

Order SPHENISCIFORMES

Family SPHENISCIDAE penguins

Well-defined group of flightless, medium-sized to large seabirds of s. hemisphere, highly specialized for marine life. Closest affinities with procellariiforms. Divergence from common ancestor happened probably by late Eocene c. 45ma, when specialized anatomy was fully developed (Simpson 1975). Seventeen or nineteen species in six genera, depending on treatment; except for genus *Spheniscus* (four species), all breed in our region. Though popularly associated with s. polar region, most species breed on subantarctic and even cool temperate islands and the species of *Spheniscus* breed on the coasts of South America and South Africa, N to the equator, in the Galápagos.

Large head, short neck and elongate body. Tail, short and wedge-shaped, with 14–18 stiff rectrices, but quite long in *Pygoscelis*; often used as a prop when standing on land. Legs short and stout with webbed feet, vestigial hind toe and large claws; set so far back that when on land, birds stand vertically, walk with upright waddling gait, and often prefer to toboggan on belly. Tarsus mostly feathered; area of bare skin near feet tends to be larger in penguins of warmer regions. When swimming, head is hunched into shoulders and feet trail behind, tucked against tail to form good streamlining. Feet and tail used to change direction but propulsion in water by wings so highly modified that they are always called flippers; lack normal remiges; wing bones much flattened and broadened; joint of elbow and wrist almost fused, forming rather rigid, strong, flat and narrow flippers. When swimming under water, move flippers in plane at right angle to long axis of body. Bill, generally straight, rather stout and slightly shorter than head; extremely heavy in *Eudyptes*. Mouth heavily lined with keratinous, backwardly-directed spines. Distinctive bill-plates in all species, as in petrels.

Long bones not pneumatic and airsacs reduced; this, with their short feathers, makes penguins only slightly lighter than the water they displace, reducing the energy needed for diving; gastroliths may also act as ballast. Physiological specializations for diving include an ability to reduce blood flow to muscles while underwater. Capacity to carry oxygen seems no better than that of other diving birds; mechanisms preventing 'the bends' unknown. Often swim fast enough to breathe by 'porpoising'; speed of swimming poorly known, but perhaps in some species 6–12 kph (Kooyman 1975). Heat-exchange system in flippers and legs, a well-defined fat-layer and low surface area – volume ratio improve thermal insulation in cold waters but, even so, probably cannot keep body temperature stable at sea for long without being active (Kooyman 1975). On land over-heating can be a problem, especially in lower latitudes.

Feathers highly specialized; short, with broad flat rachis, and closely spaced barbs, especially near rachis and tips; considerably less water-repellent than those of other waterbirds but probably prevent much water penetration (Rijke 1970); small downy after-feather forms a second layer of insulation. Efficiency underwater unknown. Feathers are not arranged in pterylea; the only apteria is the 'crissum' between the legs, used as brood-patch. Plumage blue-black to grey-blue above, and white below. Face and crown are often distinctive with long yellow to orange plumes or other colours on face; patterns of head are the most important characters for field identification at sea. Juveniles similar to adults but usually duller. Sexes similar; males larger with heavier bills. All species have one rapid complete moult per cycle; feathers replaced more or less simultaneously. Feed intensely at sea just before moult, putting on weight. Greater part of moult on land during 2–6 weeks when birds cannot swim, having impaired insulation, and must fast. Moult generally follows breeding in adults; in some *Spheniscus* species, precedes breeding. In cool temperate, subantarctic and Antarctic species, non-breeders moult first, successful breeders last; failed breeders may begin soon after eggs or chicks lost.

Restricted to cool oceanic waters of s. hemisphere, where distribution correlated with Antarctic currents. In low latitudes tend to feed within continental shelf. Usually wide post-juvenile dispersal; movements of thousands of kilometres can occur. Feed on crustaceans, fish and squid. Hunting mostly visual, may be helped by echolocation; mostly by day in shallow surface dives but nearly all can dive deep and long enough to follow any vertical daytime migrations of prey. Emperor Penguin has been recorded diving to 267m, and staying submerged for 18 minutes.

Most species fast for long periods during courtship, incubation, brooding and nesting; extreme is for 110–115 days by male Emperor Penguin while nesting in Antarctic winter, losing up to 45% of initial weight.

Highly social at sea and on land; have complex courting and mate-recognition behaviour; most developed in highly gregarious species such as *Pygoscelis* and some *Eudyptes*, in which densely packed colonies may contain tens of thousands of birds. Elaborate visual and vocal displays used to maintain small nesting territories.

Comfort behaviour: use of shade, panting, spreading of flippers to prevent overheating, tucking in of flippers when cold, and shivering.

Most species breed once a year, in spring and summer; breeding synchronized; best in subantarctic and some

Antarctic species; least in more temperate species. One species breeds over winter, and breeding cycle of King Penguin lasts longer than a year.

Monogamous, pair-bonds long-lasting and even lifelong. Breeding pairs well spaced or virtually solitary to dense colonies of thousands. Nests range from substantial piles of pebbles, debris and assorted materials to nothing in the Emperor Penguin that incubates its egg on its feet. Colonies on all sorts of terrain, near shore or at high altitudes well back, even many kilometres, from the sea, on ice and also in burrows, crevices or caves according to the species. Clutch-size, 1-2 white eggs; three eggs occasionally seen in some species but not satisfactorily proved to have been laid by one female. In eudyptids, the first chick is always noticeably smaller than the second, and the chick from the first egg invariably fails to survive unless that from the second egg is lost at an early stage. Eggs laid at intervals of 2-4 days. Both sexes incubate, except in the Emperor, in which only males incubate. Change-overs take place daily in some species or at long intervals in others. Incubation period varies from about 35 to about 65 days. The young are covered in down and brooded and guarded by both parents for varying periods before forming crèches; both parents feed the chicks by incomplete regurgitation, recognizing and feeding only their own chick, even when it has joined a crèche. Fledgelings independent of parents when they go to sea at different ages from about 6 weeks to about 6 months. First breeding, not before 2 years old in any species and often much longer.

Species of Antarctic and subantarctic are most abundant; temperate and tropical species less numerous; some populations worryingly small (e.g. Yellow-eyed). Adult survival (70-90%) low compared to other seabirds and may be inversely related to breeding success. Breeding success high in most Antarctic species, except in Emperor where only 19% of fledgelings survive first year.

Much uncontrolled taking of adults and eggs for food and bait by whalers and sealers, from eighteenth to early twentieth centuries, reduced or destroyed some populations, especially of King Penguins, in subantarctic and Antarctica; marked increases of some species in past 30 years, attributed to greater availability of krill following reduction of Antarctic whales. Effects of drift-netting unknown. In lower latitudes, some populations have declined through overfishing in inshore waters, human interference, and damage to breeding habitat.

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Pygoscelis antarctica Chinstrap Penguin

COLOUR PLATE FACING PAGE 145

Aptenodytes antarctica Forster, 1781, *Comment. Phys. Soc. R. Sci. Gotting.* 3: 134, 141; Pl. 4 — South Shetland Is.

OTHER ENGLISH NAMES Ringed, Bearded or Antarctic Penguin, Stone-cracker.

Chinstrap, referring to the thin black line across the throat, is more appropriate and descriptive than other names.

MONOTYPIC

FIELD IDENTIFICATION Length 71–76 cm; flipper 17–20 cm; weight c. 3.8 kg. Medium-sized black-and-white penguin breeding on islands in high latitudes, mainly in South Atlantic and on Antarctic Pen. White face, black bill and thin, black line passing from ear to ear under chin diagnostic. Colonies are often huge. Sexes alike. No seasonal plumages. Juveniles similar to adults but have some dark mottling on throat and face.

