied by One of the Original Pair and One Previously Unbanded Bird*	*Occupied by One of the Original Pair; Second Bird not Recovered*	*Occupied by One of the Original Pair and a Known Breeder from Another Nest*	*Occupied by Two Previously Unbanded Birds*	*Nest Empty*	*Nest not Found*
Polynesia Point gully. 44 pairs banded in 1961–62; colony checked for recoveries on 5 days during the brooding period January 1964 (2 yr. later)	15	6	5	2	–	8	8
Factory Cove bluffs. 19 pairs banded in 1959–60; colony checked for recoveries on numerous occasions in 1960–61 (1 yr. later)	16	2	–	1	–	–	–
Factory Cove bluffs. 22 pairs banded in 1960–61; colony checked for recoveries on numerous occasions in 1961–62 (1 yr. later)	14	5	–	1	1	1	–

over a 3 yr. period of observations at the Factory Cove bluffs colony that very few new nests are built, even though there appears to be plenty of room in which to do so. Only two new nests were found and both of these were built in the latter part of the season, and were not occupied in following years. The difficulty of pre-breeders in finding an unused nest site is quite great, because due to the infrequent visits by breeding birds it is easy for an unestablished or pre-breeding bird to occupy a nest site, only to be evicted when one of the rightful owners returns. The visiting birds often then move on to another site only for the same thing to occur again. This process may go on for many days until a truly unoccupied site is found, by which time it may be too late in the season for successful breeding. It therefore appears much easier for a bird that is in breeding condition, but has not yet bred, to mate with a breeding bird that has lost its partner but has an established nest than for it to acquire a mate of its own status and age group and build a new nest. Nest visiting apparently provides a means of ensuring that breeders which have lost mates can acquire new ones and provides birds breeding for the first time with an opportunity of establishing themselves at a nest site or finding an unattached breeding bird.

Recruitment into the breeding colony and age at first breeding. The data on pair-bond re-formation in the Factory Cove bluffs colony (Table IV) suggest that between approximately

5 and 16 per cent of the breeding population are replaced in any one year. One case is known of a breeding bird returning too late in the season to breed, its place having been taken by another bird, so that the figures given are not mortality figures but replacement figures. It is quite probable that some of the new entrants to the colony are birds of full breeding age that have been prevented, for example, by nest site competition from breeding in a previous year. In any event, it is clear that mortality in breeding birds is low (as discussed below and by Hudson (1966)) and that only a small proportion of each year-group of nestlings is ultimately assimilated into the breeding population. Unfortunately, it is still too early for recaptures of survivors of the large samples of nestlings banded since 1961 to be used to check this deduction, but a small sample of 87 nestlings banded in the Polynesia Point gully in 1952 is available for comment, as are rather larger samples (113 and 100, respectively) banded in 1958 and 1959. Of the 213 nestlings banded in 1958 and 1959 none had been found breeding up to the end of the 1961–62 season, although one bird banded in the gully on 2 February 1958 was in company with a known breeder at nest 18 on Factory Cove bluffs on 4 April 1962 (but definitely had not bred there). The other 5 recaptures of these year-groups were all made when the birds were feeding at the station jetty, in all cases in either November or April (i.e. during the pre-egg-laying period when nest visiting is in progress, or during the post-breeding phase), and these birds are assumed to be pre-breeders. If so, cape pigeons do not commence breeding until they are over 4 yr. old, and mortality is either extremely heavy in this pre-breeding period or only a small proportion returns to the breeding area in this pre-recruitment phase. Recoveries of the 1952 year-group show a higher recapture rate, 2 of the 87 birds being known or strongly believed to have bred in 1959–60, these and 2 others in 1960–61 and at least 2 (one a new recapture) again in 1961–62. Thus at least 5·8 per cent of the birds had survived to recruitment as breeders, the first recapture being at an age of 6 yr. 10 months, the second at 7 yr. 7 months, and others at 8 yr. 8 months and 8 yr. 9 months. Of the recaptures 4 were found breeding in the gully colony in which they themselves were hatched, while the fifth was found on the Factory Cove bluffs 500 m. away. This recapture is important in indicating that, while birds return preferentially to their natal colony, some degree of interflow may take place, and it further indicates that the recapture rate of around 5·8 per cent may be depressed not only by loss of bands and by occupation of inaccessible nests within the original colony but by movement elsewhere. Any discrepancy between this recovery figure and the deduced required recruitment rate into the breeding population is of negligible significance because of these factors and because of the small size of the sample.

In January 1965, 5 cape pigeons banded as nestlings in February 1961 were found with young, all of them at Polynesia Point gully. Other 4 yr. old birds were found in the vicinity of the colony both before and after the breeding period, but without eggs or young. Of the 5 birds, 4 originated from the same colony in which they were breeding, while one was hatched at Berry Head. It appears evident that cape pigeons may therefore breed at 4 yr. old, although the bulk of the population may not commence reproduction until a year later.

Courtship and copulation. Once both birds have met at the nest they generally spend from 1 to 6 days there together and during this time copulation takes place.

Pairs sit side by side or facing one another, occasionally going through a "courtship" routine. In this one bird stretches its neck to its fullest extent and makes a "chattering" sound; its mate responds and they both wave their heads from side to side in a swaying motion with the neck or crop fully extended, after which they sit and indulge in mutual preening of the head, neck and breast feathers, occasionally "nibbling" one another around the bill. In some cases this behaviour may be followed by copulation, but in one instance copulation was observed without any such prelude. Copulation was seen on only four occasions at the Polynesia Point gully marked colony. The first was at nest 20 on 20 October, 37 days before the egg was laid. The pair at nest 23 were seen copulating on 22 October, 38 days before the egg was laid; those at nest 43 on 29 October, 27 days before the egg was laid; and at nest 49 the pair was seen attempting to copulate on 5 November, 23 days before the egg was laid. After copulation birds continued mutual preening and displaying to each other. In all cases the top bird proved to be the male, and a white fluid was present around its cloaca on subsequent examination.

Nest and nest building. The nest consists of a varying number of small flat stones. Nests near scree slopes have fairly large piles of stones, whilst those on the higher and more inaccessible ledges are nothing more than a shallow hollow in the ground; these differences probably reflect differences in the availability of suitable stones. Stones appear to be the preferred nest material and on Bird Island, South Georgia, they were used wherever possible, although there was plenty of tussock grass available. On average the nests are about 16 cm. in diameter. Nest "building" is seen during the early part of the season and it may be done either from the nest or from one side of it. In the first case, the occupant picks up small flat stones which lie within easy reach of the nest and places them around it. In the second case, the bird shuffles on its tarsi for a few feet and transfers stones to a place behind it and in front of the nest. Such stones thus come within reach of a subsequent nest occupant. Stealing of stones from adjacent nests was seen on several occasions but it is not nearly as common as in pygoscelid penguins.

Nest defence. By the end of October, by which time both birds have returned and met at the nest, nest visiting is over and birds are commonly seen adopting a defensive attitude towards other birds and towards the observer (Fig. 5). Very little other activity in the way of nest defence was seen at Signy Island. Known breeders were occasionally seen to eject oil at intruders which landed or approached their nest sites, but this appeared to be a last line of defence. No fighting between individual birds was seen, although it has been observed in the snow petrel, and noted in the dove prion by Tickell (1962).

It was noticeable that none of the many birds handled at the station jetty ejected oil, either at other birds or when caught. In contrast, once the egg was laid, sitting birds approached by an observer took defensive attitudes and ejected oil but very rarely left the nest unless handled. The colour of the oil ejected varied. Before egg-laying it was nearly always bright orange.

