THE SHEATHBILL, *Chionis alba* (Gmelin), AT SIGNY ISLAND, SOUTH ORKNEY ISLANDS

By N. V. JONES

ABSTRACT. A study of the sheathbill, *Chionis alba* (Gmelin), was carried out at Signy Island, South Orkney Islands, between April 1961 and April 1962. The general characteristics of the species and the annual population cycle have been investigated. Breeding birds return to the island early in October, form pairs early in November, and establish territories later in November. There is a high level of fidelity to a previous year's mate and considerable nest-site tenacity. Nests are concentrated around penguin (*Pygoscelis adeliae* and *P. antarctica*) colonies, the closer association being with the latter species. Both sexes participate in nest construction, incubation and the care of the chick. Egg-laying begins in early December, but full incubation starts only when clutches, which number from one to four, are complete. The normal incubation period is 30 days. Chicks are fed largely on "krill", obtained by disturbing penguins which are feeding their own young, and the sheathbill's life cycle is suitably coincident with that of the penguins. Chicks fledge when 50 to 60 days old and at this stage they become shore feeders. Chicks and adults disperse from the island in about mid-May, and there is evidence of a rather loose northward migration in winter. No definite predators are known. A number of parasites have been recorded.

THIS paper describes work done on the sheathbill at Signy Island (lat. 60°43′S., long. 45°36′W.) in the South Orkney Islands, while the author served as meteorologist with the British Antarctic Survey. Initial observations were made around the Survey station during the 1961 winter. In the first weeks after the sheathbills returned in the spring of 1961, their breeding grounds on Gourlay Peninsula were visited on all possible days, and between November 1961 and April 1962 long periods were spent in residence at a field hut erected in this area. Some nests had already been marked and breeding birds colour-banded, chiefly by P. R. Richards in 1958–59 and the late R. Filer in 1960–61, and this preliminary ground work proved invaluable.

Between late November 1961 and late March 1962 many nests were visited daily. Individual recognition of birds was made possible by banding with 10 mm. monel metal rings, adults on the left and nestlings on the right tarsus, and by banding breeding adults with coloured plastic spirals which were conspicuous at a distance. Aircraft cellulose paint was used for temporary marking. Nest sites were marked with paint and by stakes or cairns and eggs were paint-marked within 24 hr. of laying. Eggs were weighed and measured, and certain broods of chicks were weighed and measured regularly throughout their pre-fledging period. Many adults were also weighed and measured, and a few were dissected. Counts were made of the numbers of birds seen around the station during winter and spring, and many photographs (still and ciné) were taken at all seasons.

GENERAL BIOLOGY

Classification and distribution. The sheathbill is a prominent member of the avifauna in the Scotia Arc–Graham Land region. The first specimens were collected at Isla Año Nuevo (lat. 54°40′S., long. 64°16′W.) in 1775 during Cook's second voyage (Forster, 1777), and the species was described as *Vaginalis alba* Gmelin in 1778 and re-classified in the genus *Chionis* Forster in the same year. Today the Chionididae (Charadriiformes) are considered a monogeneric family, *Chionis* (Peters, 1934) including two species, *alba* and *minor*. *Chionis minor* Hartlaub is represented by different subspecies at Prince Edward Islands, Îles Crozet, Îles de Kerguelen and Heard Island. The last of these islands is the subject of current research by M. C. Downes and others (1959).

All the known breeding grounds of *Chionis alba* lie south of the Antarctic Convergence; at South Georgia, probably the South Sandwich Islands, the South Orkney Islands, the South Shetland Islands and the northern part of the west coast of Graham Land (Fig. 1). Non-breeding birds occur regularly north of the Convergence at the Falkland Islands, and on the east coast of South America as far north as the Rio de la Plata. The numbers in these regions are reported to increase in winter (Murphy, 1936).

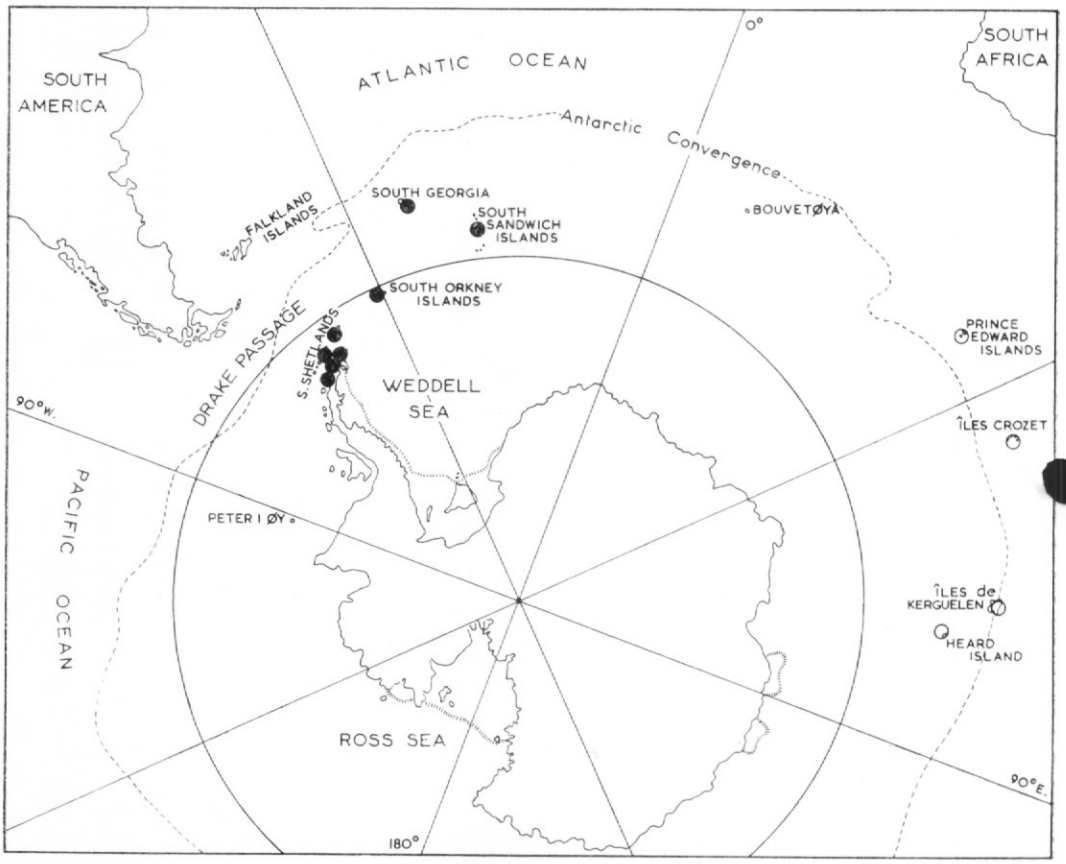

Fig. 1. Breeding distribution of the genus *Chionis*.
● *Chionis alba*. ○ *Chionis minor*.

Appearance of the adult. The plumage is pure white (Fig. 2) over a dark grey layer of down. A pink bald patch lies below the eye, and in adults this is quite convex and bears superficial markings. The eyes are also surrounded by a bald rim. Adult birds also have a small swelling in the feathered region just above and in front of the eye. Dorsally and laterally around the base of the bill there is a cluster of pink caruncles which vary in size and extent from bird to bird. These show no evident sexual difference but they are larger in older individuals (Fig. 3).