DESCRIPTION **ADULT.** Forehead, crown, nape, back and tail, black. Upper surface of flippers, black with thin white trailing-edge. Cheeks, white with sharp demarcation from black crown, passing from nostril above eye to near ear. Separation between black sides of nape and greyish-white throat less distinct. Diagnostic narrow band of black feathers extends from ear to ear, separating white chin and cheeks from white or greyish-white throat. Breast and abdomen, white. Underflippers, white with narrow blackish leading-edge and small greyish patch at tip. Bill bare of feathers and black with slightly hooked end to upper mandible. Iris, brown. Legs and feet, fleshy pink with black soles. Dorsal plumage becomes brownish before moult. **FLEDGELING.** Similar to adult but some dark spotting on face, primarily concentrated round eye, sometimes giving uniform dark appearance to face. Smaller and slimmer than adult; bill weaker.

SIMILAR SPECIES White face extending above eye separates Chinstrap Penguins from all other penguins except adult Royal Penguins *Eudyptes schlegeli*. Royal Penguins have huge orange bill and yellow-orange head plumes. Immature Adelie Penguins *P. adeliae* also have white chins but black of crown extends well below eye, and bill appears shorter.

Found in Antarctic and subantarctic waters; breed in colonies (sometimes 1000s of breeding pairs). Gregarious away from nest. Generally regarded as boldest, most pugnacious and agile pygoscelid penguin and perhaps of all penguins; charge intruder rather than withdraw as do Gentoo *P. papua* or merely stand their ground as do Adelie. The chinstrap gives truculent appearance in keeping with way in which they quarrel with conspecifics and dominate congeners. Alone among penguins can outmanoeuvre and will deliberately attack a dog. Intruders into colony may be attacked by birds rushing them, jumping and grabbing clothing well above boots. Yet at sea have been known to jump into open boats and rest there quietly until evicted (Murphy). Waddling gait when moving on land with flippers extended and pointing slightly back; fall down and propel themselves by feet without use of flippers; when climbing become quadrupedal. When in hurry or on level surface use flippers synchronically not alternately, as if running; generally scuttle on belly less than other penguins. Liable to crowd onto icebergs, leaping more than a metre to

slippery footholds in such numbers that birds already there are pushed off into water (Murphy). Toboggan on snow. Move underwater with regular propulsive beats of flippers followed by glides. Swimming underwater punctuated regularly with porpoising. Feed near land. Displays similar to Adelie Penguin, but ecstatic call louder and more piercing. Calls particularly ear-splitting, more acute than those of Adelie, giving rise to deafening cacophony at colonies, both day and night; probably origin of name 'Stone-cracker'.

HABITAT Marine; in Antarctic and subantarctic waters, mostly S of Antarctic Convergence. In Weddell Sea, few birds seen; all in light pack-ice (10–30% ice cover), none in medium or heavy pack-ice or open water (Cline *et al.* 1969). When breeding, forage mainly in inshore waters close to breeding grounds (Muller-Schwarze & Muller-Schwarze 1975; White & Conroy 1975; Croxall & Furse 1980); at King George I., feeding grounds 5–15 km from colonies, in bays and straits round island; birds concentrate near ice-floes and small ice-fields, feeding on krill concentrations (Jablonski 1985). Large congregations found in winter in open water N of pack-ice (B. Fraser, D.G. Ainley & W.Z. Trivelpiece).

Breed on ice-free land on Antarctic Pen. and islands S of Antarctic Convergence, mainly on islands of Scotia Arc. Use rocky slopes, headlands, foreshores, cliff ledges (Conroy *et al.* 1975a; White & Conroy 1975; Murphy).

Moult ashore; on Marion I., most birds move inland to moult, but few stay on beach (Rand 1955). Diving depths recorded at Signy I.: 90% of dives shallower than 45 m; deeper dives reached 70 m (Lishman & Croxall 1983). At King George I., dives of >100 m depth recorded during chick-rearing (W.Z. Trivelpiece).

Extended range and increased numbers in last few decades may have arisen from increased availability of krill as a result of whaling (Conroy 1975) or recent warming of pelagic waters used by Chinstrap Penguins in winter (B. Fraser, D.G. Ainley & W.Z. Trivelpiece).

DISTRIBUTION AND POPULATION Circumpolar, though few records s. Indian and Pacific Oceans. Breeding populations concentrated Antarctic Pen., Antarctic and subantarctic islands in South Atlantic where estimated 99% of world population occurs (Croxall *et al.* 1984); smaller colonies found s. Indian Ocean, se. Pacific Ocean and Cape Horn (Schlatter 1984). Accidental to Aust.; no records NZ.

Non-breeding distribution little known. Believed to have limited range in seas round breeding sites; may disperse to open sea to limits of pack-ice (Harrison 1983) or beyond (B. Fraser, D.G. Ainley & W.Z. Trivelpiece). Few records at sea; five birds observed between 44°E and 106°E at 55–64°S, 1946–

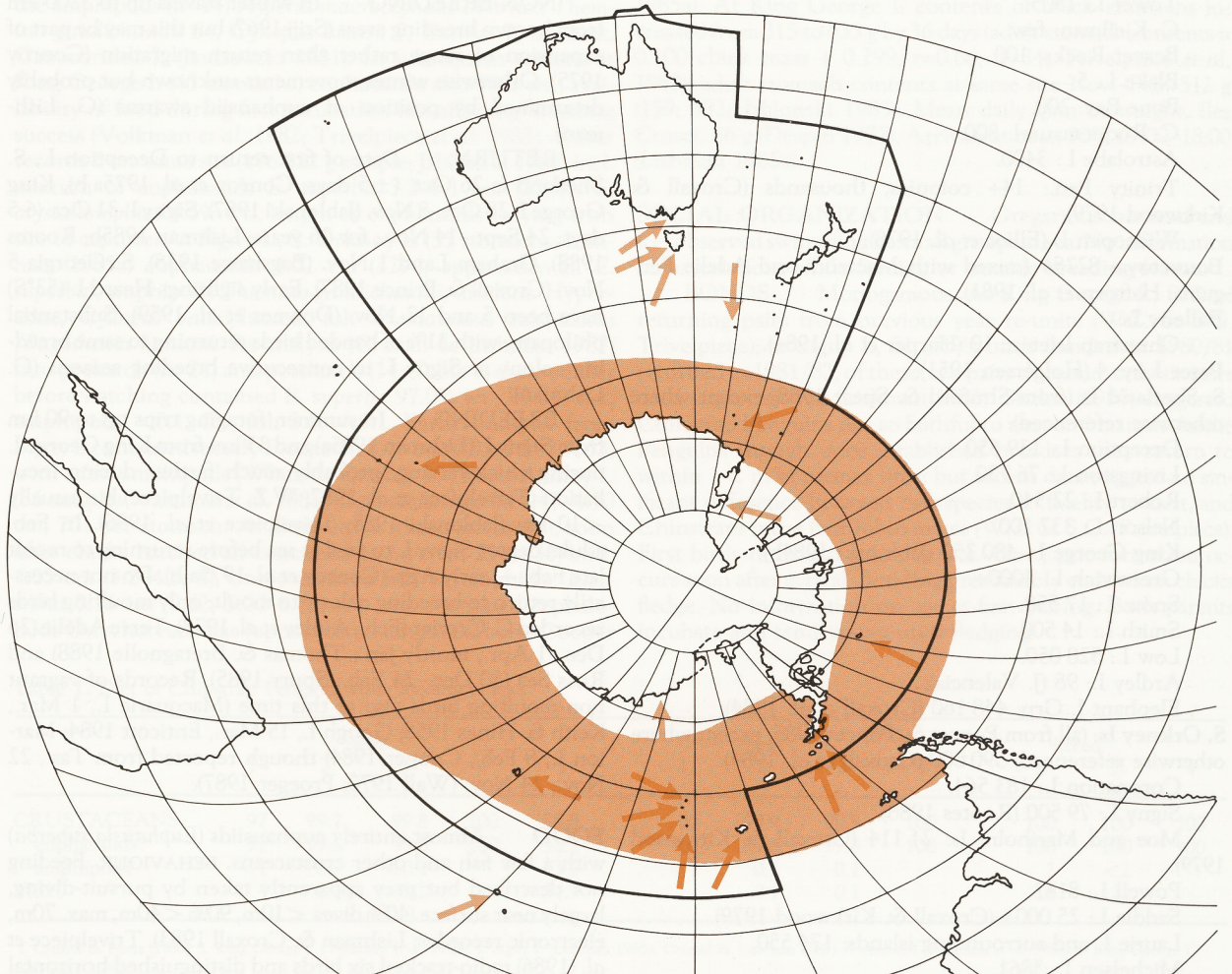
7 (Routh 1949); small numbers and group of 40 observed between 160°W and 133°W at 60–62°S (Sziij 1967); 19 records of 379 birds, between 50–70°S, largest group near S. Sandwich Is of about 200 birds on an iceberg (Enticott 1986); maximum numbers swimming of 10–70 birds between S. Georgia and S. Sandwich Is and nearby seas (55°S 34°W to 55°S 18°W), Sept. 1985; however most observations of Penguins on icebergs with one record of 2000–3000 birds (Clark 1987). Occasional records in Antarctica away from breeding colonies: Mawson Stn, 17 Feb. 1957; Lewis I., 7 Jan. 1956, and three moulting 28 Feb. 1960 (Ingham 1962); Terre Adélie, 40 records 1976–86 (Thomas & Bretagnolle 1988). Macquarie I., 1 Mar. 1953, Dec. 1956 (Keith & Hines 1958), 1959, 1963 (Aust. CL); Gough I., 15 Mar. 1983 (Enticott 1984); Marion I., Feb. 1977 (Williams & Burger 1978), 8 Feb. 1983 (Cooper 1984).

