Order PROCELLARIIFORMES

A rather distinct group of some 80–100 species of pelagic seabirds, ranging in size from huge to tiny and in habits from aerial (feeding in flight) to aquatic (pursuit-diving for food), but otherwise with similar biology. About three-quarters of the species occur or have been recorded in our region. They are found throughout the oceans and most come ashore voluntarily only to breed. They are distinguished by their hooked bills, covered in horny plates with raised tubular nostrils (hence the name Tubinares). Their olfactory systems are unusually well developed (Bang 1966) and they have a distinctly musky odour, which suggest that they may locate one another and their breeding places by smell; they are attracted to biogenic oils at sea, also no doubt by smell. Probably they are most closely related to penguins and more remotely to other shorebirds and waterbirds such as Charadriiformes and Pelecaniformes. Their diversity and abundance in the s. hemisphere suggest that the group originated there, though some important groups occurred in the northern hemisphere by middle Tertiary (Brodkorb 1963; Olson 1975).

Structurally, the wings may be long in aerial species and shorter in divers of the genera Puffinus and Pelecanoides, with 11 primaries, the outermost minute, and 10–40 secondaries in the Oceanitinae and great albatrosses respectively. The tail varies in length, being forked in Oceanodroma, forked to pointed in other forms, usually with 12 rectrices but up to 16 in fulmars. The tarsi are light and cylindrical in aerial forms; strong and laterally compressed with legs set far back in aquatic ones. The front toes are webbed; hind toe small or absent. The proventriculus is long and glandular; the gizzard small and twisted; and the small intestine often spiral in Pterodroma, presumably to aid absorption of the unusual lipids in their food. Chicks are helpless and covered in down, with two coats except in some Oceanitinae. Some larger species have a darker immature plumage, and the female is often darker than the male in the great albatrosses. The male is usually larger than the female, though smaller in the Oceanitinae and some other small species. Otherwise there is little difference in appearance with sex or age, except that young birds may have more pronounced pale or dark edges to the feathers. Many have simple counter-shaded markings that often appear to have given rise to uniformly dark or, less often, to pale derivatives; some species in most groups are dimorphic or polymorphic. The more complex groups have often developed distinctive markings of the extremities.

Breed more or less colonially on offshore islands, coastal cliffs, or on hills and deserts inland, where they perform complex vocal and aerial displays. The nest is a simple scrape or cup in a burrow or natural hole, sometimes under vegetation. The s. albatrosses build large cone-shaped nests in the open; may be lined with any debris available in the area. Smaller species visit it only at night, though larger ones and those breeding on remote islands may come to nests in the open by day. Parents incubate for spells of several days in turn and generally leave the chick alone soon after it hatches, only returning at long intervals to feed it by regurgitation. In consequence the chick is vulnerable to introduced predators and some species are now greatly reduced and at least two are now extinct. Some species also periodically lie to have unsuccessful breeding seasons. Many young or even old birds may be wrecked ashore and die when they meet bad weather or suffer shortage of food on migration or in the winter. Though it has been claimed that they are also vulnerable to all sorts of pollution, the evidence is weak (Bourne 1976). There is at present anxiety about the effect of some fishing methods, such as long-lining, which tend to fail breeders and non-breeders to begin moult before successful breeders. Five strategies of wing-moult in breeding adults: (1) In albatrosses, remiges replaced in staffelmauser interrupted while breeding; in nearly all other species, primaries moulted outwards; possibly simultaneously in some diving-petrels. (2) In most subantarctic and temperate species, moult begins soon after breeding and is completed shortly before next breeding season. (3) In most tropical species, moult aseasonal, between breeding attempts; resumption of breeding apparently depends on when moult completed. (4) In trans-equatorial migrants, wing-moult delayed until they reach non-breeding quarters, where it is completed; moult rapid but no satisfactory evidence for flightlessness. In
some species, body-moult also in winter quarters; in others, at breeding grounds. (5) In some species of high latitudes, rapid moult completed in summer when they breed; some begin moult long before breeding finished.