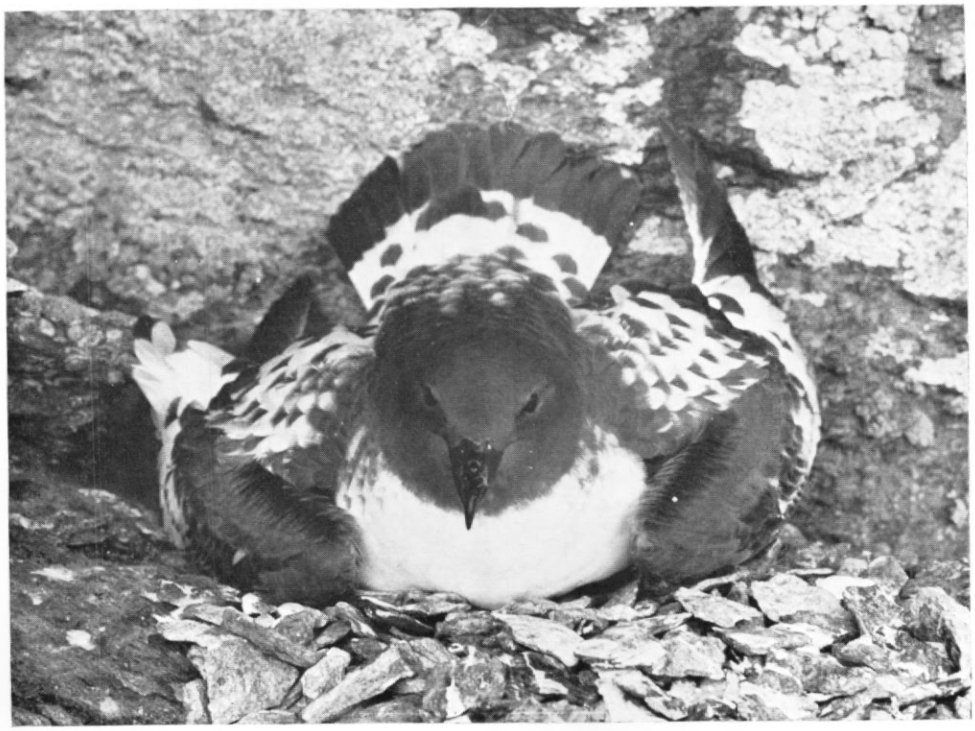

Fig. 5. An adult cape pigeon adopting a defensive attitude on its nest. (Photograph by F. Topliffe.)

After incubation commenced and on a bird's first 2 days at the nest it was also bright orange, but as the days passed it became noticeably duller and at the end of a bird's stint on the nest it was normally dull green. These changes may arise by modification of the carotenoid pigments derived from the Crustacea on which the birds feed. It was also very liquid during incubation. Once the chicks had hatched the parents' oil contained more solid food in the way of small crustaceans, and these were also usual in the oil ejected by chicks.

Exodus of breeding females in the pre-egg-laying period. Analysis of nest records proves conclusively that the female cape pigeon leaves the nest 2 to 3 weeks before the egg is laid and does not return to the nest until approximately 24 hr. before it is laid (Fig. 4). It is interesting to note that out of 28 sexed breeders caught at the station jetty during this period only one was a female, and this bird was caught 17 days before she laid her egg. This disproportionate recovery of males probably indicates that the females leave the vicinity of their colony altogether at this time and go to sea, whilst the male feeds in inshore waters nearer its nest. Nest records substantiate this, since nearly all nests were found to have been visited by the male periodically throughout the pre-egg-laying period.

These results confirm and extend observations by Valette (1906), Prévost (1953) and Tickell (1962), and are closely comparable with data for the dove prion obtained on Signy Island by the latter author. The pattern appears typical of Procellariiformes (Richdale, 1949; Dunnet, Anderson and Cormack, 1963; Warham, 1964), and its significance is discussed by Tickell (1962).

Egg-laying and incubation

Spread of egg-laying. The date and spread of egg-laying varies only very slightly from year to year. Although the local sea-ice conditions are known to affect the date at which the cape pigeons re-occupy their nests, there is no evidence that they retard the egg-laying date. Neither does latitude nor a rather wide climatic difference appear to have much influence. At South Georgia in 1963–64 the first 3 out of 20 nests had eggs on 24 November; at Heard Island the first eggs were seen on 26 November 1949 and 25 November 1950, and were plentiful by 29 November in 1953 (Downes and others, 1959). At both Heard Island and South Georgia adult cape pigeons are to be seen around the breeding grounds throughout most of the winter, although their numbers decline during June and July. At Deception Island (South Shetland Islands) the first eggs were seen on 27 November 1958. Both South Georgia and Heard Island are at the extreme edge of the pack-ice zone, whilst sea-ice conditions in the South Shetland Islands are similar to those at the South Orkney Islands. More extensive data for Pointe Géologie, Terre Adélie, given by Prévost (1964) indicate that first eggs were laid on 24 November 1956 and 25 November 1952 with peaks of laying between 27 November and 2 December in both years, and that the laying period ended on 5 December in both cases. These figures are almost exactly the same as those for Signy Island (Fig. 6), yet in Terre Adélie ice surrounds the coast for a far longer period in winter and birds were not seen between 3 April and 11 September 1952 or between 7 April and 5 September 1956.

The spread of egg-laying for 28 nests at Signy Island (at which the exact date of laying was known) was 14 days in 1960 and 15 days for 46 nests in 1961 (Fig. 6). The first egg was laid on 23 November in both years. Between 1947–48 and 1962–63 dates on which cape pigeon eggs were first seen have been recorded on ten occasions.

Date	*Season*
18 November	1955–56, 1959–60
21 November	1958–59
22 November	1962–63
23 November	1960–61, 1961–62
24 November	1947–48
25 November	1948–49, 1949–50, 1954–55

23 November is thus the mean date for commencement of laying. The last egg was laid on 6 December in 1960 and 7 December in 1961; the mean laying date for 1960 was 29 November

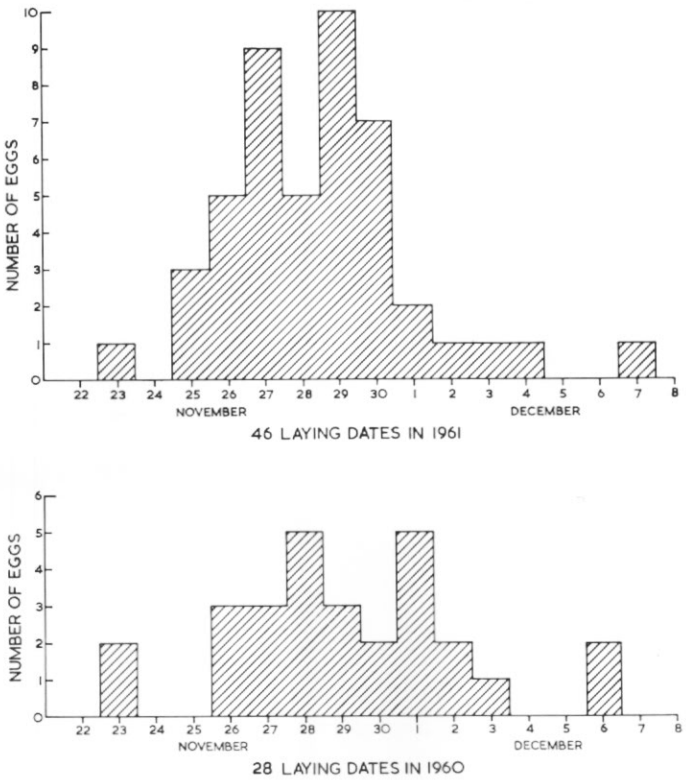

Fig. 6. Egg-laying dates for the cape pigeon at Signy Island in 1960 and 1961.

and 28 November in 1961. These figures are probably representative. The cape pigeon lays a single white egg of varying size and shape. The mean length of 46 eggs was 62 mm. (range 57–67 mm.); the mean width was 43 mm. (range 40–47 mm.) and the mean weight was 62 g. (range 51–75 g.). These figures agree well with those given by Murphy (1936).