AUST. Vic.: live bird, photographed, Venus Bay, 24 Nov. 1985 (Proeger 1987). Tas.: live bird, later died, near S. Cape, 22–23 Nov. 1968 (Wall 1970); Bathurst Channel, Jan. 1980 (Aust. Atlas).

BREEDING AND POPULATION Breed mainly on Antarctic Pen. and islands of Scotia Arc. Also on Bouvetøya and Balleny Is. Possibly breeds on Heard I. and Isla Hornos.

Antarctic Pen. (all from Poncet & Poncet 1987, except where otherwise referenced; 1–6 colonies at each locality; numbers = pairs):

- Armstrong Reef: 1.
- Quinton Pt: 8000.
- Gerlache I.: 7000.
- Port Charcot: 3.
- Anvers I.: 11 179 (Parmelee & Parmelee 1987).
- Humble I.: 1–2 (Heimark & Heimark 1988).
- Gerlache Str.: 16 colonies (Croxall & Kirkwood 1979).
- Alcock I.: 10 000.
- Midas I.: 2000.
- Brabant I.: 5000 (Furse 1987).
- Spigot Peak: 3000.
- Melchior I. (Croxall & Kirkwood 1979).
- Waterboat Pt: 20.
- Useful I.: 100.
- Duthiers Pt: 140.
- Ketley Pt: 250.
- Orne I.: 860.
- Georges Pt: 800.
- Cuverville I.: 3.
- Claude Pt: 250.
- Metchnikoff Pt: 5000 (Jouventin *et al.* 1984).



Hunt I.: 400.
 Low I.: 30 000–40 000 (Croxall & Kirkwood 1979).
 Bell I.: 25.
 Reclus Pen.: 300.
 Gaston I.: 500.
 Two Hummock I.: 3000.
 Cobalescou I.: 500.
 Hydrurga Rocks: 1000.
 Lobodon I.: 10.
 Eckener Pt.: 40.
 Small I.: 1000.
 Grinder Rock: 120.
 Intercurrence I.: 500.
 Sprightly I.: 85.
 Charles Pt.: 10.
 Sterneck I.: 1100.
 'Primavera I.': 500.
 C. Herschel: 780.
 Farewell Rock: 100.
 Spert I.: 200.
 Megaptera I.: 900.
 Monument Rocks: 270.
 Tetrad I.: 180.
 Trinity I.: 2972.
 C. Kater: few.
 Zig Zag I.: 1000.
 Tower I.: 1505.
 C. Kjellman: few.
 Beaver Rocks: 100.
 Blake I.: 5.
 Bone Bay: 200.
 C. Roquemaurel: 800.
 Astrolabe I.: 3400.
 Trinity Pen.: 14+ colonies, thousands (Croxall & Kirkwood 1979).
 Wideopen I. (Elliot *et al.* 1978).
Bouvetøya: 8228+ (mixed with Macaroni and Adelie Penguins; Haftorn *et al.* 1981).
Balleny Is.
 Chinstrap Islet: c. 10 (Harper *et al.* 1984).
Peter I øy: 4 (Holgerson 1951).
S. Shetland Is (from Shuford & Spear 1988, except where otherwise referenced):
 Deception I.: 139 650.
 Livingston I.: 76 730.
 Robert I.: 22 540.
 Nelson I.: 337 100.
 King George I.: 480 250 (Jablonski 1984b).
 Greenwich I.: 4000+.
 Snow I.: 17 550.
 Smith I.: 14 500.
 Low I.: 528 050.
 Ardley I.: 98 (J. Valencia).
 Elephant I. Grp: 448 160 (Croxall *et al.* 1984).
S. Orkney Is. (all from Poncet & Poncet 1985, except where otherwise referenced) 590 000 (Croxall *et al.* 1984).
 Coronation I.: 183 564.
 Signy I.: 79 500 (Rootes 1988).
 Moe and Mariholm Is: 21 114 (Croxall & Kirkwood 1979).
 Powell I.: 8182.
 Saddle I.: 25 000+ (Croxall & Kirkwood 1979).
 Laurie I. and surrounding islands: 174 550.
 Michelsen I.: 3861.

Grey I.: 2350.

Frederiksen I.: 40 820.

S. Georgia: 6000 (Croxall *et al.* 1984).

S. Sandwich Is: 5×10^6 (Croxall *et al.* 1984).

May occasionally breed on Heard I. (Downes *et al.* 1959), but no successful breeding recorded (Woehler in press). Colony of 1000 pairs reported from Isla Hornos, Chile (Venegas 1978, in Schlatter 1984), but unlocated in 1984 (G.S. Clark).

Total population estimated c. 6.5×10^6 pairs of which c. 5×10^6 pairs breed S. Sandwich Is (Croxall *et al.* 1984).

Status, satisfactory. Numbers increasing on islands of Scotia Arc and Antarctic Pen., some by 500% over past 25 years (Croxall *et al.* 1984). Populations appear secure at present but may be affected by increased fishing activities in region.

MOVEMENTS Dispersive, moving N of pack ice in winter; possibly sedentary in n. part of range (Murphy).

DEPARTURE Last adults leave King George I. early Apr. (Jablonski 1987), Signy I. 5 May (Conroy *et al.* 1975a,b); chicks fledge and leave Signy I. late Feb. — mid Mar. (Lishman 1985b), King George I. mid-late Feb. (W.Z. Trivelpiece), S. Georgia 1 Mar. (Croxall & Prince 1987), Graham Land, Antarctic Pen., early Apr. (Bagshawe 1938). Latest record Heard I. 26 Apr. (Downes *et al.* 1959).

NON-BREEDING In winter travels up to 3200 km from known breeding areas (Sziij 1967) but this may be part of expansion of range rather than return migration (Conroy 1975). Otherwise winter movements unknown but probably determined by position of euphausiid swarms (G. Lishman).

RETURN. Date of first return to Deception I., S. Shetland Is 26 Oct. (± 5 days; Conroy *et al.* 1975a,b), King George I. 28 Oct.–8 Nov. (Jablonski 1987), Signy I. 31 Oct. (6.5 days; 24 Sept.–14 Nov.; for 26 years; Lishman 1985b; Rootes 1988), Graham Land 1 Nov. (Bagshawe 1938), S. Georgia 5 Nov. (Croxall & Prince 1987). Early sightings Heard I. (53°S) have been 5 and 12 Nov. (Downes *et al.* 1959). Substantial philopatry with 31% of banded birds returning to same breeding colony at Signy I. in consecutive breeding seasons (G. Lishman).