The history of the classification of the Order is very confused, as is seen by comparing Timmermann's (1965) discussion of their Mallophagan parasites with that by Klemm (1969) of their leg muscles and that by Harper (1978) of their proteins, but it is now widely agreed that the Order is best divided into four families: Diomedeidae or large to huge albatrosses; Procellariidae or medium-sized, mainly aerial but sometimes aquatic, petrels, shearwaters and prions; Hydrobatidae or small to tiny, aerial storm-petrels; and Pelecanoididae or small aquatic diving-petrels.

References

Family **DIOMEDEIDAE** albatrosses

The albatrosses are a small group of some 13-16 large petrels with long wings adapted for gliding flight and with long powerful beaks adapted for seizing prey at the surface; nine species breed in our region and one other has been recorded as a vagrant. Because they are so large, they must breed in the open, where they walk well for petrels. Most s. species build substantial conical nests but n. ones, breeding in warm climates, make only scrapes. Young birds in some species have a drab plumage but adults of many species develop bolder markings with brightly coloured stripes on the bill, used in social displays when breeding. Three distinct groups occur in the Southern Ocean but the distinction between two is blurred by intermediate forms that occur in North Pacific:

(1) The great albatrosses are huge, long-winged, long- and pale-billed, short-tailed birds that glide round the world in Southern Ocean. Until recently, there were thought to be two species: the more pelagic Wandering Albatross *D. exulans* breeding on most of the subantarctic islands, which is dark with a white underwing when young, becoming more or less white with dark wing-tips when adult; and the more coastal Royal Albatross *D. epomophora*, breeding round NZ, which resembles the extreme white adult Wanderer throughout its life but has a dark cutting-edge to the upper mandible. A few birds breeding in extreme immature *exulans*-type of plumage on Ile Amsterdam in the Indian Ocean have recently been described as a third species *D. amsterdamensis* but there is continuing debate whether this is justified owing to the occurrence of similar populations in South Atlantic and round NZ (Bourne 1989).

(2) The medium-sized albatrosses *Diomedea* (Thalassarche), often called mollymawks, are a compact group of white-bodied, dark-backed species with brightly marked bills in adults, all five species being found in our region. They consist of two comparatively coastal species, the Black-browed Albatross *melanophrys* with main breeding colonies round South America, and the Shy *cauta* with 3-4 rather well-defined subspecies, sometimes treated as separate species, breeding in Asia. There are also three pelagic species: Grey-headed *chrysostoma* to the south, Yellow-nosed *chlororhynchus* in subtropical South Atlantic and Indian Oceans, and Buller's *bulleri* in equivalent parts of South Pacific.

The differences between Groups (1) and (2) are rather marked and they would doubtless be treated as distinct genera if it were not that four other albatrosses with intermediate characters breed in North Pacific: Black-footed *nigripes* with plumage resembling that of sooty albatrosses, though shape differs; Laysan *immutabilis* with plumage like that of the medium-sized albatrosses (Group 2); Short-tailed *albatrus* with a sequence of plumages rather like those of Wanderer, though smaller; and the Waved *irrorata* with dark plumage except for pale head, neck and underwing. Because it is hard to make any clear distinction between these birds they are normally all included in an unusually wide genus *Diomedia*.

(3) The sooty albatrosses *Phoebetria*. Two extremely aerial, highly pelagic and rather aggressive or predatory species with fairly small bills with a groove along the lower mandible; long wings; long pointed tails; and dark plumage; nest on steep places and have vocal aerial displays.
General characters are: body, short and broad; head, large; neck, short. Wing, long and narrow, folded in three almost equal parts, 11 primaries, $p_{10}$ longest, $p_{11}$ minute; up to about 40 secondaries, diastataxic. Tail, short and square in Diomedea, longer and wedge-shaped in Phoebetria, 12 feathers. Bill, heavy and composed of several horny plates; hooked; nostrils in tubes on either side. Legs, strong; three front toes joined by web; hind toe absent or vestigial. Oil gland, feathered. Sexes similar; male larger on average. Plumage mainly white except in Phoebetria, in which it is dark grey. Juveniles and immatures generally generally separable but mostly not very different from adults except in $D. \text{exulans}$ and $D. \text{albatrus}$; fully adult plumage attained only after several years. Stance upright and able to walk much better than most other Procellariiformes. Swim and rest on sea buoyantly with head held high. Feed mostly on fish and squid by surface-seizing or shallow diving, but sooty albatrosses also take birds. Follow ships for scavenging.