The beak is strong and stout with a deep broad base. The characteristic horny sheath, usually greenish with local yellow and blue shadings, completely covers the base of the upper mandible and extends forwards to just in front of the nostril. Anterior to the sheath, both mandibles bear an orange patch. The dorsal and ventral surfaces and the tips of the beak are black.

The legs are dark grey and bear unwebbed toes with strong black claws. The wings have a short black spur.

Gait. Sheathbills run quickly for short distances, with rapid strides and little movement of the body, presenting a strongly galliform appearance. The birds often appear reluctant to take to the wing even when chased. Breeding birds, which spend most of their time in the nesting area, generally forage and carry food to the young on foot.

Flight. Sheathbills fly with a flapping action reminiscent of a pigeon. Over the breeding

grounds they generally fly below about 20 m. and they also fly very low when crossing short stretches of water, but farther out at sea they seem to fly at, or above, mast height.

Feeding. The species is omnivorous and exploits all available food sources. Generally at Signy Island the birds are shore feeders, taking algae and limpets from the intertidal and splash zones. Limpets are common in the lower littoral zone and form an important element in the diet during spring and autumn. The birds prise the molluscs from the rocks with the sides of the beak and remove the flesh from the shell by vigorous shaking or by holding the shell with the feet and pecking out the contents. The alga most commonly taken is a green filamentous species which grows abundantly in the upper littoral and splash zones in summer

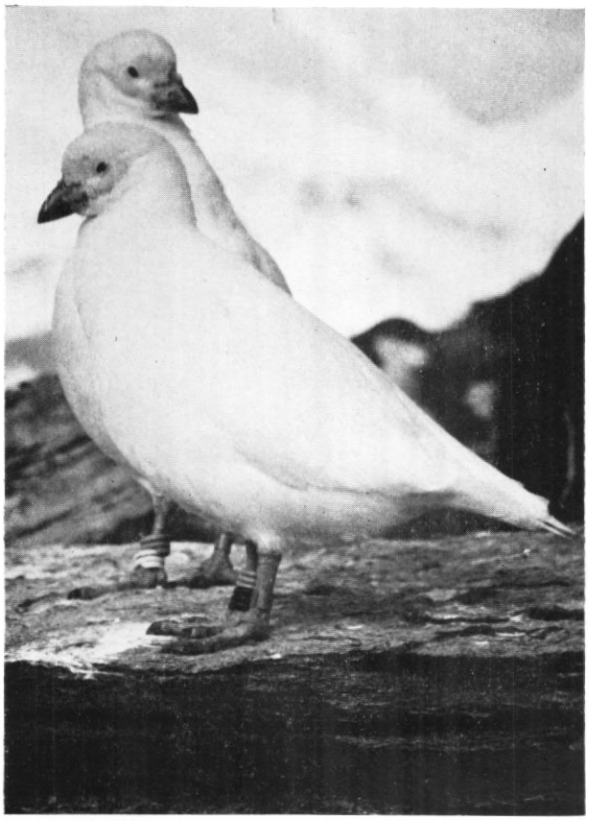

Fig. 2. A pair of sheathbills above their nest.

and autumn. This food is not available in spring because winter snow cover and frost, and the lack of spray from the frozen sea, causes die-back and renders the coastal rocks barren at the beginning of the open season. But during late summer and autumn, especially when breeding is finished, this coastal algal felt is an important food. The birds scrape it from the rock with a scissoring action of the beak, the head being held on one side. The very long (20–25 cm.) rectal caecae of the bird may be a specialization for the digestion of such food.

During the penguin breeding season the sheathbills generally forsake the seashore and feed among the penguin colonies. They are adept at stealing poorly guarded penguin eggs and are suspected of killing very young chicks. Penguin excrement—a food of doubtful nutritional value—is eaten in quite large quantities. Any carrion, such as the remains of skua (*Catharacta skua*) meals, is also taken. The most important food source in penguin colonies is, however,

regurgitated "krill" (mainly euphausids) which the penguins feed to their young. This is the primary diet of sheathbill chicks and is discussed in detail in a later section.

During the breeding season of the Weddell seal (*Leptonychotes weddelli*) in August–September, the sheathbills attend pupping animals and feed on afterbirths and blood (see also Valette, 1906). In winter the Survey station also provides a food source, the birds foraging for kitchen refuse and among the dog spans. Finally, dissected birds invariably have gravel in the gizzard and in many cases they also contain cephalopod beaks. These are presumably picked up on the shore, either washed up or possibly from seal faeces.

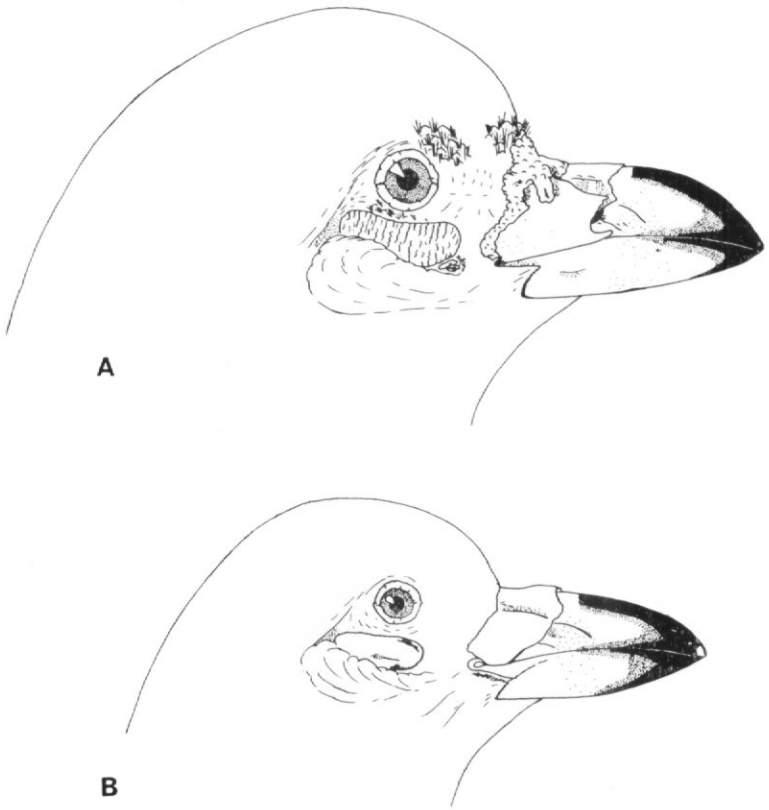

Fig. 3. Heads of sheathbills showing the facial characteristics.
A. Adult bird. B. Juvenile bird (first winter).

Excretion. The faecal material is generally rather wet. When excited, the birds evacuate the rectal caecae which contain a mass of fluid, the nature of which depends on the diet. This reaction commonly occurs when the birds are handled and may be repeated several times within a short period.