BREEDING In summer, foraging trips up to 90 km from Signy I. (Lishman 1985a) and 33 km from King George I. during chick-rearing, probably much farther during incubation (Trivelpiece *et al.* 1987; W.Z. Trivelpiece) but usually <10 km (Jablonski 1985; Trivelpiece *et al.* 1986). In Feb. adults depart Signy I. to feed at sea before returning to moult late Feb. — early Apr. (Conroy *et al.* 1975a,b). Do not necessarily return to breeding colony to moult; only moulting birds recorded C. Crozier (Feb.; Ainley *et al.* 1978), Terre Adélie (26 Dec.–1 Apr., mostly Jan.; Thomas & Bretagnolle 1988) and Ross Sea (30 Dec.–24 Feb.; Spurr 1985). Records of vagrant non-moulting birds also at this time (Macquarie I., 1 Mar., Keith & Hines 1958; Gough I., 15 Mar., Enticott 1984; Marion I., 8 Feb., Cooper 1984) though reported from Tas., 22 Nov., 24 Nov. (Wall 1970; Proeger 1987).

FOOD Almost entirely euphausiids (*Euphausia superba*) with a few fish and other crustaceans. **BEHAVIOUR.** Feeding not described but prey apparently taken by pursuit-diving, largely near surface (40% dives <10m, 90% <40m, max. 70m, electronic recorder; Lishman & Croxall 1983). Trivelpiece *et al.* (1986) radio-tracked six birds and distinguished horizontal

or searching dives from vertical or feeding dives but birds may also take food within few metres of surface (Lishman & Croxall 1983). On foraging trips in Admiralty Bay, King George I., three birds averaged 4.8 km/h (3.9–5.7), 5.3 h/foraging trip (4.4–6.8) and 14.0 foraging dives/h (10.0–17.9), of which 76.3% were feeding dives and 23.7% searching dives (Trivelpiece *et al.* 1986). Feeding dives lasted 1.5 min (0.1; max. 2.1–2.3; 222) with 36 s (6; 222) between dives (31–47; 6; Trivelpiece *et al.* 1986). Local differences in feeding schedule of adults: shallow dives and euphausiid diet at Signy I. suggest feeding mainly at night (Lishman 1985a) but birds tracked at King George I. by Trivelpiece *et al.* (1986) fed only during daylight. Mean feeding time during foraging trips 2.5 h (Trivelpiece *et al.* 1987). Occasionally takes in water in the form of snow (Bagshawe 1938).

BREEDING Summarized Table 1. At **Elephant I., S. Shetland Is** (44 stomachs, 19 males, 25 females; Croxall & Furse 1980) crustaceans euphausiids (*Euphausia superba*; those 4.0–6.5 cm long: 94% wt., 83% no., 100% freq., 4.39 cm (0.46; 426); those 1.5–3.5 cm long: 2, 5, 9, 3.08 cm (0.36; 10); *Thysanoessa*: 1, 12, 7, 1.89 cm (0.15; 27), amphipods thought to have been eaten previously by fish. At **King George I.** (29 stomachs, 14 males, 15 females; Volkman *et al.* 1980) euphausiids 4.23 cm (SE 0.02; 1.1–5.5): *E. superba* 99.6% no., *E. crystallorophias* 0.2; amphipods 2.50 cm (1.7–5.5); highly digested fish 0.3, 0.1, 21, incl. *Pleuragramma antarcticum*. Of the amphipods (n=14) *Hyperia macrocephala* 14% no., *Themisto gaudichaudii* 64, *Cylopus lucasii* 7, *Eusirus* 7, unident. Gammaridea 7, (Jazdzewski 1981). In subsequent seasons at King George I. (43 stomachs) euphausiids also 99% wt., availability of food during first incubation fast affecting breeding success (Volkman *et al.* 1982; Trivelpiece *et al.* 1983). Other records from same site (176 822 g sample; Jablonski 1985) incl. mixture of euphausiids *E. superba* 3.3–6.1 cm (2248), *E. crystallorophias* 4.5% wt., length of euphausiids varying with site of capture. At **Signy I., S. Orkney Is** (35 stomachs; Lishman 1985a) euphausiids 4.02 cm (2294; apparently all *E. superba*), amphipods *Themisto gaudichaudii*, unident. Hyperiidae, *Cylopus batesi/lucasii*, fish *Trematomus eulepidotus/Pagothenia hansonii*. Re-analysis (Croxall & Lishman 1987) into prehatch (n=21) and posthatch (14; Table 1) showed diet before hatching contained *E. superba* 97.0% wt., 99.8% no., amphipods <0.1, 0.1, fish 3.0, <0.1. Earlier samples from Signy I. contained mostly *E. superba* 3.16 cm (0.35; 2.5–3.9; 53) with a few amphipods (White & Conroy 1975). At **Ardley I.** (36 samples; Valencia *et al.* 1988) *Euphausia superba* 3.47–4.50 cm, 701 per stomach. At **Bouvetøya** (three stomachs); soon after chicks hatched all contained *E. superba*, 231–430/bird, 4.03 cm (3.2–4.8; 8), one contained fish Myctophidae *Electrona* 7.16 cm (0.62; 5.00–8.17; 60), one contained cephalopods Onychoteuthidae (upper rostral length 0.21 cm; Cooper

et al. 1984). At same site another sample (six stomachs; Haftorn 1986) contained only *Euphausia superba*. Chinstrap Penguins consistently catch larger euphausiids than Adelie Penguins *P. adeliae* when sampled at same site and time (Croxall & Furse 1980; Volkman *et al.* 1980; Lishman 1985a).

INTAKE At **Elephant and Clarence Is**, in first 14 days, chicks receive about 2.3 adult feeding visits/day (Conroy *et al.* 1975a,b) decreasing to 1.4 visits/day at 38 days (Croxall & Furse 1980). During successful year at Signy I. twins had 0.56 feeds/day (0.39; 149); singles had 0.68 (0.39; 255) during guard-stage and 0.79 (0.43; 53) during crèche-stage (Lishman 1985a). Difference between two areas thought to be related to distance to edge of continental shelf (15–35 km, Elephant and Clarence Is; 60 km, Signy I.; Lishman 1985a). At **King George I.** receive 1.44 meals/day during guard-stage with feeding interval of 16.7 h (SE 0.9; Trivelpiece *et al.* 1987). At **Bouvetøya** feeding frequency about 1.9 visits/day for same period (Haftorn 1986). Size of meal increases with age of chick. At **Elephant I.** (Croxall & Furse 1980), size of meal increased to 436 g (152; 5) for 31-day-old chicks and 527 g (178; 16) for 19–40-day-old chicks. Adults feeding 1 or 2 chicks, 1–10-days-old, were carrying 185 g (72; 5); for 7–11-day-old chicks, 283 (10; 120); for 8–12-day-old chicks, 344 (10; 98); but size of meal per chick could not be determined. At **Signy I.** meals during guard-stage in successful year 106.6–178.6 g; during crèche-stage 270.7–313.4 g (based on daily weighings; Lishman 1985a). At King George I. contents of chick stomachs increased from 315 to 635 g by 36 days (adult stomach contents = 0.100 chick mass + 0.299, r=0.66, n=34; Trivelpiece *et al.* 1987); adult stomach contents at same site Nov.–Feb. 512 g (159; 592; Jablonski 1985). Mean daily gain in weight, Iles Crozet, 86 g (Despin 1977). Arrivals at nest: 90% 09:00–18:00 (Lishman 1985a).

SOCIAL ORGANIZATION Gregarious on land and ice; observed swimming in small groups at sea. No information on associations while feeding or outside breeding season.