Long-lasting monogamous pair-bond. Breed colonially, pairs often returning to same site. Defend small nest-territories. Perform spectacular agonistic and sexual displays at nest in Diomedea; vocal aerial displays in Phoebetria. Eggs, white, minutely spotted reddish. Clutch-size; one; no replacement laying. Incubation by both sexes in long alternate spells. Incubation period, 2 or more months. Nestling, semi-altricial, nidicolous; hatched in down. Brooded for a short time after hatching; then left alone in nest, parents returning only to feed chick by incomplete regurgitation. Nestling period long, up to 12 months, and so in some species successful adults cannot breed annually. Young independent on fledging. Maturity reached only after several years. Some populations were reduced in the past, notably by egg-collecting, but there appear to be few threats now except that some great albatrosses are caught by long-line fishing.

REFERENCES
Phoebetria fusca Sooty Albatross

Diomedea fusca Hilsenberg, 1822, in Froriep, Notiz. 3: Col. 74 — Mozambique Channel.

The generic name is derived from the Greek god Phoebus (Apollo) or goddess Phoebe (Diana), meaning the Bright One and, as φοίβετος prophetic, inspired; hence, perhaps φοίβητρια one after the sort of Phoebe or prophetess; fusca alludes to the dark colour of the birds.

There is a temptation to join the two species of Phoebetria in the English group-name, sooty-albatross. To do so would mean qualifying this species (fusca) and thereby creating two clumsy names instead of one.

MONOTYPIC

FIELD IDENTIFICATION Length: 84–89 cm; wing-span: 203 cm; weight: males 2.7 kg, females 2.4 kg. Slender-bodied, all dark-brown albatross with very long, narrow wings and long pointed tail, appearing wedge-shaped when spread. Sexes similar; male slightly larger. No seasonal differences in plumages, except by wear. Immatures differ from adults.

DESCRIPTION ADULT. In fresh plumage, entirely dark greyish brown to blackish, except for white crescent almost encircling eye (broken at lores and visible only at close range) and white or pale shafts on primaries and rectrices. In good light, back, mantle and abdomen show slightly lighter than rest of plumage. Bill, slender and dark or marked creamy to creamy yellow or orange stripe (sulcus) along lower mandible. Iris, brown. Legs and feet, mauve or greyish flesh.

As breeding progresses, plumage becomes worn, browner and paler with tips of individual feathers buffish, creamish or even whitish, particularly on nape and sides of neck; outer primary tips usually broken. JUVENILE. Differ in having grey sulcus, grey crescent round eye and shafts on all remiges dark (Murphy; Berruti 1979b). Fledgelings at Iles Crozet have shafts of remiges pale as in adults (Jouventin & Weimerskirch 1984).

IMMATURE. Older immatures have mottled buff or creamy collar, extending down to sides of neck (sometimes to upper mantle) and whitish nape. In Indian Ocean, pale collar recorded in birds with dark and yellow sulci, which suggests that this plumage pattern is common to immatures and adults in worn plumage; birds with yellow sulci account for only a small proportion in Jan.-Mar. but half in June-Oct. (Ferguson 1921; Alexander 1922; Falla 1937; J-C. Stahl).