Roosting. Outside the breeding season the birds tend to congregate in small groups and roost on sheltered rocky ledges overlooking the sea and usually only a few metres above it. During the breeding season non-breeders continue to use communal roosting places, while breeders roost near their nests. The birds usually roost on one leg, with their heads tucked into the axilla. The habit of standing on one leg is common, especially in winter when the birds even forage for food with one leg tucked up into their ruffled feathers.

Bathing and preening. Sheathbills keep their plumage in remarkably clean condition, even when foraging in muddy penguin colonies in summer. They bathe frequently in pools by the shore and preen on the spot, or near to the nest if they are breeding birds.

Voice. The voice is harsh and throaty and, although there are several different calls, the voice varies little.

Annual Population Cycle and Migrations

Although sheathbills are present at Signy Island throughout the year, the population is by no means static. Fig. 4 shows the approximate maximum number of birds around the area of the station between April and November (as a block histogram) and the number of colour-ringed known breeders from Gourlay Peninsula seen in the same area at the same time (dotted curve).

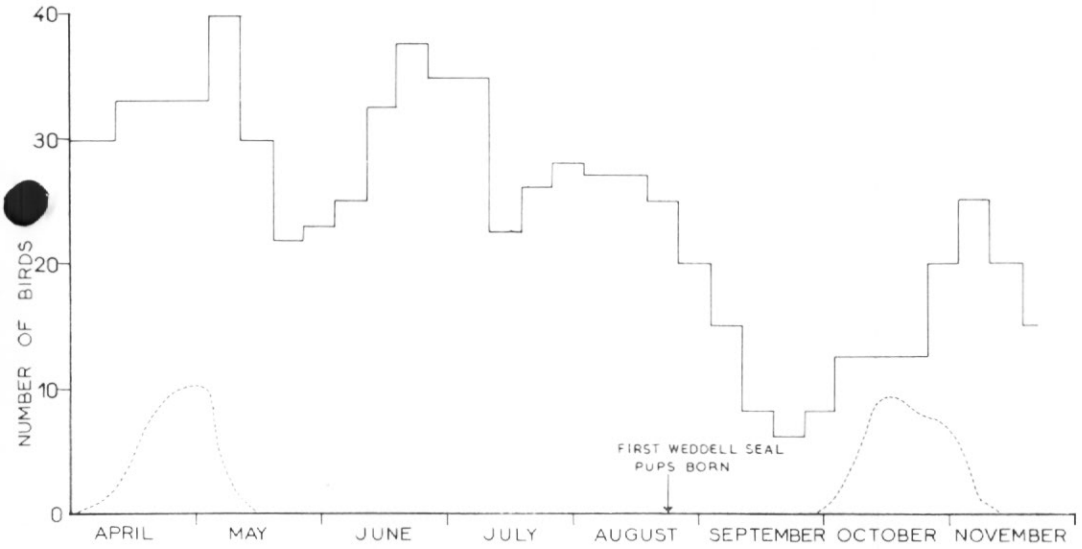

Fig. 4. The winter sheathbill population as recorded at the British Antarctic Survey station on Signy Island. The histogram is based on counts of the maximum number of birds seen at any one time during each day (excluding colour-banded birds). The dotted curve represents the total number of colour-banded birds seen during each day.

Very few birds occur near the station in the summer since most of them are in the penguin colonies some distance away. During the second half of March numbers increase and then remain high until May or June. This March–May peak is partly due to an influx of breeding birds and the May–June drop is believed to be correlated, at least in part, with their departure from the island. The second increase, which occurs in June and includes no known breeding birds from Signy Island, may be due to the arrival of birds from farther south. The decline in July, which becomes more noticeable during and following very cold spells, may similarly indicate a continued northward movement.

The very evident decline in numbers in late August has been reported before, and is correlated with movement to the pupping areas of the Weddell seal. The ensuing rise in numbers in October–November is certainly partly due to the return of breeding birds, and therefore the population may be assumed to be migrating southwards again at this season. Finally, after mid-November the majority of the birds are concentrated in the neighbourhood of penguin colonies.

It has long been suggested that sheathbills cross Drake Passage from the Antarctic to the Falkland Islands and South America in the autumn, to augment the groups which spend the summers there but are not known to breed. The general pattern of population increase and decline at Signy Island, and the known disappearance and return of marked breeders, supports such a concept of a rather loosely defined seasonal migration, and there are some banding returns which provide more concrete examples. One bird marked in the Falkland Islands

in August 1961 was recovered at Signy Island in January 1962, and there has been a sight record in the Falkland Islands of a bird believed to have been ringed at Signy Island as a nestling.

These migrations are, however, not simply north–south movements as is shown by the recovery near the South Shetland Islands of a bird banded as an immature on Signy Island. This bird was banded in June 1961 and recovered on a Russian ship in December 1962 in lat. 60°14′S., long. 62°07′W.

Some homing experiments have shown that sheathbills can return successfully to their breeding grounds over large tracts of ocean, but that they do so rather slowly. Two breeding birds from Signy Island were sent to South Georgia in January 1961 by the late R. Filer, and returned to Signy Island in time for the following breeding season. In another experiment before breeding started in December 1961, two birds were released at sea to the south-west of the Signy Island. One bird, liberated 72 miles (116 km.) away, returned 10 days later, but the second, released 180 miles (300 km.) off, has not yet been recorded back. Finally, two unsuccessful breeders were transported to the Falkland Islands in February 1962 and released in the outer harbour while approaching Port Stanley. One of these birds was found dead on a nearby beach soon afterwards, while the other returned to Signy Island in October 1962.

There is, therefore, good general evidence for a seasonal migration northwards and southwards, but it is certainly not a universal or regular movement. For example, while none of the 73 banded breeding birds at Signy Island was seen there during the winter, a pair of breeders marked at the Argentine Islands by the late C. M. Smith (1960) remained around that station during the winter. At Signy Island many adult sheathbills of uncertain provenance stay all winter around human habitation, and it is difficult to decide whether they remain in the area only because the station is there, or whether the station attracts birds that would under natural conditions be more widely spread over the surrounding country. In winter these birds can probably find natural food among the seals and penguins in the pack ice and where planktonic Crustacea are washed up on to ice floes.

The Breeding Cycle

Return and pre-nesting activities. In 1960–61 73 birds breeding on Gourlay Peninsula were banded by the late R. Filer and R. Pinder. All disappeared during the following winter and the first to be seen again arrived at the British Antarctic Survey station on 3 October 1961. No colour-banded birds had been observed during visits to the breeding area on the two preceding days.