BONDS Monogamous. At King George I., 83% of returning pairs from previous year re-unite (W.Z. & S.G. Trivelpiece); at Signy I., 51 (31%) birds banded in 1980/81 returned in 1981/82; of these, ten pairs the same; only six pairs used same nest-site (Lishman 1983). Sladen (1955) suggested Chinstrap Penguins not so faithful to nest and mate as Adelie Penguins though once established breeders they return to within 1–2 m of former sites; but recent data suggest no significant difference between two species in fidelity to nest, and Chinstraps more faithful to mates (W.Z. & S.G. Trivelpiece). First birds return to colonies Oct.–Nov.; pair formation occurs soon after arrival. Bonding presumably ends when chicks fledge. No information on age at first pairing. Both parents incubate and tend young until fledging.

Table 1. Diet of Chinstrap Penguin while feeding chicks

	%wt.					%no.				%freq.		
	1	2	3	4	5	1	2	3	4	1	2	4
CRUSTACEANS	97	99.7	99.8	100	55.8	100	99.9	99.9	100	100	100	100
euphausiids	97	99.6	99.8	100	38.2	100	99.8	99.8	100	100	100	100
amphipods	<1	0.1	<0.1		3.6	<1	0.1	0.1		2	<2	
FISH	4	0.3	0.2		34.9		0.1	0.1		15	21	

1. Croxall & Furse (1980). 2. King George I. (Volkman *et al.* 1980). 3. Signy I. (Lishman 1985a; Croxall & Lishman 1987). 4. Ardley I. (Valencia *et al.* 1988). 5. King George I. (Jablonski 1985).

BREEDING DISPERSION Colonial. Distance between nests c. 60 cm (Volkman & Trivelpiece 1981). Territory restricted to nest and surroundings during breeding. In mixed colonies competes with Adelie Penguin for nest sites. Arriving Chinstrap Penguins drive off Adelie Penguins by pecking and striking with flippers; smaller distance between nests of Adelie Penguins then increases to that of Chinstrap Penguins (Trivelpiece & Volkman 1979).

ROOSTING Presumed non-breeding or failed breeding birds roost at fringes of colonies, on beaches or more distant coastal areas at night; evening gatherings on icebergs also observed. Most pairs rest and sleep on nest, in prone or upright position, whether moulting, incubating or attending chicks (Conroy *et al.* 1975a; Haftorn 1986). Large flocks of 200–3000 birds observed on icebergs (Enticott 1986; Clark 1987).

SOCIAL BEHAVIOUR No detailed studies; information largely anecdotal; supplied by G. Lishman. Detailed observations would be simple because most interactions likely to be at breeding site. Sladen (1955, 1958), Muller-Schwarze & Muller-Schwarze (1980), Jouventin (1982) and Haftorn (1986) liken behaviours to those of Adelie Penguins, without being specific. Haftorn (1986) gives proportion of time spent in agonistic and sexual display in late incubation and early nestling periods.

AGONISTIC BEHAVIOUR Not known. Said to be the same as Adelie Penguin (Roberts 1940; Jouventin 1982).

SEXUAL BEHAVIOUR At site, give Ecstatic and Mutual Displays, Circling and Bowing. **Ecstatic Display.** Bird lifts head backwards, stretching head and neck vertically, with flippers outstretched, and calls loudly. Occurs at nest during incubation and guard-stage; given by both sexes (unlike Adelie Penguin, where male usually performs Display); generally repeated several times in succession, often stimulating nearby nesting birds to do same (Haftorn 1986). **Loud Mutual Display.** Birds face each other and wave heads back and forth while uttering loud cackling with open bill. Used as part of nest-relief and in recognition process between chicks and adults. **Quiet Mutual Display** Differs in that bird makes soft humming sound with closed bill instead of cackling. **Bowing** (described by Jouventin 1982) common; birds approach nest, bend heads toward nest, bill held 30–60° below horizontal, then twist head and present side of head to partner. Mutual Display also accompanied by Circling. Both versions used as nest-relief ceremony. **Circling.** One bird walks round rim of nest while nodding head. Suggested that display synchronizes nest-relief and minimizes time of exposure of eggs or chicks (Muller-Schwarze & Muller-Schwarze 1980), but, in later study, this display used by few pairs ($\leq 50\%$) during nest-relief (W.Z. & S.G. Trivelpiece). **COPULATION** occurs c. 14 days before laying (Lishman 1983), largely similar to that of Adelie Penguin. Incomplete copulation, where male treads female's back, but without cloacal contact, practised by failed and unsuccessful breeders during incubation and guard-stages of successful breeders.

RELATIONS WITHIN FAMILY GROUP Both adults at nest until laying; female takes first incubation shift 65% of time, male 35% (W.Z. Trivelpiece). Thereafter, incubation alternates between partners in shifts of 5–10 days, being reduced to 1–2 days close to hatching (Lishman 1985b). During incubation, 95–97% of time spent resting or sleeping, 2–3% egg-shifting, rotating on nest, preening or nest-building

0.3–0.6% in agonistic and territorial behaviour, 0.1–0.3% in sexual display (Haftorn 1986). During guard-stage, chicks fed alternately by each parent, on returning to nest to relieve partner, until chicks aged 23–29 days (Lishman 1985b) when loose crèches form and both parents begin to forage for food simultaneously. Nestlings beg for food by tapping bill against tip of adult's bill until food regurgitated directly into mouth. During crèche-stage, chick and parent use Loud Mutual Display as part of recognition process before regurgitation. Rest of recognition process (i.e. calls and feeding chases) not described, but similar to Adelie Penguins. Upon fledging, chicks complete moult before leaving colony; possibly given last feed by parents on shoreline before first trip into sea. Virtually independent of parents after fledging (Lishman 1983).

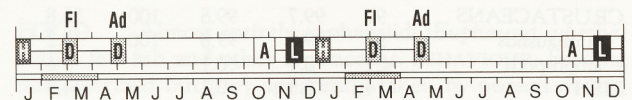
VOICE Very poorly known; no studies. Some information in review by Jouventin (1982); information supplied by G. Lishman from opportunistic observations. Utter loud cackling and quiet humming and hissing calls, mostly at nest-site during breeding season; probably have contact call, but not described. Call during Ecstatic and Mutual Displays and, unlike other penguins (except Gentoo), during Bowing Display (Jouventin 1982). Calls said to be generally similar to those of Adelie Penguin, though Jouventin (1982) shows that calls given during Mutual Display very different from Adelie and those during Ecstatic Display are more clipped than Adelie. From recordings, variation of songs between individuals greater than variation within songs of individuals but no further information. No information on sexual differences or geographical variation.

ADULT Ecstatic Call. Described as loud, shrill, clipped repeated series of syllables; songs last 5–10 s ($n=10$ songs), with maximum frequency c. 4.0 kHz. Calls repeated several times and often stimulate neighbours to call, giving rise to 'chorus of screams' (Haftorn 1986). This call possibly individually distinctive (Haftorn 1986). **Mutual Display Call.** (A) Loud cackling with bill open, during Loud Mutual Display; similar to, but less clipped than Ecstatic Call; (B) Soft humming sound with bill held closed during Quiet Mutual Display. **Bowing Call.** Utter hissing sound as part of Bowing Display; duration c. 1.5 s ($n=4$ songs) with a maximum frequency c. 2.5 kHz.

YOUNG Little information; parents give Loud Mutual Display to call chicks from crèches to be fed; acts in parent-chick recognition (Jouventin 1982); Quiet Mutual Display given by adult to begging chicks (W.Z. Trivelpiece).

BREEDING Fairly well known. Major studies at King George I. (Volkman & Trivelpiece 1981; W.Z. Trivelpiece & colleagues); at Signy I. (Lishman 1985b; G. Lishman); others at Signy and Elephant Is (Conroy *et al.* 1975a,b); and at Bouvetøya (Haftorn 1986). Information supplied by G. Lishman. Breeds colonially, often associated with other penguins.

SEASON Adults arrive at colonies in late Oct.–early Nov.; fledgelings depart late Feb.–early Mar.; adults leave late Apr.–early May. First arrivals fairly well synchronized and



Fl = departure of fledgelings.
Ad = departure of adults.

consistent annually (Conroy *et al.* 1975a). At Signy I., earliest and latest dates of first arrivals 16 Oct. and 12 Nov.; arrival dates at King George and Deception Is and Waterboat Pt within this range (G. Lishman).