SIMILAR SPECIES Can be confused only with Light-mantled Sooty Albatross Phoebetria palpebrata. Adult Light-mantled Sooty Albatross has diagnostic contrast on upperparts between light-grey neck, mantle and back and dark head, upperwings and tail. Immature Light-mantled Sooty Albatross has pale areas of plumage whitish rather than buffy or creamy, not restricted to collar but extending from nape to lower back and down to underparts, isolating dark mask. Some Sooty Albatrosses have markings and colours that render them, as yet, inseparable from Light-mantled Sooty Albatross (Harrison 1983). In hand, Sooty Albatross also identified by heavier bill, and culminicom far less concave in profile and slightly longer than in Light-mantled Sooty Albatross; eye-ring more complete but narrower. Both sooty albatrosses fairly easily distinguished from other albatrosses by dark plumage, long slender wings, long pointed tails and effortless gliding flight. Juvenile Wandering Albatross Diomedea exulans much larger with white underwings and mask; Black-footed Albatross D. nigripes has whitish area at base of bill at all ages and, when adult, whitish base of tail and under-tail-coverts. Giant-petrels Macronectes spp are almost as large but fly with flap-and-glide action, have heavy pale-coloured bills, thickset head and body; head more prominent and larger relative to body-size; wings broader and shorter, rounded tail.

Pelagic, solitary or in small groups. Fly swiftly and apparently effortlessly, seldom flapping actively; wings always slightly flexed; in windy conditions, unusually slender build and exceptional gliding and soaring ability very evident. Supreme ability in flight without flapping, flying higher and stooping more rapidly than other albatrosses, stressed by
Murphy; appear to fly higher above water than other albatrosses except Light-mantled Sooty Albatross, partly because undulations while soaring smoother. Swim with upright erect posture typical of albatrosses. Feed by surface-seizing; possibly mostly during twilight and at night. Regularly follow ships but usually only for short periods. Mostly silent at sea, trumpet-like calls at colonies. Gait on land, awkward, deliberate with hunched body and bobbing head; less agile than other albatrosses but can take off from level surfaces. Nest in loose colonies or small groups on ledges of cliffs, not so densely as other albatrosses.

**HABITAT**  Marine; pelagic. In summer, mainly S of 35°S in subtropical and subantarctic waters, but most abundant near Subtropical Convergence (Falla 1937; Tickell & Woods 1972; Weimerskirch et al. 1986); range S of Antarctic Convergence in sw. Indian Ocean but rarely elsewhere (Bierman & Voous 1950; Johnstone & Kerry 1976; Naito et al. 1979; Jouventin et al. 1982; Weimerskirch et al. 1986). In late autumn and winter, mainly in Subtropical Zone (Rand 1963; Tickell & Woods 1972; Jouventin et al. 1982; J-C. Stahl). Immatures restricted to Subtropical Zone throughout year (Stahl 1987). Tolerate wide range of sea surface-temperatures and salinities (Bierman & Voous 1950; Jouventin & Weimerskirch 1984). In breeding and non-breeding seasons, occur widely over pelagic waters, exploiting dispersed sources of food (Weimerskirch et al. 1986); but observed over inshore waters in Aust. on occasions (Thiele 1977) and forage over coastal kelp beds off Tristan da Cunha (Richardson 1984). Breed on subtropical and subantarctic islands in Indian and Atlantic Oceans; on vegetated cliffs and steep slopes sheltered from prevailing winds, often among tussock grass (Berutti 1979a; Weimerskirch et al. 1986; Roux 1987). On Marion, Prince Edward Is, Iles Kerguelen and Crozet, breeding confined to coastal sites, but nest inland on Ile Amsterdam, Gough I. and Tristan da Cunha Grp, on ridges, cliffs, high slopes and plateaux (Hagen 1952; Segonzac 1972; Shaughnessy & Fairall 1976).

Fly within 10–15 m of sea surface, using updrafts off wave fronts for lift; food taken at surface. Repeated fires at Iles St Paul and Amsterdam may have caused decrease in vegetation cover at breeding sites; material for nest construction now scarce (Segonzac 1972; Jouventin et al. 1984). Predation by introduced rats most likely cause of breeding failure at Ile St Paul (Segonzac 1972).