Double clutches. Three double clutches were seen during the present study. At marked nest 42 on the Factory Cove bluffs in 1960, 4 birds were found to be using the nest. The incubation routine for this nest was as follows: first day female plus egg, second day male incubating, third day an unmarked bird plus two eggs (this bird was then given a distinguishing mark), and on the fourth day another unmarked bird incubating both eggs. This bird was also marked and it continued to incubate the eggs until the seventh day; on the eighth day both eggs were missing but the original male was present. This nest was not studied during the pre-egg-laying stage. In the following season nest 42 was unoccupied.

During 1962 two double clutches were found, both at unmarked nests. Neither of these was successful, although at one nest both eggs were incubated until several days after the mean hatching date, and when checked they were found to be addled. It is not known how many birds were at these nests. Gain (1914) recorded one double clutch at Deception Island, and remarked that "almost certainly" two females were concerned.

It is thought that most of the double clutches seen are the work of either one male and two females, or by two pairs using the same nest.

Egg loss. Fig. 7 clearly shows the egg loss during the first 8 days after laying. It is evident that losses are fairly high during the first 8 days after laying, and this agrees with the figures obtained by Dunnet, Anderson and Cormack (1963) for the northern fulmar, *Fulmarus*

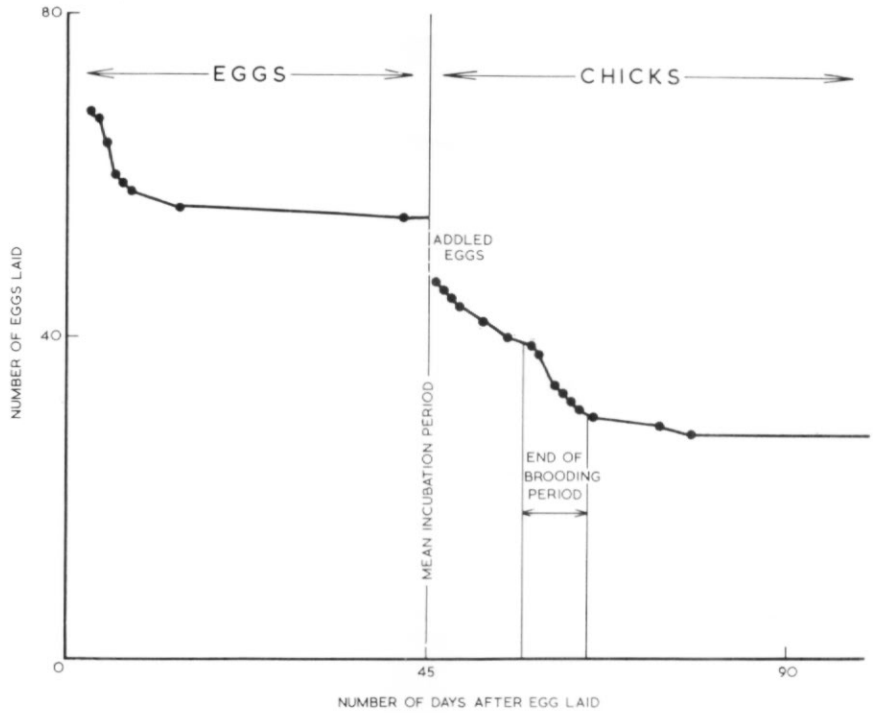

Fig. 7. Mortality in eggs and chicks of cape pigeons at 74 nests in the two seasons of observation.

glacialis. Human interference was reduced as far as possible but as it was necessary to weigh and measure each egg some of the losses must be attributed to disturbance.

However, almost all incubating birds disturbed for egg weighing returned to the nest within a few minutes. A record was kept of those which returned and resumed incubating before the observer left the colony. If they did not return and the egg was found to be missing on the following day, its loss was assumed to be due to disturbance. The figures show that the loss of only 6 out of 16 eggs can be attributed to human interference. The other known causes of egg loss were as follows:

i. At 3 nests the male failed to return to take the second incubation shift.
ii. At 3 nests the female failed to return to take the third shift.
iii. At 1 nest both birds remained at the nest together for the first shift and then eventually left the egg unattended.

It was noticeable that birds which lost their eggs or chicks soon lost interest in the nest and were seen there only rarely. These birds were not found feeding locally.

Infertile eggs. Of the 74 eggs laid at the marked nests in two seasons, 7 failed to hatch. These eggs were incubated for a mean period of 53 days, which is 8 days longer than the normal mean incubating time. In 1963 F. Topliffe found 4 out of 43 eggs were unproductive. Therefore, it can be expected that about 9 per cent of eggs laid will not hatch.

Share of male and female cape pigeons of the incubation period. It can be seen from Fig. 4, and has already been explained, that the female departs 2–3 weeks before the egg is laid and returns usually within a few hours of laying. The male is invariably either present at this time or appears at the nest within 24 hr. of laying and takes over the second shift which may last 3–7 days. Thereafter, shifts alternate, the period varying between the different pairs until the