SITE Colonies, often mixed with Adelie and Gentoo Penguins, usually on rocky slopes (White & Conroy 1975). On King George I., 1.6% pairs on moraines, 6.9% on raised terraces and cliffs, 38.6% on steep lava plugs, intrusions and flows, and 52.9% on elevated, level lava flows ($n=8237$; Jablonski 1984a). On Antarctic Pen., settle higher elevations first (Muller-Schwarze & Muller-Schwarze 1975). Colonies on flat, gently or steeply sloping ground. Vegetation sparse or absent in nesting areas; on King George I., most nests on impermeable strata; rock slabs and blocks, lava flows, and fine rock debris (Jablonski 1984a). Nest at higher altitudes than Adelie Penguins in area of Antarctic Pen. (Muller-Schwarze & Muller-Schwarze 1975) though at Signy I. sometimes the reverse (G. Lishman). At King George I., on slopes of c. 9° gradient and c. 90 m from nearest landing beach; maximum slope 60–80° (Jablonski 1984a). Nests averaged 60 cm apart; distribution asl: 17%, 1–10 m; 15%, 11–20; 68%, 21–20 m; none higher. On Signy I., nesting to 75 m asl (BAS). Size of colonies and spacing of nests intermediate between those of Adelie and Gentoo Penguins (43.2 and 74.3 cm respectively) so that steeper habitat with more obstacles can be used but containing fewer nests.

NEST, MATERIALS Roughly circular platform of small stones, 30–50 cm in diameter and 5–10 cm high, with shallow cup; feathers and artificial objects (nest-markers) may be incorporated. Stones collected from inside and round perimeter of colony (G. Lishman). At King George I., stones ($n=50$ nests) measured on average $52.1 \pm 1.5 \times 11.5 \pm 0.6$ mm, volume 11.4 ± 0.9 ml; objects (rocks, whale bones) large enough to act as wind-breaks, 0.22 ± 0.04 per nest. No clear preference for particular nest-sites (Volkman & Trivelpiece 1981); compete successfully with Adelie Penguins for sites and conflicts between arriving Chinstraps and already nesting Adelies may last from less than 10 min to more than an hour (Trivelpiece & Volkman 1979). Some nests used for at least 2 years by same pair; nearly all nests used each year though not much of each nest remains at start of breeding (G. Lishman). No knowledge of routine of building, but stones added and re-arranged throughout incubation and nestling periods, by both sexes; occasionally by sitting bird, but more often by unoccupied bird, which collects stones away from nest and carries them back one by one in bill (Haftorn 1986).

EGGS Ovate; smooth textured; off-white to cream, sometimes streaked or tinged green.

MEASUREMENTS:

Elephant I.: 67.39 (3.05; 51) \times 51.96 (0.09) (Conroy *et al.* 1975b);

Signy I.: single eggs: 66.3 (1.9; 65–69; 3) \times 52.7 (0.5; 52–53); First egg of C/2: 67.1 (2.5; 62–72; 51) \times 52.3 (1.6; 49–57); Second egg of C/2: 67.0 (2.3; 62–73; 56) \times 52.4 (1.6; 49–56) (Lishman 1985b).

WEIGHTS: for different categories of egg: single, 113.7 (2.9; 110–117; 3); first egg of clutch, 113.6 (8.7; 94–140; 51); second egg of clutch, 112.2 (7.7; 96–130; 56; Lishman 1985b).

Volume of smaller egg in 21 clutches, 87–99.4% of larger egg (Conroy *et al.* 1975b). At Signy I., eggs of all categories almost exactly equal in mean length, width, volume and weight; unlike other *Pygoscelis* penguins, in which first egg of clutch, on average, largest and heaviest (Conroy *et al.* 1975b; Lishman 1985b).

CLUTCH-SIZE Usually two; a few C/1 or C/3 (Conroy *et al.* 1975b); C/3 rarely, if ever, successfully incubated (Conroy *et al.* 1975b). At Signy I.: 6 \times C/1, 73 \times C/2, 1 \times C/3, ($n=80$; Lishman 1985b). No replacement after loss.

LAYING In C/2s, at intervals of 3.2 days (1.1; 1–6; 134); laying interval of third egg, after loss of first, 2–3 days after second (Lishman 1985b). Start of laying at Signy, King George, Deception and Elephant Is, and Waterboat Pt: 19 Nov. to 3 Dec., mean 25 Nov. (G. Lishman). At Signy I., laying as follows:

C/1: 6 Dec. (1.7 days; 4–8 Dec.; 6)

C/2 (1st): 4 Dec. (2.5 days; 28 Nov.–10 Dec.; 73)

C/2 (2nd): 7 Dec. (3.0 days; 2–14 Dec.; 73)

At King George I., laying dates intermediate between those of Gentoo (less synchronized) and Adelie Penguins (more synchronized; W.Z. Trivelpiece).

INCUBATION Both sexes incubate, in alternate shifts: usually first by female, for 6.0 days (2.4; 1–14; 128), after 13–14-day pre-laying attendance, which means a fast of about 3 weeks; second by male for 9.8 days (2.9; 5–18; 103); third by female for 7.8 days (2.3; 4–15; 98); fourth by male for 4.9 days (1.6; 1–9; 90); finally period of irregular short shifts (Lishman 1985b); recorded in late incubation period at Bouvetøya as averaging 35.1 h (15.8; 14–60; 10; Haftorn 1986). At Elephant I., shifts averaged 2.84 days (1.88; 1–9; 12) without difference in length towards hatching (Conroy *et al.* 1975a). Most change-overs in middle of day (09:00–13:00), evening or night (21:00 onwards). During fasts while incubating, parents lost up to 29% of weight at rate of 1.45%/day for females and 1.10%/day for males, which equals cost of 1.9 times theoretical BMR and weight-specific metabolic rate of 2.9 W/kg (Lishman 1983). Incubating bird covers eggs with brood patch on lower part of abdomen, occasionally turning eggs with bill. Mean egg-temperature, 10:00 to 17:00: 37.38 °C (0.52; 34.8–38.0; 1 nest, 189 measurements); evening and night (after change-over): 34.45 (2.84; 29.0–38.0; 1 nest, 49 measurements). Hatching in C/2 asynchronous, maximum interval 2–3 days ($n=6$). Time between pipping and hatching in two eggs: 15 h, 28 h. Hatching better synchronized than laying: at Signy I., first chicks hatch on average 8 Jan. (3.2 days; 3–18 Jan.; 79); second chicks, 9 Jan. (4–16 Jan.; 22; Lishman 1985b). **INCUBATION PERIOD.** At Signy I., period for first egg in C/2, 36.2 days (1.3; 65); for second 33.9 days (1.1; 71; Lishman 1985b). At Elephant I., mean period 35 ± 1 day (Conroy *et al.* 1975b). Sladen (in Conroy *et al.* 1975a) recorded 38 days at Signy I.; Bagshawe (1938), 37 days (34–40) with mean for first egg 37.3 days and for second, 35.2 days at colonies farther S on Antarctic Pen. Thus, incubation period for first egg longer than for second; at Signy I. by 3 days in one year and by 2.3 days in next. Because laying interval in both years was c. 3 days, first egg was incubated only partially for 75–77% of time before second egg laid (G. Lishman).

NESTLING Semi-altricial, nidicolous; hatched with silver-grey protoptile, eyes open. Mesoptile appears when c. 20 days old as darker grey on back and crown, pale grey below (G. Lishman). Early chicks begin to lose down in early Feb. when c. 30 days old (Conroy *et al.* 1975a). Both parents alternately attend chick during a brood-guard stage. At Bouvetøya, for first 3–8 days of stage, shifts averaged 14.8 h (5.11; 8–32; 22; Haftorn 1986). At Signy I., parents stopped attending chicks when 3–4 weeks old and crèches began to assemble: single chicks at age 28.7 days (4; 22–36; 19); first chicks of B/2, at 24.0 days (3.6; 20–30; 6); second chicks, at 23.0 days (3.3; 19–27; 3; Lishman 1985b). **NESTLING PERIOD:** first hatched chicks, 53.7

days (3.0; 49–59; 15); second chicks, 52.5 days (3.1; 48–56; 8) (Lishman 1985b). Both parents feed chick by incomplete regurgitation.