**DISTRIBUTION AND POPULATION**  Usual pelagic range South Atlantic and s. Indian Oceans, in summer between 35° and 50°S, to 64°S in sw. Indian Ocean; in winter, 30°S and 40°S. Reaches Aust. but not normally NZ or Pacific
Ocean. Breed on subantarctic islands in Atlantic and Indian Oceans between 36°S and 49°S.

At sea, over much of South Atlantic and s. Indian Oceans. In South Atlantic Ocean, w. limit of range c. 40°W (Tickell & Woods 1972; Thurston 1982); accidental to C. Horn, Chile; specimen in Mus. natn., Santiago (‘capturado hace anos en los alrededores del Capo de Hornos’; Goodall et al. 1951); occasional in Antarctic waters in summer, southernmost record 61°S (Novatti 1960); northernmost record in winter 25°S (Tickell & Woods 1972). Rare visitor to s. Africa (Clancy 1980; Ryan & Rose 1989); type-specimen from Mozambique Channel. In Indian Ocean, accidental to Mauritius (Meinertzhagen 1912) and Réunion Is (Gruchet in Rowlands 1987); extends E to Tas. and e. coast of Aust. No records NZ, Macquarie I. Only records Pacific Ocean in SE: two individuals at 61°37'S 98°58'W in Dec. (Holgersen 1957).

AUST. Clearly sooty albatrosses are fairly regular in small numbers off s. Aust., mostly beyond continental shelf, but identification and description of sightings has generally been inadequate so that it is not possible to say whether Sooty or Light-mantled Sooty was seen. In Aust. Field Atlas (1977-81), Sooty was claimed 15 times in eight 1° blocks between 32° and 43°S and 115° and 151°E, mostly from Mar. to Nov. None was supported by field description of modern standard and only two can be accepted as being truly Sooty Albatross: one, off WA in block 32/115 and one off Green Cape, Vic. in block 37/150. Before 1977, there were at least 20 records in as many degree blocks, even as far N as 27° and 23°S in e. Aust. (e.g. Elkington 1930; Ferguson 1916; Macgillivray 1920, 1927; and others) of which some (e.g. Learmonth et al. 1951) have been recorded in mixed flocks with Yellow-nosed Albatross Diomedea chlororhynchos, Great Shearwater Puffinus gravis, Antarctic Tern Sterna vittata and Common Noddy Anous stolidus near Tristan da Cunha (Richardson 1984).

BREEDING Subantarctic islands between 36° and 49°S. Localities and population estimates summarized in Table 1. Extralimitally, breed Iles St Paul and Amsterdam (Roux & Martinez 1987), Tristan da Cunha Grp (4125–5250 pairs; Williams 1984) and Gough I. (5000–10,000 pairs; Williams 1984).

Status satisfactory at present. One colony at Ile Amsterdam declined from several tens of chicks in 1956 to 15 in 1970, at Ile St Paul, one colony reported last century now deserted (Segonzac 1972). Tristan da Cunha population increased by two-thirds between 1952 and 1972–74 despite harvest of 100–325 chicks and 5–10 adults each year by Tristan islanders (Richardson 1984). No changes reported from other localities.

MOVEMENTS Dispersive, possibly migratory, from nesting islands but little known of movements at sea.

DEPARTURE Young fledge Tristan da Cunha and Gough I., mid-May (Elliott 1957; Swales 1965; Richardson 1984); Marion I., Apr.–late May (Rand 1954; Berruti 1979a); Iles Crozet, May–early June (Mougin 1970b; Weimerskirch et al. 1986).

NON-BREEDING Disperse N in winter, deserting subantarctic and Antarctic waters and N limit shifts to 30–35°S (Jouventin et al. 1982); most records South Africa, winter (Liversidge 1959). E. movement in Indian Ocean suggested by rarity in sw. Indian Ocean, May-Aug. (Rand 1962, 1963; Grindlay 1981; J-C. Stahl), increase in abundance E of 74°E (Macgillivray 1920; Hansen 1978) and observations of up to 20 individuals together in the Great Australian Bight (Ferguson 1921).