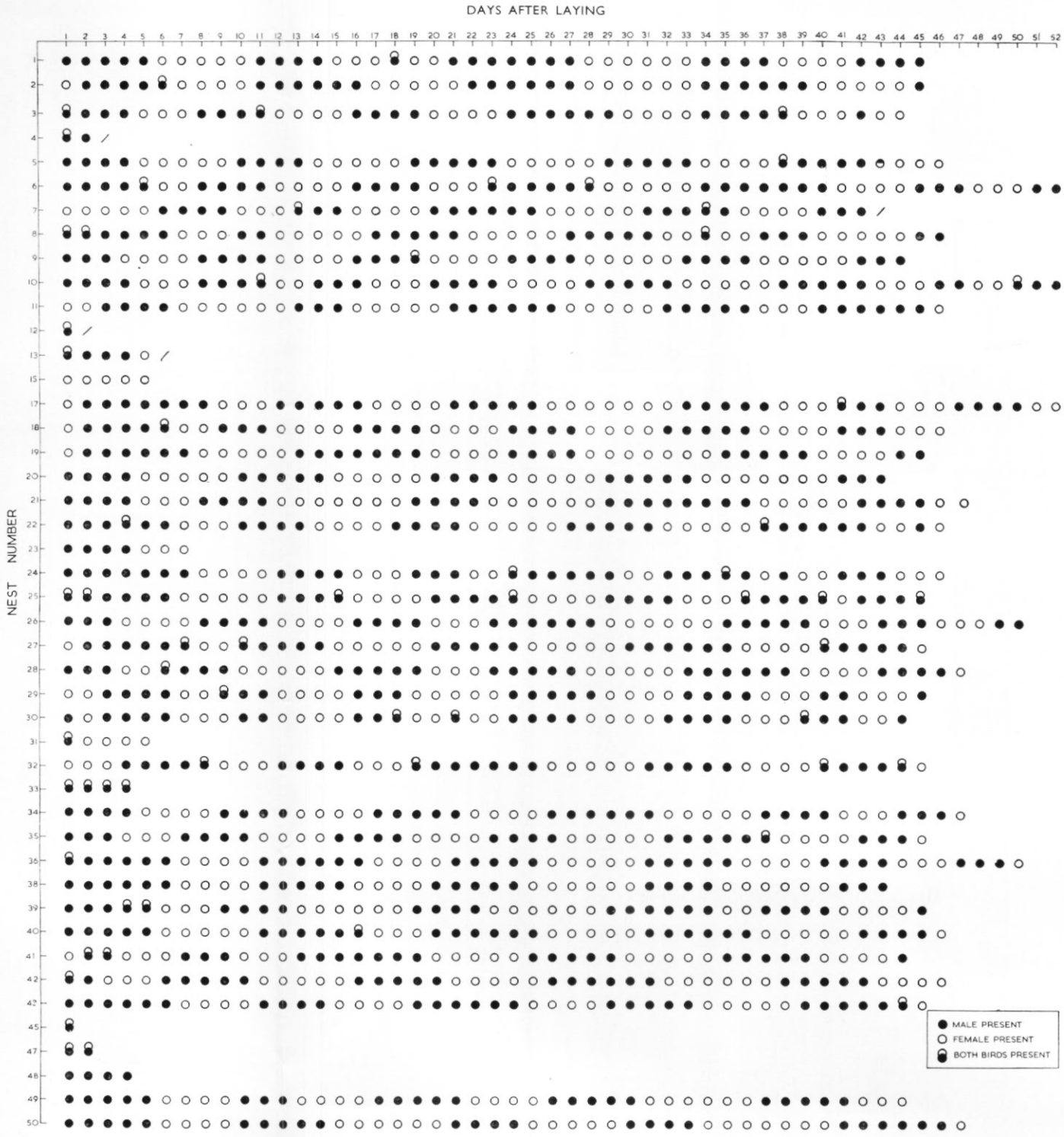

Fig. 8. Occupants of the 50 marked nests in the Polynesia Point gully colony during the incubation period. In nests 6, 10, 17, 26 and 36 the eggs failed to hatch.

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chick has hatched (Fig. 8). Should the chick hatch at the beginning of a shift the bird broods it until its mate returns after its normal period of absence.

Once both birds have seen the chick at the nest however, the routine changes, visits becoming very irregular and probably more frequent than Fig. 9 shows.

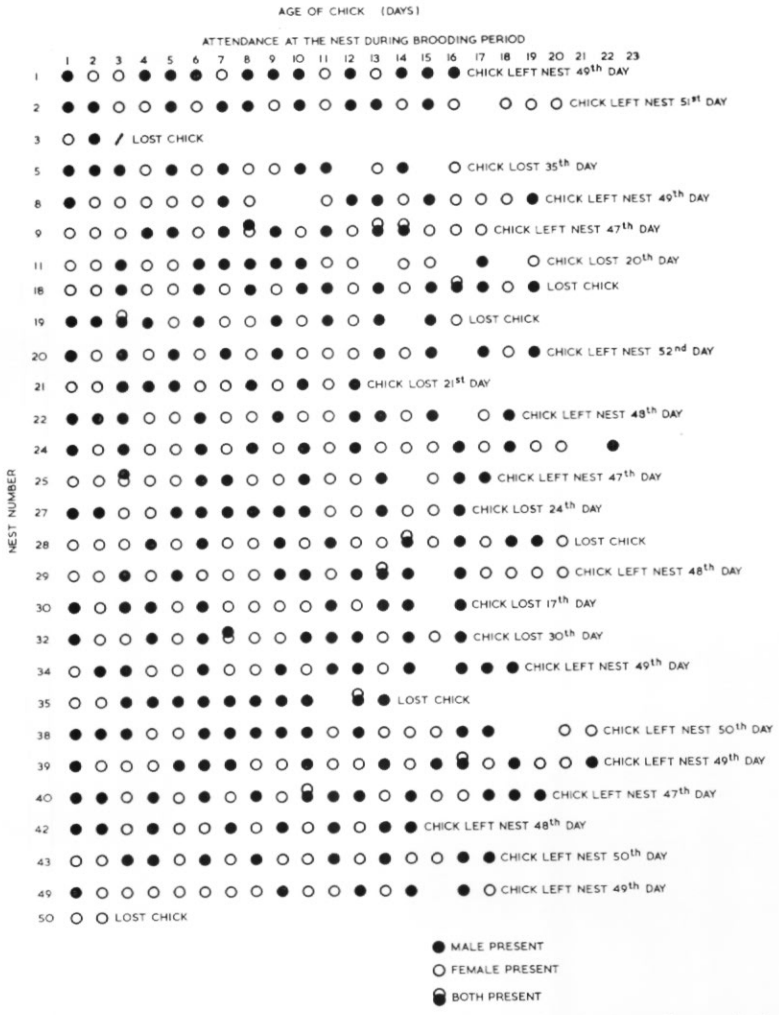

Fig. 9. Attendance of parent cape pigeons at the 50 marked nests during the brooding period. A blank space indicates the chick was on its own.

During the incubation period very few known breeding birds were to be seen around the station jetty in Borge Bay, even when there was an abundance of food available (e.g. in the form of seal blubber). The off-duty bird therefore probably feeds well out to sea.

Length of incubation period. From 47 nests under observation during the two seasons 1960 to 1962 the mean length of the incubation period was 45 days, with a range of 43–48 days. Downes and others (1959) have stated that the incubation period for the cape pigeon on Heard Island is also about 45 days. Prévost (1964) has reported a mean period of 44 and 45 days for Pointe Géologie, Terre Adélie, with a range of 43–46 days.

Hatching dates. The hatching dates from a number of marked nests are available for three seasons. Laws (1949) has given the mean hatching date for 12 chicks as 15 January. Hatching data collected in 1960 and 1961 show a mean date of 13 January for both years. In 1960 the hatching dates for 19 nests ranged from 8 to 16 January, and in 1961 for 28 nests from 7 to 16 January. The earliest date for hatching recorded from 1948 to 1963 was 5 January. Prévost (1964) has given 13 hatching dates for Terre Adélie, spreading from 5 to 20 January. Downes and others (1959) have given 9 January 1950 as the first hatching date at Heard Island and 15 January as the general hatching date. Falla (1937) recorded hatching dates for Enderby Land as 14 to 16 January. The remarkable synchrony in the breeding cycle of the cape pigeon, despite wide variations in latitude and climate, is again demonstrated by these figures.

Chipping. Chipping was first noted 4 days before the chick hatched; the average time for all eggs is probably between 2 and 3 days.

Chicks. The chicks are covered with a dark grey down except under the wings and about the base of the beak (Figs. 10 and 11). They are covered by the adult bird until they are about 12 days old, after which they sit beside the parent bird and "assist" in the defence of the nest (Fig. 10). During the early brooding period the adults defend the nest as vigorously, are as hard to dislodge, and return as rapidly if disturbed, as during incubation. Occasionally brooding birds have been known to alight on the observer's lap while he was sitting near the nest holding and weighing the chick. Four-day-old chicks are themselves capable of ejecting oil up to a distance of 1 ft. (0·3 m.). Their effective range increases with age, and by the end of the brooding period reaches up to 3 ft. (0·9 m.). The length of the brooding period varies between different pairs, the mean duration at 30 nests being 16 days and the range 12–22 days. One chick was left on its own on the eighth and ninth days after which brooding continued until the eighteenth day. Prévost (1964) considered the end of the brooding period to coincide with