Between 5 October and 5 November the number of marked birds on Gourlay Peninsula increased rapidly (Fig. 5). At the beginning of this period the island was still completely

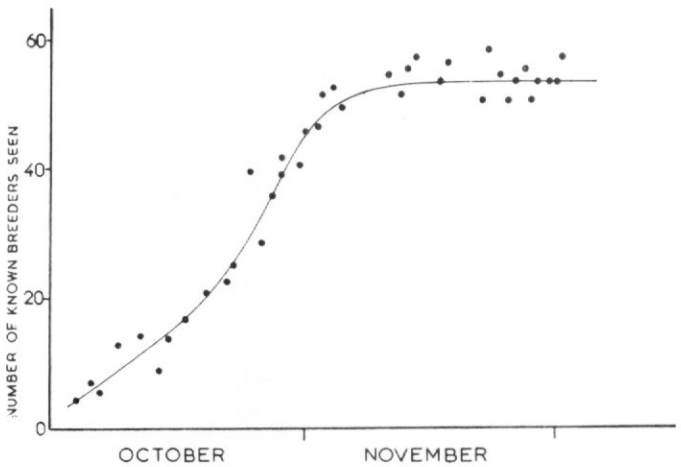

Fig. 5. Build-up of the breeding population in the nesting area during the spring of 1961.

surrounded by ice and, although leads and pools appeared during October, the final break-up did not occur until early November. During this time, the greater part of Gourlay Peninsula was snow-covered, and this was the case even when the Adélie penguins (*Pygoscelis adeliae*) commenced laying on about 24 October. The nest sites of most of the sheathbills were not free of ice and snow until late November or early December.

During the pre-breeding period the sheathbills spent their time foraging among the penguins and seals on the shore, or around the British Antarctic Survey station. They also spent considerable periods in the vicinity of their previous season's nests, but they did not establish territory and appeared to take little interest in their past season's mates.

Pairing. In a few cases, pairs were seen together in the early pre-nesting period, but such associations were loose and temporary, and probably occurred because of chance meetings in the vicinity of the old nest. However, one known pair was seen displaying to each other at the station on 6 October, but this display was at low intensity and the birds were later seen performing the same ritual with several other individuals. It was not until early November that attachment to the nest area increased significantly, and definite pairs formed and began to defend a territory. In the majority of cases the pair-bonds of the previous year were re-formed and the same nest site was occupied.

Of the 73 colour-banded breeding birds of 1960–61, 66 returned, including 20 pairs and individuals rendered "unattached" by the failure of their mates to return. All the pairs that returned re-formed and re-occupied their old territory. The "unattached" birds soon found new mates and occupied the territory used by the banded bird in the previous season. This suggests that the birds that fail to return are usually replaced by unestablished breeders. Some changes of nest site were recorded, mostly temporary ones necessitated by the presence of ice in the original nest. The only other changes were of sites within the same territory and these were suspected to be due, at least in part, to the observer's interference at building time.

These observations indicate a considerable degree of faithfulness to the previous year's partner, and a high degree of nest-site tenacity.

The most conspicuous display performed by sheathbills is the "bowing ceremony" which is seen both during and after pair formation. The birds stand facing each other about 1 ft. (0·3 m.) apart and bow to one another, usually several times in quick succession, within a 5-sec. period. Bowing is usually accompanied by a low "muttering" sound, and the birds often peck at each other's bills between bows. The intensity of the ceremony varies from an almost casual nod to a prolonged series of bowing periods. The intense display is universal during the courtship period but it is also very common between established pairs and seems to be important in maintaining the pair-bond.

Territory. Establishment of territory is a gradual process which follows pairing. Although some pairs are formed fairly early in November, the territory is often not really established until two or three weeks later. Its size is primarily governed by the situation of the nest, although there is a good deal of variation which depends on the birds themselves. If the nest is sited inside a penguin colony, the territory is often quite small, but otherwise it may be rather extensive (of the order of 200–2,000 m.^{2}). It was found difficult to map territories accurately, except where the boundaries lay close to nests, mainly because of the penguins and the rough terrain. Most birds had a single territory within which they both bred and fed, but in a few instances separate breeding and feeding territories were held and in one case these were about 350 m. apart. This latter situation arises in birds which feed in penguin colonies offering no good nest sites. In such cases one bird generally remains near the nest while the other forages. The feeding territories are poorly defended but the nesting ones are easily looked after as they are quite small.

Judging from the existence of such cases, and the presence of a number of non-breeders which showed signs of maturity, the Gourlay Peninsula colonies seen to be supporting about the maximum number of breeding sheathbills they can accommodate.

Defence of territory. Boundary encounters between the occupants of neighbouring territories were frequently seen, especially where nests lay close together. On these occasions the birds stood facing each other in threatening attitudes, each on its own side of the boundary, and usually moved slowly along the boundary in such postures before one turned and returned to its nest. The threat posture of the sheathbill is a forward-oblique pose which is usually

accompanied by a "bill-wiping" action on the ground in front. The posture is usually accompanied by a single "caw" and this call is repeated during the bill movement.

Fights were seen occasionally, mostly during the courtship period, when territories were still imperfectly established. While fighting, the birds faced each other in extended upright postures, pecked at each others heads and often beat at one another with their wings. When a fight was at its most heated a bird sometimes rushed at its opponent, gripped any appendage with its beak and hung on tightly. This resulted in vigorous fluttering and apparent submission of the bird thus treated. Such fights occasionally caused minor injuries around the head, but usually resulted only in muddied and bedraggled plumage.

The territory is generally watched from a prominent rock above the nest by one or both birds. If an intruder appears, the occupant either runs or flies from its vantage point towards it. In the latter case it alights close by, finally attacking on foot. Threatening movements of this kind normally cause the immediate retreat of an intruding sheathbill. Attacks are also made on intruding brown skuas (*Catharacta skua*), penguins which approach too near the sheathbill nest and humans; the author has many times been attacked while handling chicks. If a skua alights anywhere near a nest the occupants commence an excited threat display with frequent "bill-wiping" and "cawing", and in many cases one sheathbill will fly at the intruder. Such attacks are generally made from behind and are only lunges followed by hasty retreat, but they are usually sufficient to discourage the intruder.

Nesting localities. Sheathbills were not seen in the interior of even so small an island as Signy Island, and they appear to travel and breed strictly within the coastal zone (Fig. 6).

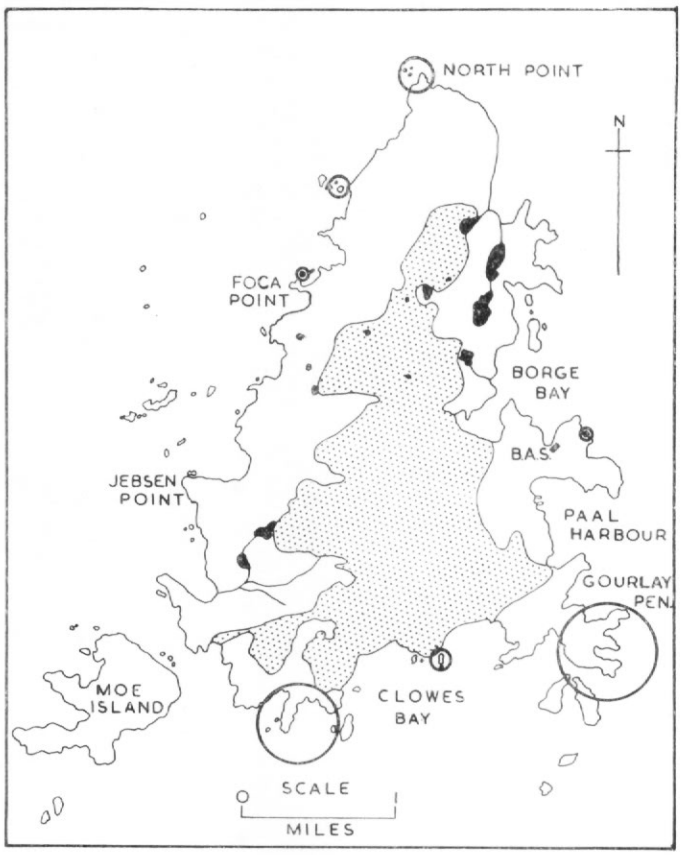

Fig. 6. Map of Signy Island showing the sheathbill breeding areas (excluding Moe Island). These coincide with penguin colonies except the two marked ⊙. Stippling represents permanent ice.