RETURN Arrive breeding colonies: Tristan da Cunha, mid-July (Elliott 1957); Iles Crozet, mid-Aug. (Weimerskirch et al. 1986); Marion I. and Gough I., late Aug. (Berruti 1979a; Swales 1965) though sometimes as late as early Sept. at Tristan da Cunha (Richardson 1984).

BREEDING When feeding chicks potential maximum foraging range 2150 km but most adults recorded within 1200 km along transects E and S of Iles Crozet (Jouventin & Weimerskirch 1984); 90% of 104 observations, <600 km (Stahl et al. 1985).

FOOD Mostly cephalopods but fish, crustaceans, siphonophores and carrion including dead birds recorded.

BEHAVIOUR. Only surface-seizing recorded (Harper et al. 1985) but rarely observed feeding possibly because crepuscular or nocturnal (Berruti & Harcus 1978; Weimerskirch et al. 1986). Usually feed alone (Weimerskirch et al. 1986) but have been recorded in mixed flocks with Yellow-nosed Albatross Diomedea chlororhynchos, Great Shearwater Puffinus gravis, Antarctic Tern Sterna vittata and Common Noddy Anous stolidus near Tristan da Cunha (Richardson 1984). Have also been seen feeding in association with pilot whales Globicephala and Southern Right Whale Dolphins Lissodelphis peronii off s. Africa (Enticott 1986) and following whales off Iles Kerguelen (Paulian 1953). Excluded from feeding groups by other albatross species and giant-petrels Macronectes (Weimerskirch et al. 1986).

NON-BREEDING A beachcast bird from sw. WA contained cephalopod beaks (Serventy 1945).

BREEDING At Iles Crozet (Weimerskirch et al. 1986), cephalopods predominated in 74% of 81 regurgitated samples (actual freq. 95.1, largely Cranchiidae) with fish dominant in 12 (20.9), crustaceans 2 (11.1, incl. very few Euphausia) and carrion 12 (32.0, mostly penguins Eudyptes but also prions Pachyptila and a seal). In another sample from Iles Crozet, cephalopods 94% freq., birds 11 (18; Mougin 1970b). At Marion I. regurgitated casts contained mostly cephalopod beaks (see Table 2), also fish, crustaceans and feathers from penguins and other birds (Berruti & Harcus 1978). Maximum estimated weight of individual cephalopods 5.4 kg, which sug-

<table>
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<tr>
<th>LOCALITY</th>
<th>YEAR OF ESTIMATE</th>
<th>POPULATION (pairs)</th>
<th>REF.</th>
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<td>2732</td>
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<tr>
<td>Iles Crozet</td>
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<td>2</td>
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Table 2. Cephalopods in the diet of the Sooty Albatross at Marion I.

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<td>5.3</td>
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<tr>
<td>Alloposus mollis</td>
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</tbody>
</table>

TOTAL NUMBER 2789 3442

(1) Berruti & Marcus 1978 (2) Imber & Berruti 1981.

gests that at least some scavenged. Further analysis of all casts collected at Marion I., Oct. 1974–May 1975 (Imber & Berruti 1981) also summarized Table 2.

At Tristan da Cunha (31 regurgitations; Richardson 1984), cephalopod beaks 97% freq. (0.5–3.5 cm), bird remains 74% (Rockhopper Penguin Eudyptes chrysocome, Great Shearwater Puffinus gravis (2 in 1 stomach), Broad-billed Prion Pachyptila vittata, Common Diving-Petrel Pelecanoides urinatrix, storm-petrels Fregetta), fish 32% (5–20 cm), crustaceans 3%. Algae and seaweed found in stomachs of incubating birds. Three stomachs from Tristan da Cunha contained mainly cephalopod beaks as well as fish, a crustacean, penguin feathers and remains of P. urinatrix (Hagen 1952); at Gough I. regurgitated pellets included cephalopods and penguins (J. Cooper) and regurgitations at Ile Amsterdam contained cephalopods, crustaceans incl. amphipods, decapods, fish incl. Thysites atun, hydrozoans Velella velella, small medusae 0.8–1.2 cm diam., penguin feathers and algae (Segonzac 1972). Sooty Albatross also recorded eating egg of Yellow-nosed Albatross Diomedea chlororhynchos (Swales 1965).