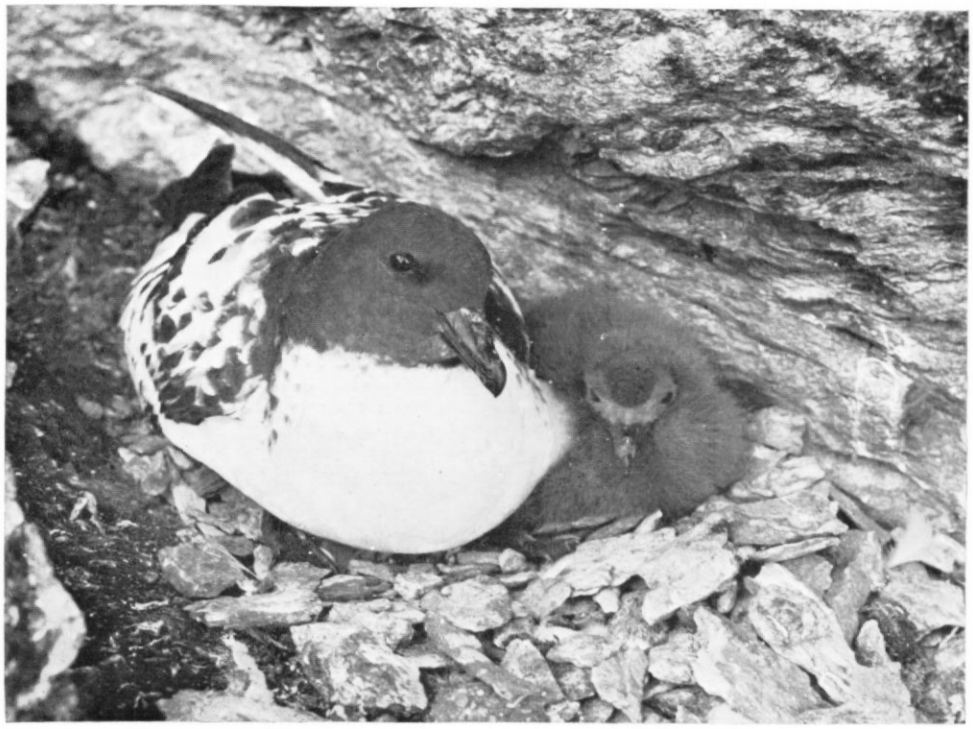

Fig. 10. An adult cape pigeon with a chick about 10 days old. (Photograph by F. Topliffe.)

Fig. 11. Cape pigeon chick, approximately 10 days old. (Photograph by F. Topliffe.)

the development of homeothermy in the chick, and placed this at between the eleventh and fourteenth days.

Feeding of nestlings. Feeding during the brooding period is undertaken by both parents. The adult, arriving at the nest, gives the chick a greeting call and the chick then generally harasses the parent and begs for food. With its beak, the chick "nibbles" the beak of the adult, accompanying this behaviour with a sharp "cheep-cheep". The adult then opens its bill and the chick places its own bill sideways in the parent's. Food is regurgitated into the chick's open beak, and at one session a chick may receive as many as six feeds in this manner. Occasionally the parent bird stays with the chick and preens it, but usually the time spent at the nest is about 5 min.

During the banding of 460 cape pigeon nestlings in Polynesia Point gully, 3 very light-weight and obviously starved chicks were found. No case of desertion of a chick by its parents was found in the nests under close observation, and consequently it is thought that these starvelings result either from the death of one or both parents, or from the chick moving away from its nest. At one of the marked sites, when the chick moved only a few feet away from its nest, its parents did not feed it and it became a starveling. (Both adults were subsequently recaptured and bred successfully in the following season.) From this observation it is suggested that parents recognize the locality of their nest sites primarily, rather than their chicks, but no experimental transportation of chicks was made and hence no statement can be made on any second-order individual recognition. Since chicks which move away from their nests may not be found and fed by their parents, and may become starvelings, strong selection pressure must favour sedentary behaviour.

Growth of chicks. Chick weights show a steady overall increase (Figs. 12 and 13) until the end of the brooding period, after which feeding becomes irregular. Figs. 14, 15 and 16 present

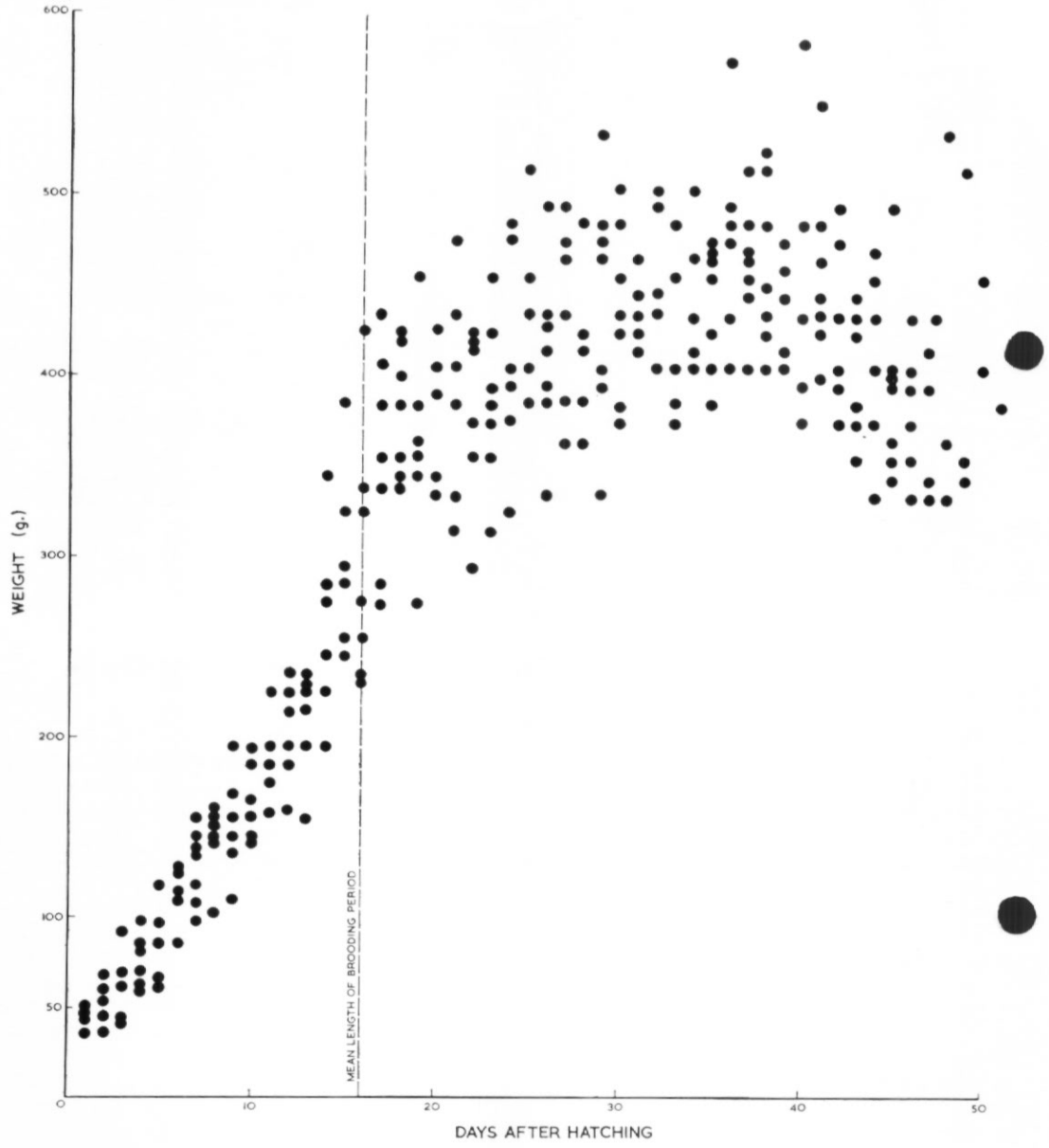

Fig. 12. Recorded weights of chicks in the period between hatching and departure from the nest.