All except two of the known nests were associated with Adélie (*Pygoscelis adeliae*) or chinstrap (*P. antarctica*) penguin colonies. Both penguin species breed on promontories which become snow-free in summer, the Adélie penguins occupying flat ground while the chinstrap penguins concentrate on rocky slopes overlooking the sea.

The majority of sheathbill nests are situated in crevices between, or in holes below, rocks and some of them are very deeply placed. A few occur on rather open ledges. The terrain prevents burrowing. The general requirements seem to be:

i. A sheltered position, preferably in a crevice.
ii. Proximity to a food supply.
iii. Suitable observation point above the nest.
iv. Proximity to the shore.

Such conditions are more commonly found on the rocky slopes occupied by chinstrap penguins than among the Adélie penguin colonies, and it is therefore not surprising that the majority of sheathbill nests occur close to, or among, colonies of the former species (Fig. 7).

The nest and its construction. During the last weeks of November 1961 there were signs of scraping and rearrangement of material in the nest holes. At this time, however, many nests were still ice-bound, and a number remained so until mid-December. Under these conditions, where the nest hole itself was accessible, the birds often started a new nest on the ice above or near the old one. The subsequent thawing of this ice was often followed by a shift of the nest to the old position.

In one case, a pair of birds, whose original nest was still buried by ice as late as 18 December, built and laid two eggs in a new nest 20 m. away and on the other side of another territory. By 21 December, however, the original nest had thawed out. Eggs were laid in it on 22 and 26 December, and no further attention was paid to the new nest from which the eggs soon disappeared.

Both birds participate in nest building, the male in general being the more active in collecting material while the female does more of the arranging within the nest hole. This division of labour is, however, a tendency rather than a rigid or universal rule. The nest material is gathered within the birds' own territory and foraging is a lengthy and apparently selective occupation. Often many pieces of material are picked up and discarded before a bird finally takes something back to the nest.

Nest construction involves simple actions. A bird sits in the middle and picks up any material within reach of its beak, dropping it in front or over its shoulder. This process is repeated on both sides of the body and while facing in different directions, so that the nest acquires its shape and loose structure. As might be expected, the nest is usually loose and untidy, and made up of penguin feathers, egg membranes and shells (Fig. 8). The proportion of seaweed and limpet shells used increases with proximity to the sea. Any other available material, such as bones, moss, lichen, and in one case even a handkerchief, may be incorporated.

Copulation. Only four acts of copulation were observed, all from a distance, and in all these cases the birds were near their nests. The complete behaviour sequence was never seen, and the pre-copulatory display was witnessed only once. On this occasion the male strutted stiff-leggedly around the female, which stood still with a slightly lowered head and a raised tail. This pair were disturbed before copulating, but Downes (personal communication), who has described similar behaviour more fully in *Chionis minor* at Heard Island, states that here, after a similar strutting behaviour the male stands facing in the same direction as the female and after making quick and repeated clutching movements with his feet, mounts. In both *C. minor* and *C. alba* the male does not grip the head of the female with his beak. Downes also describes invitation movements by a female *C. minor*, and one case of what might be auto-erotism, but these phenomena were not observed in *C. alba*.

In the Signy Island sheathbills, one bird of a pair usually displayed tread marks on its back prior to egg-laying, which helped in differentiating the sexes. One or two birds showed marks which might indicate reversed positions in copulation (or attempted copulation).

The egg. Sheathbill eggs resemble those of a plover in colour and shape. The ground colour is usually a dirty white, but it may be fawn or even light olive. The surface is liberally marked