GROWTH At Signy I., weight at hatching in two consecutive seasons as follows (Lishman 1983):

Season 1: First chick 66.0 g (9.8; 47–93; 52)

Second chick 66.0 g (8.6; 49–84; 39)

Season 2: First chick 77.4 g (8.1; 62–98; 40)

Second chick 77.7 g (11.4; 58–110; 40)

Mean weights of 14 chicks at Signy I.: day 10, 0.3 kg; day 20, 1.1 kg; day 30, 2.0 kg; day 40, 3.8 kg; day 50, 4.4 kg (Conroy *et al.* 1975a). Growth rates of 4 pairs of chicks at Elephant I. given in Conroy *et al.* (1975b). Elder chick in brood gained very little weight before second chick hatched and thereafter both chicks had similar rates of growth. Chicks fledged with flippers 84%, bill 69% of adult length (Lishman 1983). At King George I. (55 chicks), increments of growth in 3- and 6-day intervals described by logistic equation with constant = 0.127 and asymptotic weight = 4.05 kg; feet and flippers grew more rapidly than bills; growth slow for first 5 days, then linear till 36 days; after reaching maximum weight (85% av. ad. wt.), decrease to fledging at 55–60 days; no differences in rates of growth of chicks of different categories (Volkman & Trivelpiece 1980).

FLEDGING TO MATURITY At departure, chicks stay near colony or at edge of water, occasionally entering and swimming frantically but not diving; usually soon land again. Unattended by adults, some of which, however, may return to colony, call for young and may feed them if near the water but generally do not do so (G. Lishman). Quite independent of parents after departure. Two-year-olds form pair-bonds; age at first breeding, three years in both sexes (W.Z. Trivelpiece). Juveniles return to natal colonies and stay till second moult complete (Volkman *et al.* 1982).

SUCCESS At Signy I., 64 pairs laid 123 eggs, hatched 55 (45%) chicks and fledged 23 (41.8%) for total success of 18.7% or 0.36 chicks/pair (Lishman 1985b) but great differences between seasons depending on ice conditions; success lower in years when pack-ice persists round shores in summer, restricting access to sea for foraging (Lishman 1985a); in one bad season, only 26% of chicks fledged at 0.016 chicks/pair (Conroy *et al.* 1975a; Lishman 1985b). At King George I., fledged 1.06 chicks/pair in 1977–78 (12 colonies, c. 450 pairs; W.Z. Trivelpiece). At Signy I., in an average season climatically, loss of first and second eggs similar (45 v. 43%) but loss of second chick much higher than that of first (90 v. 52%). Most eggs lost at 19–21 days of incubation; second chicks, at 11 days old; first, at 19 days old (Lishman 1985b). Predation mainly by Greater Shearwater *Chionis alba*, of eggs and possibly young chicks (Jones 1963); skuas *Catharacta* take eggs and even chicks up to 3 kg in weight. At sea, birds of all ages killed by Leopard Seals *Hydrurga leptonyx*. Variation in climate (late break-up of sea-ice) greatly affects breeding success but size of colony and location of nests within colony do not (Conroy *et al.* 1975a; Lishman 1985b; W.Z. Trivelpiece; G. Lishman). At King George I., late breeders significantly less successful (W.Z. Trivelpiece) but not so at Signy I. (G. Lishman). Handling of birds may (Lishman 1985b) or may not (W.Z. Trivelpiece) affect survival of chicks.

PLUMAGES

ADULT HEAD AND NECK. In fresh plumage, crown to nape, black (89); extending from forehead, above eye to nape and continuous with dorsum. Crown-feathers have

narrow tips of light blue-grey (88); slight on nape. Narrow black (89) eye-ring. Lores, narrow margin above eye, chin and throat, sides of head, to lower foreneck, white. Black (89) tips of feathers form thin line extending from one auricular area to other, forming chinstrap. **UPPERPARTS**, black-brown (119), with tips of feathers, light blue-grey (88); tips more prominent in outer mantle and outer upper tail-coverts; elsewhere prone to wear. **TAIL**, black-brown (119); outer pair of rectrices, white on outer webs, to sometimes with black-brown (119) edge near tip. **UPPERFLIPPER.** Feathers, scale-like anteriorly, longer posteriorly, ordered in distinct rows. Upper-surface, as for dorsum but grey tips of feathers more prominent posteriorly. Last single posterior row of feathers, white, extending from carpal flexure approximately to tip of flipper; thin narrow line of white feathers extends along anterior margin of flipper. **UNDERPARTS**, including under tail-coverts, white; slight inward progression of white plumage near axilla and extending to sides of thighs. Outer thighs, similar to dorsum. **UNDERFLIPPER.** Under-surface, white with narrow black-brown (119) margin from base to carpal flexure; much wider patch at tip of flipper. Posterior margin of flipper from base to opposite carpal flexure, dark brown (121) with small white patch. In worn plumage, differs noticeably in dorsum and flippers, being faded and pale dark-brown (121). Concealed parts of feathers on dorsum noticeable in dislodged feathers and in pre-moult: concealed feather bases, white. Rachis, basally white, merging through brown in central part, to black (89) tip.

DOWNY YOUNG Protoptile down short. Crown and sides of head, white. Entire upperparts, light grey (86) with white tips to down. Entire underparts, pale grey (86). Upper-surface of flipper, as for dorsum; under-surface as for ventrum. Teleoptile thicker and hairy. Down on crown, sides of head, chin and throat, excluding forehead, pale grey (86). Rest of dorsum, including forehead, brown-grey (79); most down has prominent white tips. Underparts, white with brown-grey (80) shade. Upper-surface of flipper as for dorsum; under-surface as for crown.

JUVENILE Similar to adult. Differs primarily in plumage of head: tips of feathers on chin, sides of face and particularly round eye, black (89) (Watson 1975; Trivelpiece *et al.* 1985). Chinstrap acquired at juvenile moult.

ABERRANT PLUMAGES Albino and isabelline birds recorded (Murphy; W.Z. Trivelpiece).

BARE PARTS Based on photos in Lindsey (1986).

ADULT Iris, red-brown (41). Bill, grey-black (82). Legs and feet, pink (3) to salmon (6).

DOWNY YOUNG Iris, dark brown (-). Bill, grey-black (82); egg-tooth, white. Legs and feet, pink-buff (121D).

JUVENILE Similar to adult.

MOULTS Few data.

ADULT POST-BREEDING Complete, Feb.–Mar.; C. Crozier, actual dates of moult, 13–27 Feb. (Ainley *et al.* 1978); noticed 26 Feb. (Conroy *et al.* 1975a). Duration c. 13 days; last moulting bird, 6 Apr. (Conroy *et al.* 1975a). Tail last to be renewed (Holgersen 1945). Further study of moult sequence required.

JUVENILE Chicks moult early Feb.; complete within month; last chick present, 12 Mar. (Conroy *et al.* 1975a).

POST-JUVENILE Complete; involves loss of mott-

ling of face, chin and throat feathers at c. 14 months of age (Trivelpiece *et al.* 1985).

MEASUREMENTS Few data. (1) Various parts of w. Antarctic region; BILL(G) = bill length from gape, TOE = middle toe and claw (6 skins from AMN and published measurements, unknown sample size; Murphy). (2) Deception I., adults; FLIPPER(A) = flipper from axilla (Holgersen 1945). (3) South Atlantic (56°45'S, 8°50'E; 56°40'S, 6°10'E), one male, 2 females; BILL(G) = bill length from gape (Bierman & Voous 1950). (4) Location unknown (G. Lishman).