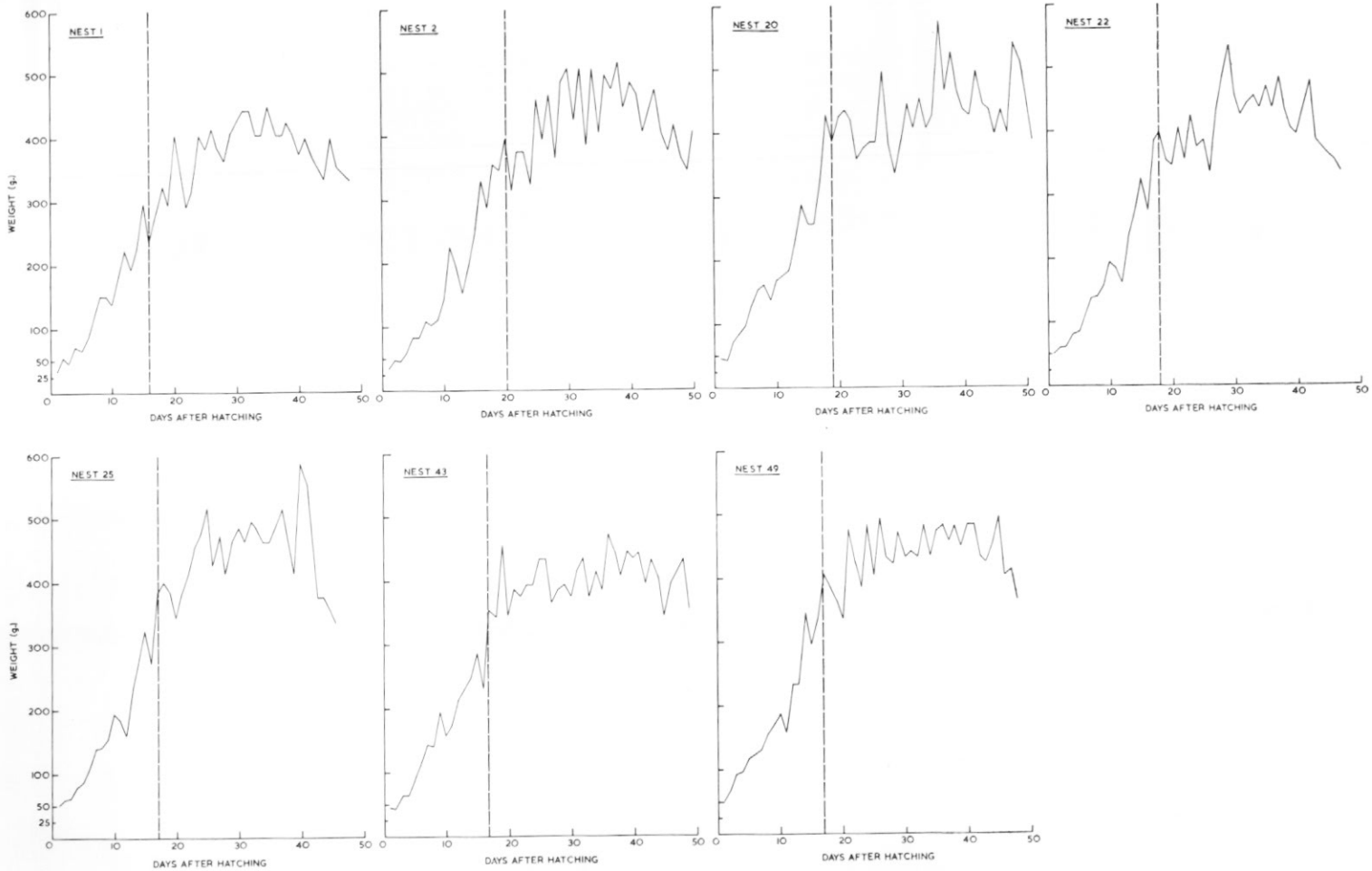

Fig. 13. Weight increase curves for 7 individual cape pigeon chicks. The pecked line indicates the end of the brooding period.

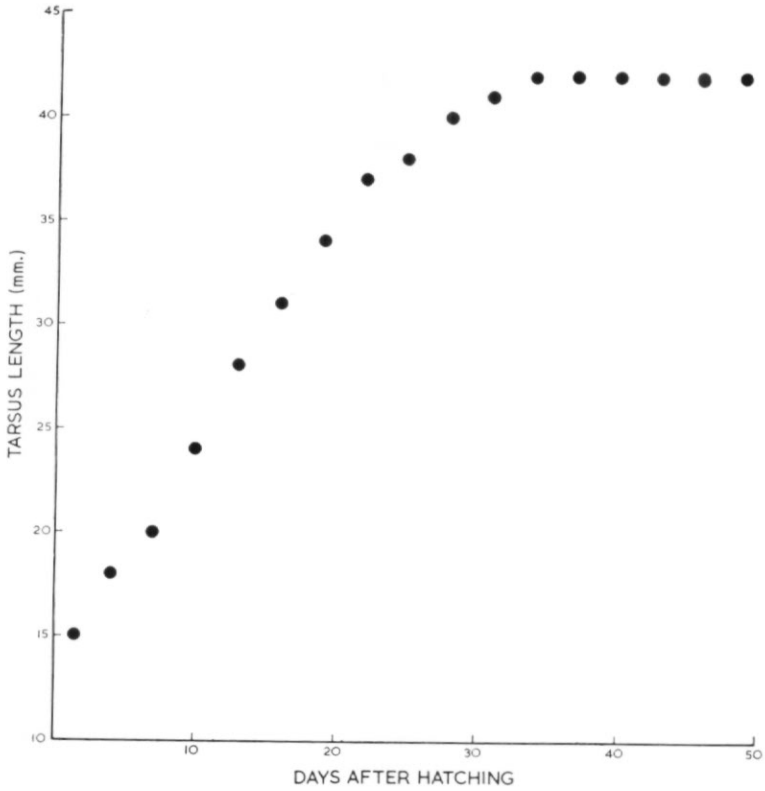

Fig. 14. Mean growth curve of the tarsus in cape pigeon chicks.

records for the growth in certain linear dimensions (culmen, tarsus and wing); data for the tail are insufficient for analysis. It will be noted that the tarsus grows very rapidly at first and reaches an asymptote at around 35 days, the culmen grows more steadily and the curve levels off at about 40 days, and the wing does not reach its full dimensions by the time the bird leaves the nest. The tail, which begins to grow last, starts at about the fifteenth day. Although chicks tend to lose weight during the last 6 days at the nest, they are never completely deserted. The average weight of fully fledged chicks on the day before departure was 359 g. as opposed to their maximum of 474 g. 14 days before departure. Of 7 chicks weighed daily, 1 received its last feed 4 days before departure, 2 at 3 days, 3 at 2 days and 1 on the day it left the nest. There is a considerable discrepancy between these chick weights and those reported by Prévost (1964) from Terre Adélie. In the latter colony the chicks are said to weigh about 200 g. at 12 days, as they do at Signy Island. However, the maximum weight of 12 specimens, which was attained between 34 and 40 days, is much greater than at Signy Island, ranging from 586–770 g. with a mean of 694 g. The heaviest chick ever found on Signy Island weighed only 585 g. At the last weighing before departure from the nest Prévost's chicks weighed around 489 g. (range 340–675 g.), while those at Signy Island averaged 359 g. (range 335–405 g.). The significance of this divergence is not clear.

Mortality in the period up to fledging. In 1960–61 at 25 nests which were observed daily and therefore liable to disturbance there was a 64 per cent total mortality rate between egg-laying and fledging. In 1961–62 the same nests were left undisturbed and the mortality was then only 55 per cent. Rather similar results were obtained from a larger sample of 45 nests in the Polynesia Point gully colony, in which there was a 71 per cent total mortality in 1961–62 when

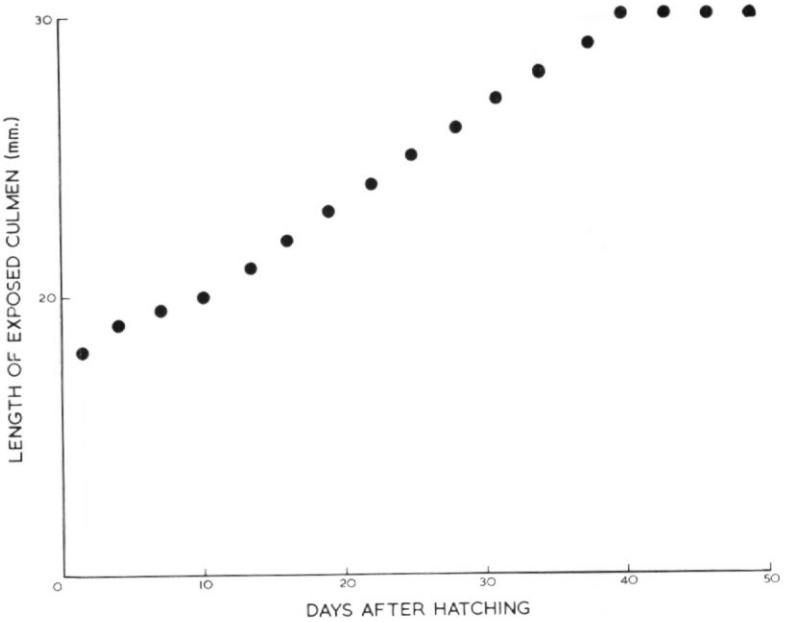

Fig. 15. Mean growth curve of the culmen in cape pigeon chicks.