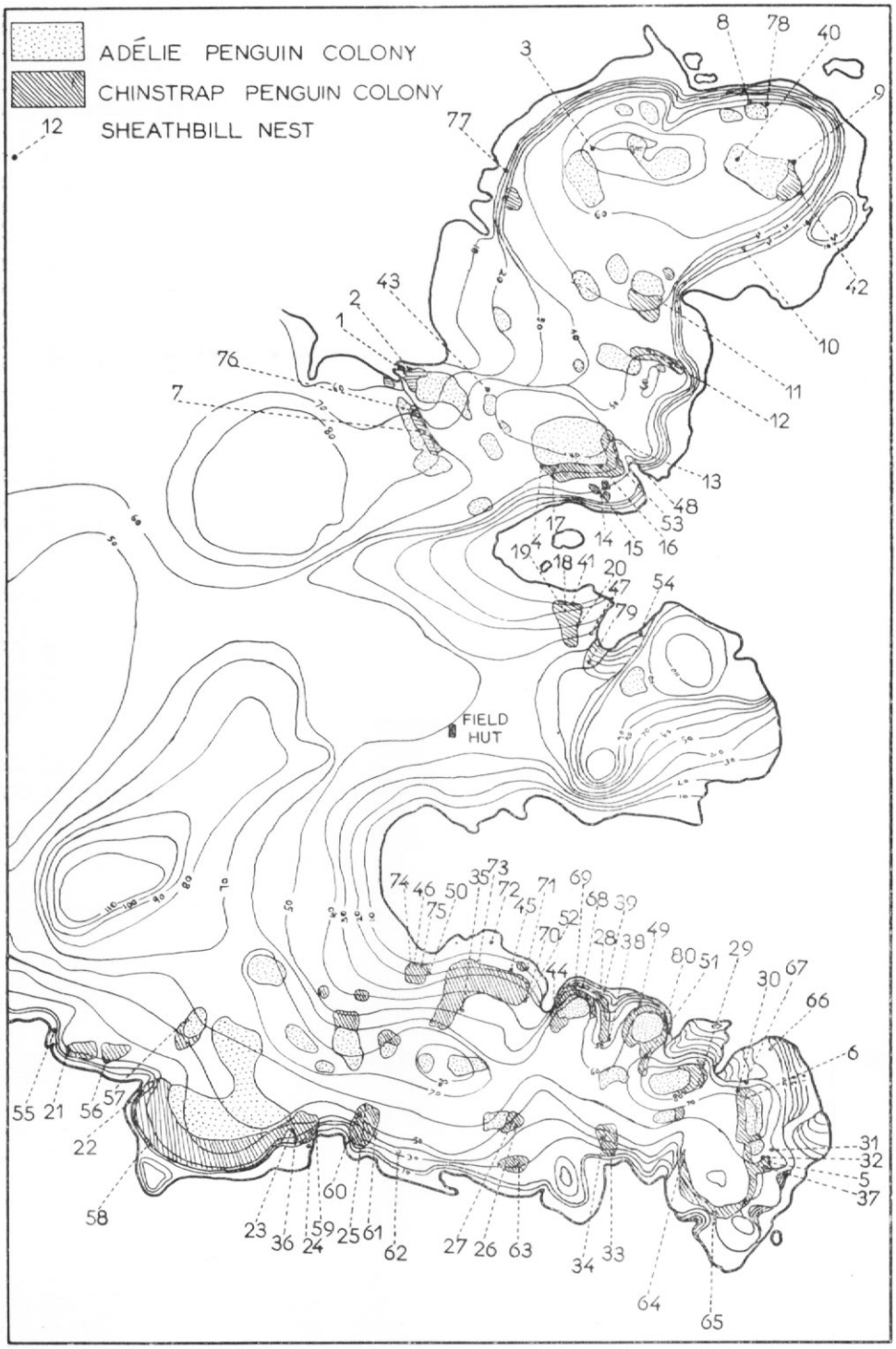

Fig. 7. The Gourlay Peninsula penguin rookeries showing the distribution of sheathbill nests during the 1961–62 season. (Survey by J. J. Cheal, 1951.)

Fig. 8. One of the more open nests containing eggs.

Fig. 9. The same nest as shown in Fig. 8 with young chicks.

with brown and grey blotches, which tend to be larger and darker at the broad end. The dimensions and weights of 103 eggs are summarized in Table I.

TABLE I. MEASUREMENTS OF EGGS OF *Chionis alba*

	Number in Sample	*Mean*	*Range*	*Standard Deviation*
Weight	103	45·5 g.	52–40 g.	2·47 g.
Length	103	57·6 mm.	64·5–52·5 mm.	2·49 mm.
Breadth	103	38·5 mm.	40·5–36·0 mm.	1·10 mm.

The first egg of the season was found on 7 December and thereafter the number of nests containing eggs increased steadily. By 20 December most nests contained eggs; the last recorded laying was on 14 January. Laying must have commenced at about the same date in the Laurie Island birds studied by Pirie (Wilton and others, 1908), since he found two clutches of three, and two of two eggs on 11 December 1903. Roberts (1948) reported first eggs as early as 29 November at Hope Bay in 1947. At Gourlay Peninsula the minimum interval between the laying of two eggs in a clutch was one day, and the maximum four days. These data contrast somewhat with the statement of Bennett (1927) that a week may elapse between the laying of two eggs. The interval between the laying of eggs in a clutch was not constant. Clutch size varied between one and four eggs (Table II), and this range of variation exceeds that reported at South Georgia by Murphy (1936). The number of fledglings produced per pair in the South Orkneys Islands also seems greater than at South Georgia.

TABLE II. CLUTCH SIZE OF *Chionis alba* AT SIGNY ISLAND

Number of Eggs in Clutch	*Number of Nests*
1	9
2	23
3	13
4	3

Incubation. It has been stated (Bennett, 1927; Murphy, 1936) that incubation commences as soon as the first egg has been laid, and this is clearly desirable in a species nesting in such a cold climate. However, while the period between the laying of the eggs in a clutch at Signy Island was often several days, most chicks hatched within a couple of days of one another. This near-synchronization of hatching occurs because, although the birds do cover their eggs as soon as the first one has been laid, they do not incubate them fully at this stage. During the first few days, the early eggs of a clutch feel warm to touch, but when the clutch is complete and incubation has commenced in earnest they feel very much warmer. Development of the early eggs is thus held back until the clutch is complete. There is no rigid rule about the commencement of incubation; however, in some cases it starts before the last egg is laid and in a few others it does not begin until some days after that event.

Table III summarizes the data collected for incubation periods of a series of selected clutches of varying size. The "real incubation period" is taken as the period from the laying of the last egg to its time of hatching, and the average incubation period was calculated using these real incubation times only.

Incubation is shared by both sexes, although they do not usually sit for equal periods. Generally, the male appears to take the longer spells during the laying period and for a few

TABLE III. INCUBATION PERIODS IN CLUTCHES OF VARIOUS SIZES

Nest	*Egg Colour*	*Date Laid*	*Date Hatched*	*Apparent Incubation Period* (days)	*Real Incubation Period* (days)
20	blue	2 January	2 February	31	31
19	blue	18 December	18 January	31	31
5	blue	22 December	21 January	30	27
	red	25 December	22 January	28	28
18	blue	22 December	23 January	32	29
	red	25 December	24 January	30	30
1	blue	9 December	11 January	33	27
	red	12 December	12 January	31	28
	yellow	15 December	lost	—	—
6	blue	11 December	15 January	35	30
	red	13 December	15 January	33	30
	yellow	16 December	15 January	30	30
17	blue	11 December	16 January	36	30
	red	14 December	16 January	33	30
	yellow	17 December	18 January	32	32
7	blue	12 December	inviable	—	—
	red	14 December	18 January	35	29
	yellow	17 December	18 January	32	29
	green	20 December	20 January	31	31

The real incubation periods for 29 last eggs of clutches ranged between 28 and 32 days, with an average of 29·9 days.

days afterwards, but during the remainder of the incubation period the female spends the longest periods on the nest. Some males, however, persist in long incubation spells. It proved difficult to measure the length of incubation duties because the birds are easily disturbed, but the longest spell observed reliably was 5 hr. 14 min., while short spells lasted in some cases only 1 or 2 min. The "off-duty" bird forages for food or nest material, or stands guard on a nearby vantage point.

Nest relief is usually quick, and the relieving bird moves on to the nest as soon as its partner comes off. Sometimes there is a "bowing ceremony" when the birds meet.

Egg losses at Gourlay Peninsula were fairly high but their causes were obscure. In a few cases eggs vanished without trace, and the only suspect agents were the birds themselves or other sheathbills. Several eggs failed to hatch, and these had fine cracks in the shells which were probably caused by freezing. However, the importance of this factor under natural conditions is uncertain since the eggs may have been chilled after the birds had been disturbed by the observer. Some birds, especially early in the incubation period, tended to stay off the nest for rather a long period after disturbance, and on a cold windy day this may have caused egg mortality.

Hatching and brooding. Most eggs hatch within three or four days of showing the first "starring" of the shell but in a few cases a five-day interval was observed. At hatching the chicks are capable of movement within the nest and they can open their eyes, but these activities are only kept up for short periods at a time.

The egg-shells are usually removed but they may be incorporated into the nest structure. Both sexes share brooding duties, but to varying degrees, as in incubation. The chicks are brooded quite closely for ten to eighteen days, and less intensely thereafter. Although the chicks are fairly well developed and capable of moving about soon after hatching, they usually

remain in the nest for about a fortnight. Chicks hatched in the more open nests (Fig. 9) leave them for better shelter long before the chicks emerge from the more sheltered nests.

Nest hygiene is maintained by the chicks themselves, which generally move to the rim of the nest and defaecate away from it, and in a few cases may move right away from the nest to excrete. This habit was established in chicks observed at four days old and it seems to begin even earlier as droppings were already present near the nest at this time.

Feeding of chicks. The omnivorous diet of adult sheathbills is less suitable for the chicks, and in fact these are fed largely on a much richer food source, "krill", which is available at this time. This "krill" is obtained from penguins, which bring it for their own young, and this relationship is probably the sheathbill's greatest dependence on penguins.