UNSEXED		
FLIPPER	(1)	171-201
TAIL	(1)	132-200
BILL	(1)	43.5-52
BILL(G)	(1)	60-69
TARSUS	(1)	21-24
TOE	(1)	70-81
FOOT	(1)	102-109

	MALES	FEMALES
FLIPPER(A)	(2) 180, 181	177, 171
FLIPPER	(3) 180	185, 188
BILL	(2) 45, 49, 45	48, 45
	(3) 48	44, 47
	(4) 49.8 (2.4; 44.0-55.0; 39)	45.4 (2.0; 41.0-49.5; 24)**
BILL(G)	(3) 63	64, 64
BILL D	(4) 18.8 (0.7; 17.5-20.0; 39)	17.3 (0.8; 16.0-19.0; 24)**
TAIL	(3) 140, 146	

Full details of growth rates of chicks, given in Conroy *et al.* (1975a,b), Despin (1977), Volkman & Trivelpiece (1980).

WEIGHTS Few data. Weights in kg. (1) Clarke (1906). (2) S. Orkney Is, 9 Feb. (Murphy). (3) S. Shetland Is, live (Croxall & Furse 1980). (4) Bouvetøya, adults, live (Haftorn 1986).

	MALES	FEMALES
	(1) 4.08 (n=7)	3.88 (n=8)
	(2) 4.13 (3.17-5.33; 7)	3.92 (3.06-4.54; 8)
	(3) 4.435 (0.315; 19)	3.876 (310; 25)

UNSEXED	
(4)	3.95-5.30 (n=7)

Some seasonal data presented by Croxall & Furse (1980). Weight loss during moult; females fast for up to 30 days (Sladen 1955); but no data (Croxall 1982). Adult weights at beginning and end of incubation in two seasons in Lishman (1983). For weight change in non-moulting birds see summary in Croxall (1982). For full details of weight changes in chicks see Conroy *et al.* (1975a,b), Volkman & Trivelpiece (1980), Taylor (1985).

STRUCTURE Flightless. Flipper, hard and bony, long and narrow. Feathering of body dense, strongly lanceolate; rachis, broad and flattened at tips, producing glossy appearance. Tail: 14-18 rectrices, t1 longest, t7 85-90 mm shorter. Ventral surface of rachis on rectrices, strongly concavely ridged. Tail, long and rectangular. Bill slender; culminicorn rounded at tip. Legs very short; hexagonal or pentagonal scutes on tarsus and toes; feet webbed; extraneous fold of skin along outer edge of inner toe; slight on either side of middle toe. Pads of soles thick. Claws, long, thick and curved. Outer toe c. 94% of middle, inner c. 63%, hind c. 24%.

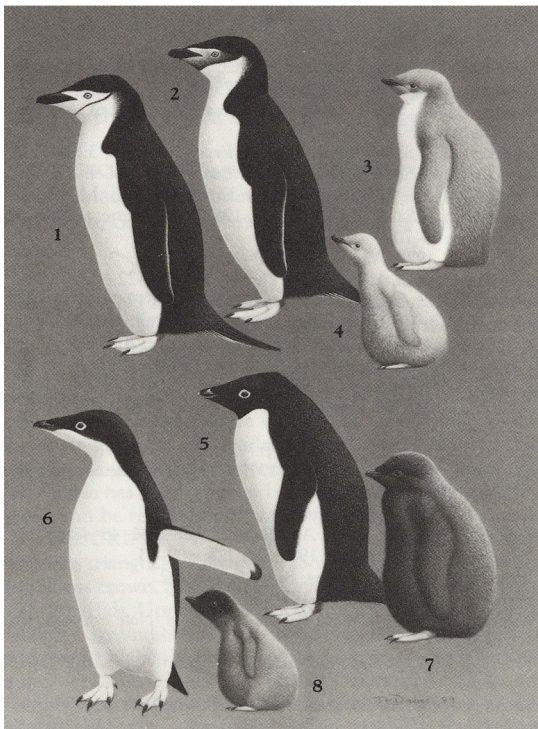
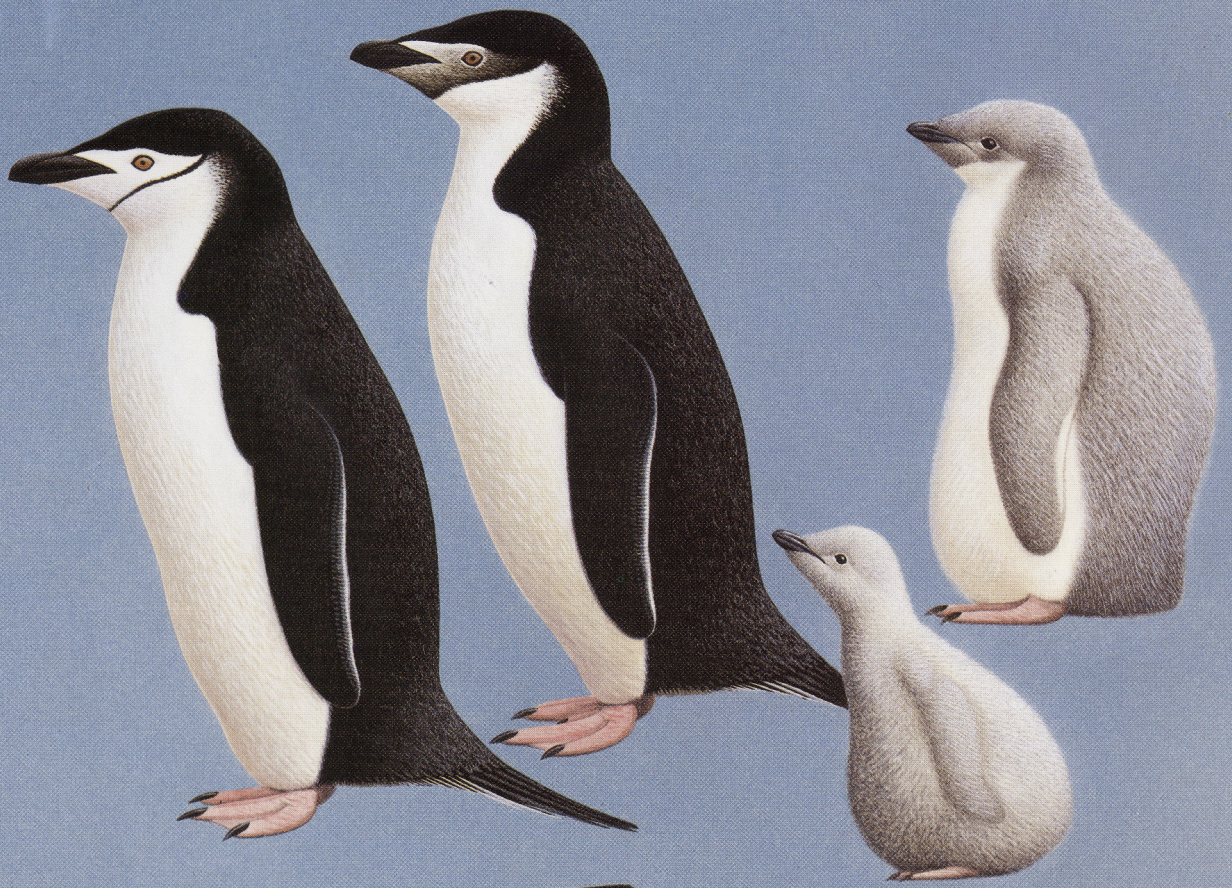
GEOGRAPHICAL VARIATION None. Forms superspecies with *P. adeliae* (Peters).

RMO

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Volume 1 (Part A), Plate 8

Chinstrap Penguin *Pygoscelis antarctica*

- 1. Adult
- 2. Juvenile
- 3. Downy young, mesoptile
- 4. Downy young, protoptile

Adelie Penguin *Pygoscelis adeliae*

- 5. Adult
- 6. Juvenile
- 7. Downy young, mesoptile
- 8. Downy young, protoptile

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