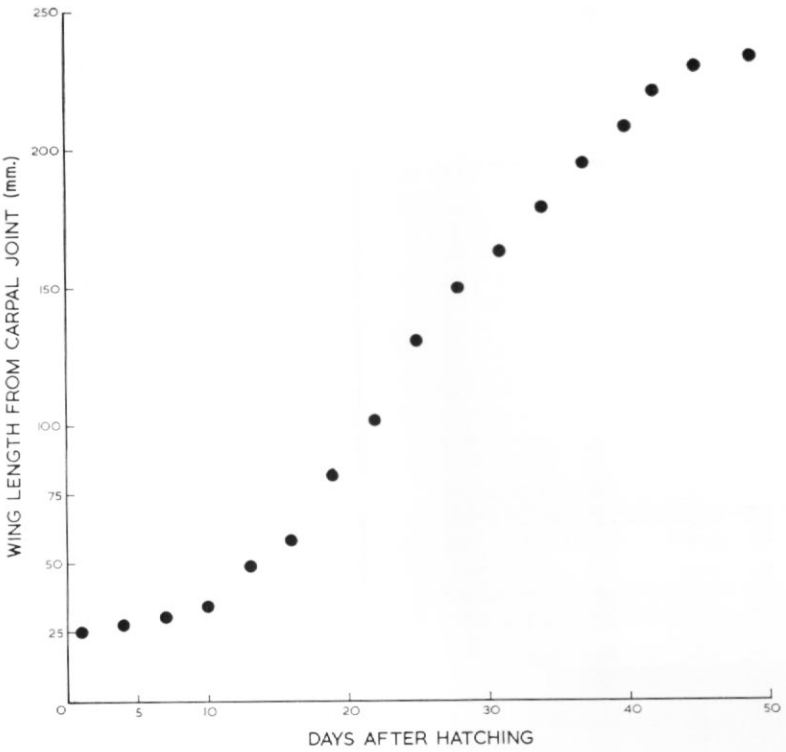

Fig. 16. Mean growth curve of the wing in cape pigeon chicks.

the nests were under study, but only 67 per cent mortality in 1962–63 when there was no disturbance. Fig. 7 shows how the losses in 1960–62 were distributed in time, and the pattern of egg-loss has already been discussed. As far as chicks are concerned, it is noteworthy that fairly high losses occur during the early period after hatching, despite close brooding, and that mortality increases immediately after the brooding period when the chicks are first left to themselves. In the later period, just prior to fledging, mortality again declines. The overall indication is that on average only 33 per cent of eggs laid yield chicks that survive to fledge and depart. This figure is much lower than the 60–65 per cent overall survival rate obtained in Terre Adélie by Prévost (1964), but the small size of the samples makes the discrepancy of doubtful significance.

Departure of nestlings. The departure of nestlings was spread over 14 days in 1961 and over 9 days in 1962. In 1961 the first chick left its nest on 24 February and in 1962 on 26 February. The last chick left on 8 March in 1961 and 5 March in 1962. The mean nestling departure date for 1961 was 1 March and 28 February for 1962. The mean age at departure was 49 days in both years.

Chicks can be seen stretching and exercising their wings from the age of 3 weeks onwards and this activity increases in the last few days spent at the nest. The majority of chicks do not move from their nests until the day on which they leave the colony. Such movement would be dangerous for an unfledged chick, because it might be "lost" by its parents and hence not fed, and because many nests are on the brink of sheer cliffs. A few nestlings do move a few feet away from the nests on the day before they depart but these are the exception rather than the rule.

Normally, by the time the chick departs it is completely free of down. Birds which were disturbed for banding 14 days before the mean departure date, however, still had some down on their tails and were unable to fly; they could only glide from the nest down to the sea. In contrast, some chicks banded only 5 days before the mean departure date succeeded, after a period of erratic flight, in flying out to sea.

Departure from the nest is quite sudden. There is no evidence of "test flights" or that once the chick leaves the nest it returns either to the colony or to the waters surrounding the island until it is about 16 months old. A close watch was kept on all birds seen near the station jetty and none of the colour-banded birds of the year was seen. Nestlings were seen to leave their nests on several occasions. After short periods of rapid wing exercises, the bird shuffled on its tarsus to the edge of the nest ledge and glided down towards the sea. About 10 m. above sea-level it straightened out and flew with a rather erratic course low across the water, the direction seeming to depend on the site of the colony. Those from colonies facing east flew eastwards and those from sites on the west coast flew westwards; in all cases the birds were seen to fly away from land and out to the open sea.

Departure of breeding adults

Breeding birds cease to visit their nests after their chicks have fledged and they have not been seen feeding at the station jetty in Borge Bay. There is a total disappearance of all cape pigeons during the second week in March, the dates for two seasons being almost identical. In 1961 no birds were seen from 9 until 17 March, and in 1962 from 7 until 16 March. Although data on this part of the season are rather scanty, records suggest that the breeding birds leave the island as soon as their chicks have fledged and they do not return for about a month. Visits to the marked colonies during this stage showed that some nests were occupied, but by birds which had not bred at those nests. The first of the breeders was seen again on the 4 April and thereafter a few successful breeding birds were seen occupying their own nest sites. There was no evidence of display, nest clearing or nest defence during this period. The last identified breeder was seen on 23 April but other recoveries of banded birds from unmarked nests show that a few breeders may linger on until the end of the month.

Pre-breeding birds. The numbers of birds assumed to be pre-breeders seen around Borge Bay decreased gradually during the last week of February. There was then a sudden drop in numbers around 4 March and by 7 March all birds had left the area. Birds returned gradually

after 16 or 17 March and by the end of that month several hundreds could usually be seen feeding in and around Borge Bay. During this time unmarked birds were seen at the Factory Cove bluffs and Polynesia Point gully marked nests. These were probably birds which were nearing breeding status and may have been prospecting sites for the following season. Birds of uncertain status were usually present throughout the month of May, their final departure depending on the local sea-ice conditions, and in a very open sea-ice year very small numbers have been seen throughout the winter months (Fig. 3).