There are several records of sheathbills feeding euphausiids to their chicks, but there are few descriptions of how the material is procured. Hall (1900) and Sladen (1958), however, describe a method which is commonly followed at Gourlay Peninsula. While some "krill" is collected off the ground, after penguins have been feeding their young, more is obtained by direct interference in the feeding process. This interference is most prevalent when the penguin chicks are in crèches and food chases (Sladen, 1958) are common, since at this time a sheathbill can attend a parent penguin and chick without interference from neighbouring penguins. The sheathbill waits until the penguin chick is being fed and then either pecks at or flies on to its back (Fig. 10). This disturbs the chick, which usually ducks away and breaks off feeding. The parent penguin cannot stop regurgitating food immediately and some usually falls to the ground where the sheathbill picks it up. This source of food is of paramount importance to the Gourlay Peninsula sheathbills; the few that did not rely on it for feeding their chicks were either late breeders or unable to hold a territory covering a penguin colony.

The sheathbill's breeding cycle coincides with those of the penguins, in that most chicks hatch about mid-January when the Adélie penguin chicks are forming crèches. The Adélie penguins disperse rapidly in late January or early February, but by this time the chinstrap penguin crèches are present, and this penguin species disperses more slowly since the birds

Fig. 10. A sheathbill disturbing a feeding chinstrap penguin chick in order to obtain food for its own young.

stay ashore to moult. Consequently, "krill" may be obtained from mid-January onwards, almost into March.

Most sheathbill territories include colonies of both penguins, but some take in Adélie penguin colonies only. In this case the food supply diminishes abruptly in late January. Fig. 11 shows the consequences for the two sheathbill chicks in nest 78. These chicks were

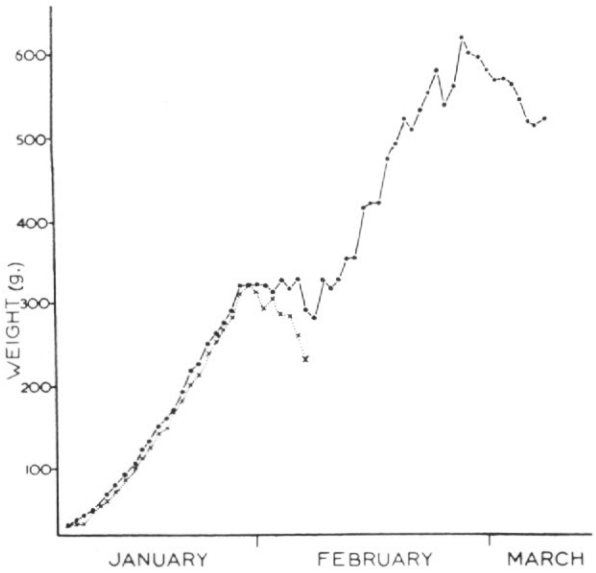

Fig. 11. Weight curves of the two chicks from nest 78. This pair's territory included Adèlie penguins only.

increasing in weight normally until the sudden and complete departure of the Adélie penguins. The parents were then unable to obtain "krill", and the chicks lost weight despite some feeding on algae. One chick vanished without trace; it may have died of starvation or, in its weakened state, fallen an easy prey to a skua. At this stage, however, the parents were able to establish a feeding territory in the corner of a chinstrap penguin colony, and so obtain "krill" for the remaining chick, which resumed normal development. The data in this figure may be compared with those for the uninterrupted growth of two chicks in a "normal" territory including colonies of both penguins (Fig. 12).

This example illustrates the close relationship between the life cycles of sheathbills and penguins. Whether the sheathbill has adapted its breeding cycle, or the relationship is coincidental, is a matter of conjecture. Its occurrence is perhaps best regarded as a further example of the resourcefulness of the sheathbill in exploiting the available food supplies. The dependence is not absolute; one pair successfully reared chicks without any contact with penguins and a number of late breeders had to rely on shore feeding for a period before the chicks fledged. It is clear, however, that the food made available by the penguin colonies permits the establishment of a far greater sheathbill population than could otherwise occur.

Parent sheathbills carry food to their young in their beaks and, if necessary, call them from the nest with a short "caw". The chicks take the food directly from the beak but if any falls, they immediately peck it up, even when they are only a few days old.

Appearance of chicks. At hatching the chick weighs about 30 g. and is clothed in a dark brown down which bears light-coloured, hairlike tips and therefore presents a "smutty brown" appearance. There is a bunch of white, hairlike feathers below the bill and a similar smaller one beneath the eyes. The down is in well-defined tracts (Lowe, 1916), and the bare patches at the wing bases are very apparent in the young bird. The eye is surrounded by a bald white ring, and there is also a bare patch of skin below the eyes. The bill is strong, dark brown, and with a pale tip bearing a white egg-tooth. The sheath is not clearly differentiated

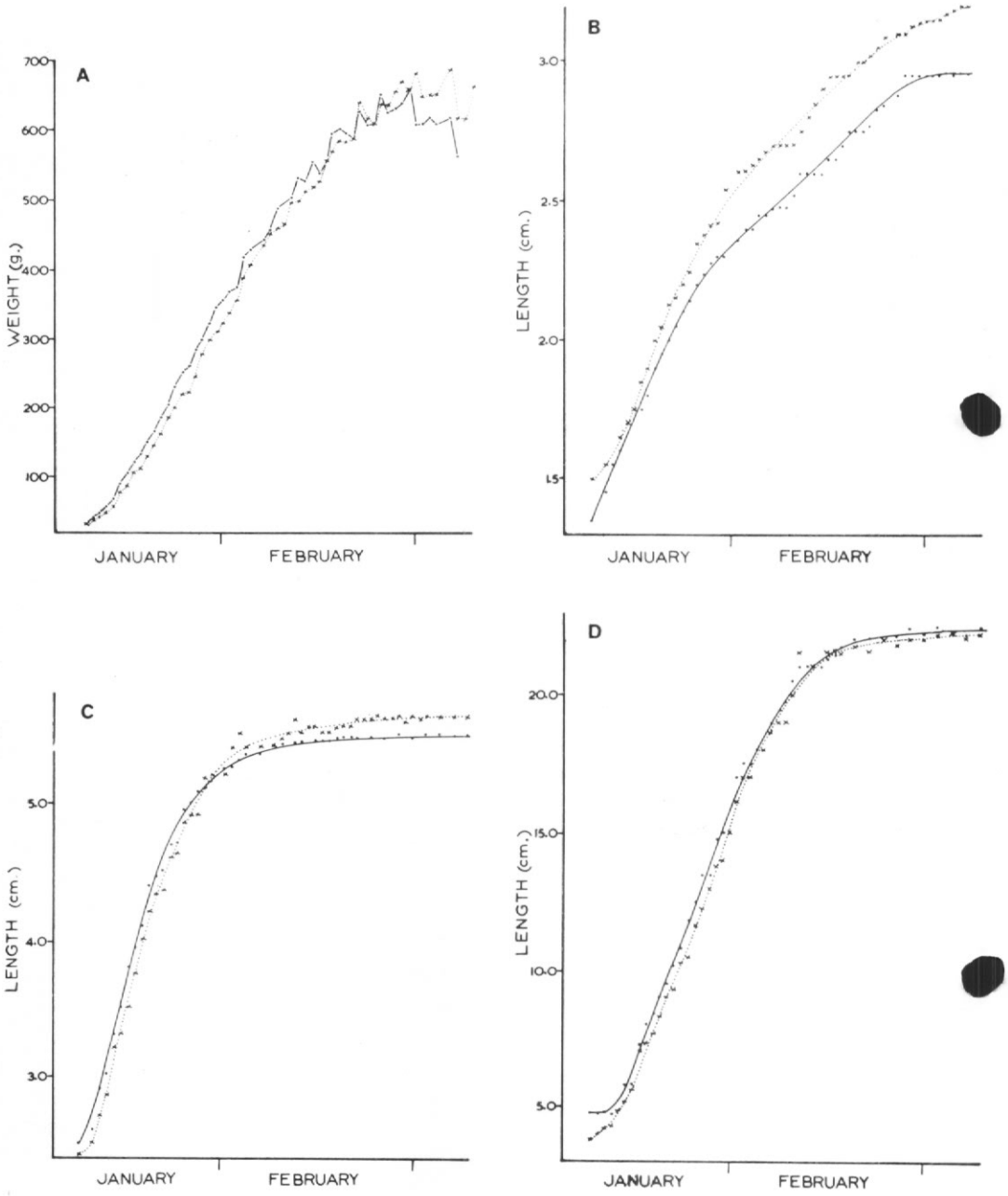

Fig. 12. Growth curves for the two chicks from nest 38.
(Territory included both species of penguin.)

A. Weight. C. Tarsus.
B. Culmen. D. Wing.

from the rhamphotheca except on the dorsal surface. The differentiation gradually increases but the nostrils remain uncovered even after the young have fledged. The legs are dark brown and the toes have strong dark claws. The wings bear small black spurs.

Behaviour of chicks. The chicks can leave the nest when they are three or four days old, and they often do so to excrete. They soon become familiar with the nest precincts and when removed a little distance from the nest young chicks soon run back if they are set down facing the right way. Chicks react readily to the parent's alarm call, or to its sudden departure from the nest, usually by "freezing" in the middle of the nest or squeezing into its darkest corners. When brooding has ended the chicks may wander from the nest, although they avoid the open unless the parents are nearby. Often, especially if they have hatched in an exposed nest, the chicks use some other hole or shelter at this time.

If they are approached by other sheathbills, as may happen when the parents' vigilance is relaxed, the chicks cower and give repeated high-pitched "cheeps". This soon brings the parents, which chase away the intruders. The latter are usually non-breeders which display interest in chicks and have several times been observed to peck at them.

Fledging. Before the white contour plumage of the juvenile bird is acquired a dark grey layer of down develops which soon shows through the initial brown prepennae and becomes the down layer of the juvenile bird. The contour plumage then develops from the same follicles as the brown down, so that the latter are pushed out and ultimately fall off the white feathers. The last areas to lose the remnants of the brown down are the head, neck and rump. The juvenile plumage is acquired in 7 to 8 weeks after hatching. The main changes are summarized in Table IV.

Most of the chicks fledge when they are between 50 and 60 days old. After leaving the nest, they generally become shore feeders and their diet often changes from "krill" to algae quite

TABLE IV. PLUMAGE DEVELOPMENT OF *Chionis alba* CHICKS

Age (days)	*Plumage*	*Other Features*
1–10	Uniform smutty brown down.	*Beak:* dark brown with pale tip bearing egg-tooth. *Iris:* dark brown shading to grey. *Legs:* dark brown/black becoming dark grey.
10–20	Dark grey down appears about twelfth day and shows through the prepennae by the twentieth day. Contour feathers are developing and wing coverts and secondaries are now prominent.	*Iris:* appears grey with dark brown around the pupil.
20–30	Contour feathers are now showing all over the body except the head, neck, breast and rump.	*Beak:* egg-tooth lost. Sheath differentiated on dorsal surface only. Sheath pale and culmen pinkish shading to pale green and then black with pale tip.
30–40	Brown prepennae are only present on the head.	
40–55	Full juvenile plumage has been acquired, but a few prepennae are still present on the head.	*Beak:* sheath: greenish with bluish base and dark forward edge. culmen: creamy shading through green and dark to pale tip. *Iris:* grey with brown around the pupil. *Legs:* grey.

abruptly. Towards the end of March the young birds begin to wander away from the Gourlay Peninsula area, and at this time some arrive in the neighbourhood of the Survey station. They have been seen around the island until mid or late May, at which time they disappeared. Banding returns showed that they did not return until they were at least 2 years old. Recently, however, Topliffe (personal communication) reported the reappearance of six 1962 nestlings in late July and early August of that year. No information is yet available to suggest a reason for this and their subsequent movements are not known.

Post-breeding activity. The adults leave the nest area and territory as soon as the young are fledged. Although they may return later to the vicinity, they then show no territorial behaviour and usually spend little time there, since by this stage they are largely shore-feeders. They gradually become more scattered, appearing around the Survey station in late March and disappearing from the island about mid-May.

Non-breeding population. Non-breeding birds apparently make up about one-quarter of the summer sheathbill population of Signy Island. These are believed to be immatures (but 2 years old), or mature birds prevented from breeding by lack of success in acquiring territory or by late arrival (one colour-banded bird did not return until February). These birds spend their time foraging on the shores or in unclaimed or poorly guarded areas in penguin colonies.

Predators

No certain predation on adult sheathbills has ever been observed. The only likely predator is the brown skua (*Catharacta skua*) and this probably does not take healthy adult sheathbills. The behaviour of the sheathbill chicks and adults when skuas approach the nests suggests that these birds are regarded as a potential danger, and there are several records of skuas diving at young sheathbills, although none of the chicks were certainly killed. One chick studied at Gourlay Peninsula was apparently eaten by a skua but the cause of death was not evident. Probably other sheathbills, especially non-breeders which are believed to take eggs from poorly guarded nests, are the principal active predators.

Parasites

External parasites. Sheathbills at Signy Island are commonly infested with lice and feather mites. Mallophaga are abundant on the head and neck, and they have also been collected from the body. The species obtained (kindly identified by Dr. T. Clay) are:

Quadraceps antarcticus Timmermann,
Actornithophilus pauliani Séguy,
Saemundssonia sp.

Analgesid mites are mainly present in the rump feathers anterior to and over the preen gland, and on the underside of the wings. The mites in the latter position were more numerous in the summer.

Internal parasites. The only internal parasites collected were Acanthocephala, found in the posterior sections of the intestine. However, a detailed search was not made and parasites such as the trematodes reported from the gall bladder of *Chionis minor* by Downes (personal communication) may have been missed.

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with information on *Chionis minor* and in allowing me to use the bibliography he has compiled for the genus.

I wish to pay a special tribute of thanks and admiration to the late R. Filer, whose name this work should bear. It was the dedication that cost him his life during his sheathbill observations that stimulated this work.

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