Migrations of the Signy Island population

Only two of the 3,221 nestling cape pigeons banded on Signy Island have been recovered in their first winter after leaving the breeding grounds. One was found dead near Quintero, Chile, and the other on the island of Tanna, New Hebrides (Table V). None of the 885 adults banded

TABLE V. RECOVERIES OF BIRDS OF KNOWN AGE

Band Number	*Date and Location Banded*	*Date and Location Recovered*	*Age* (yr.	mths.)	*Remarks*
EC02540	23 February 1961 Berry Head	16 July 1961 Near Quintero, Chile (lat. 32°45′S., long. 71°31′W.)	0	5	Found dead
EC32526	14 February 1963	Early September 1963 Island of Tanna, New Hebrides (lat. 19°30′S., long. 169°15′E.)	0	7	Found dead
EC02217	20 February 1961 Polynesia Point gully	21 April 1962 Station jetty	1	2	
EC02474	22 February 1961 Berntsen Point	14 April 1962 Station jetty	1	2	
EC02504	23 February 1961 Thule Islands	14 April 1962 Station jetty	1	2	
EC02091	13 February 1961 North Point	28 November 1962 Station jetty	1	9	
EC02309	22 February 1961 Polynesia Point gully	27 April 1963 Station jetty	2	2	
EC02041	13 February 1961 North Point	25 January 1964 Polynesia Point gully	2	11	Alone at empty nest
301909	20 February 1958 Polynesia Point gully	29 April 1961 Station jetty	3	2	Re-banded EC02605
301802	17 February 1959 Polynesia Point gully	10 April 1962 Station jetty	3	2	Re-banded EC16453
301919	20 February 1958 Polynesia Point gully	10 November 1961 Station jetty	3	9	Re-banded 303219
302756	26 February 1958 Polynesia Point gully	11 November 1961 Station jetty	3	9	Re-banded 303220
302805	26 February 1958 Polynesia Point gully	4 April 1962 Factory Cove bluffs nest 18	4	2	At nest with known breeding bird; definitely did not breed at this nest in 1961–62
301932	20 February 1958 Polynesia Point gully	25 April 1962 Station jetty	4	2	Re-banded EC16455

TABLE V (*continued*)

Band Number	*Date and Location Banded*	*Date and Location Recovered*	*Age* (yr.	mths.)	*Remarks*
30084?	4 March 1952 Polynesia Point gully	5 January 1959 Polynesia Point gully	6	10	No breeding details (may have bred as very few pre-breeders found around nests at this time of year)
30084?	4 March 1952 Polynesia Point gully	25 January 1961 Polynesia Point gully	8	10	Brooding chick; Re-banded EC02009
300957	1 March 1952 Polynesia Point gully	25 October 1959 Factory Cove bluffs	7	7	At nest 22; bred at this nest in 1959–60; also breeding in same nest in 1960–61 and 1961–62; identified as female
301094	1 March 1952 Polynesia Point gully	7 November 1960 Station jetty	8	8	
301094	1 March 1952 Polynesia Point gully	3 December 1961 Polynesia Point gully	9	9	Incubating egg in nest 4; re-banded EC15022
3009??	1 March 1952 Polynesia Point gully	3 December 1960 Polynesia Point gully	8	9	Incubating egg in unmarked nest; re-banded 302892 (series 300901–301000 all used on nestlings)
30114?	1 March 1952 Polynesia Point gully	13 November 1960 Polynesia Point gully	8	8	Alone at nest; not known if breeding

has so far been recovered away from Signy Island. These disappointing results are probably partly due to the small size of the cape pigeon, which is less likely to be recovered than the larger and more conspicuous giant petrel. More recoveries are evidently needed before comparison with the movements of other petrels can be made. However, results from the banding of cape pigeons at the Tory Channel whaling station, New Zealand (lat. 41°12′S., long. 174°19′E.) indicate that there is a significant movement of birds between there and the South Orkney Islands. Twelve birds (of unknown age) banded at Tory Channel have been recaptured at the station jetty on Signy Island, and one at the Argentine station "Orcadas" on Laurie Island. Although none of these was found to be breeding, their presence in the vicinity of the colonies during the breeding season suggests that they may well belong to the South Orkney Islands population.

It is known from recoveries of age-marked birds (Table V) that some cape pigeons return to the vicinity of their colony of origin when about 16 months old. Thereafter there are sporadic recoveries of most year-groups around the breeding grounds but there is no definite proof of breeding before the fourth year.

Taxonomic distinctness of the Signy Island population

Table VI gives the results of measurements of 102 adult *Daption capensis* from Signy Island. Data from other breeding populations are rather few, and most of the measurements available (such as those given by Murphy (1936) or Prévost (1964)) are from birds taken at sea and hence of unknown provenance.

Predators

Brown skua (*Catharacta skua lönnbergi*). The adult cape pigeon in the South Orkney Islands has only one predator on land, the brown skua, and there is no evidence that this bird will take a normal healthy and alert adult. Remains of cape pigeons have been found below colonies

TABLE VI. MEASUREMENTS OF CAPE PIGEONS (*Daption capensis*). (ALL MEASUREMENTS OF LIVE BIRDS.)

	Number of Specimens	*Culmen* (mm.)	*Wing* (mm.)	*Tarsus* (mm.)	*Tail* (mm.)	*Weight* (g.)
Fully fledged nestlings	7	30 (30–32)	238 (235–247)	41 (40–43)	—	359 (335–405)
3-year-old birds	4	31 (30–33)	268 (262–275)	45 (44–47)	103 (100–109)	445 (400–510)
Breeding males	23	31 (29–34)	266 (258–278)	44 (40–47)	102 (91–110)	442 (380–550)
Breeding females	22	30 (29–33)	265 (257–277)	42 (39–46)	104 (91–105)	407 (360–510)
New Zealand banded birds	6	32 (30–35)	267 (263–275)	44 (42–46)	101 (90–112)	454 (450–460)
Breeders (sex unknown)	53	32 (29–35)	270 (252–280)	44 (39–47)	101 (90–110)	448 (370–550)

at the beginning of the season, and on one occasion 4 skuas were seen tearing an adult cape pigeon carcass apart. Again, this event occurred at the beginning of the season soon after both species had returned from winter migration. It is possible that a high level of skua predation at this time is due to a comparative shortage of normal food for the predators, which are forced to look for alternative supplies. All skua nests on Signy Island were located and mapped, and it could be seen that there is at least 1 skua nest within a few hundred yards of every cape pigeon colony. The examination of remains around skua territories showed that young cape pigeons are a definite food source for the skuas and their young. Some skuas appear to have a particular preference for them. The Polynesia Point gully colony probably helps to support pairs of breeding skuas on either side of it, and throughout the breeding season birds from these 2 nests could be seen at vantage points overlooking the gully. Remains of cape pigeon eggs were common at both these nests. Skuas will take an unguarded egg but it is doubtful whether they can move an incubating bird off its nest. The records show that after the first 8 days of incubation there are very few eggs lost until hatching time (Fig. 8), so presumably during this period skuas have to search for an alternative food source. Skuas were not seen to take chicks from nests, but from the first date of hatching until the end of the brooding period there was a steady "disappearance" of chicks. The nests under observation were so situated that it was not possible for a chick to fall out of its nest without being detected by the observer. Skuas were also seen to be particularly active during the brooding period and remains of nestlings could be found around their territories. Cape pigeon chicks are known to be able to eject oil at an early age but the number of losses suggests that this does not give them immunity from predation. A skua, however, may be able to approach a sleeping chick and remove it from the nest before it has time to defend itself. Skuas have been seen taking young giant petrels (*Macronectes giganteus*) from their nests, and in this case the victim is picked up in the beak and taken to the vicinity of the nest where it is torn to pieces by both adult skuas. It is likely that cape pigeon chicks are taken in a similar manner. The number of cape pigeon nestling's bands found in the vicinity of the skua nests shows that they are quite capable of taking almost fully fledged birds. Skuas were twice seen to chase and force into the water young fledged cape pigeons which had just flown off from their nests, but on both occasions the skua then appeared to lose interest and returned to its look-out post. Although it is evident that the skuas do take the eggs and young of the cape pigeon, they do not rely on them solely as a food source and also take dove prions, Wilson's petrels, young penguins (*Pygoscelis adélie*, *P. papua* and *P. antarctica*) and young giant petrels.

Southern black-backed gull (*Larus dominicanus*). Southern black-backed gull chicks were seen to regurgitate the remains of young cape pigeon nestlings. Adult gulls were not seen to take them but it is possible that they prey on nearby colonies much as skuas do.

Sheathbill (*Chionis alba*). Sheathbills are found in the vicinity of some cape pigeon colonies during the egg-laying period, and they have been seen to take eggs from birds which have been disturbed by the observer. They may be responsible for a small loss of eggs but they are unlikely to be serious predators.

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