INTAKE Mean interval between feeds for chicks: 2.4 days (Marion I.; Berruti 1979a), 2.7 days (Iles Crozet; Mougin 1970b); chicks receiving 0.37 meals/day (Weimerskirch et al. 1986) and 500 g (146; 100–630; 4) (Jouventin & Weimerskirch 1984).

SOCIAL ORGANIZATION Based on Berruti (1981) and Jouventin et al. (1981). Usually solitary, or in twos and threes at sea throughout the year. Gregarious in breeding season, forming small colonies, occasionally solitary. Non-breeding period spent at sea, but some non-breeding birds return to breeding colonies during breeding season. No detailed knowledge of behaviour at sea; while foraging, occasionally associated with other seabirds and cetaceans (see Food).

BONDS Monogamous. Pair-bonds life-long, divorces very rare. At Iles Crozet, 99.2% of individuals with same partner in following breeding season (n=254); only divorces observed caused by late arrival of partner (Jouventin & Weimerskirch 1984). Bonds renewed each season at nest site; no evidence that pairs associate at sea. Sex ratio apparently balanced. At Iles Crozet, age of first return to land 8.4 years (2.3; 5–14; 67). Establishment of pair-bond occurs over 3.4 years (2.0; max. 7; 17) in immatures and 1.7 years (0.9; 7) in adults after loss of partner. Breeding adults re-establish pair-bond in Sept.–early Oct. Immatures present at colonies: Dec.–June in third year before laying; Aug.–May, second year before; and Sept.–Dec. year before laying (Jouventin & Weimerskirch 1984).

BREEDING DISPERSION Breed in groups of up to 100 nests; occasionally solitary. At Marion I., usually in groups of 50–60; occasionally singly, depending on terrain; at three colonies, 94% of nests had two or more nests within 3 m (Berruti 1979a). At Iles Crozet, c. 12% of individuals (n=1787) breed solitarily and 54% within groups of 2–5 nests (nests ≤3 m apart); largest groups 18 nests (Weimerskirch et al. 1986). Compete with Light-mantled Sooty Albatross for breeding sites at Marion I. (Sooty Albatross returns to breeding colonies 1 month earlier than does Light-mantled). On Tristan da Cunha, some nests have been usurped by Yellow-nosed Albatrosses (breeding slightly earlier) following increases in populations of that species (Richardson 1984). Highly territorial, defending nest-site from conspecifics and Light-mantled Sooty Albatrosses. Territory used for courtship, copulation, incubation and care of young. Non-breeding birds, or those establishing pair-bonds, gather at prominent loafing sites. Nest-sites attended 7–8 months. After brood-stage, only non-breeding birds present for more than a short time at breeding grounds because parents return only to feed chick.

ROOSTING At or near nest-site when breeding, at night and during day; on sea at other times.

SOCIAL BEHAVIOUR Reasonably well known. Detailed studies by Berruti (1981) and Jouventin et al. (1981); also described by Richardson (1984). Most social interaction takes place on or near nest-site. Displays conspicuous and easily observable but difficult to interpret because sexes similer in plumage and behaviour, and non-breeding birds not easily distinguished before laying.

AGONISTIC BEHAVIOUR Agonistic displays performed by adults and immatures defending nest or nest-site. At first, feathers of head, neck and mantle are erected and wings lifted slightly away from body. With increasing intensity, bill opened and birds may lunge at intruder giving guttural gaaau call, sometimes developing into Skycall; may also Gape or snap bill several times in rapid succession; may regurgitate at intruder. Physical attacks rare. Plumage becomes...
SEXUAL BEHAVIOUR Descriptions based on computer analysis by Jouventin et al. (1981). Most active behaviour and complex displays found in immature birds establishing pair-bonds. Sexual behaviour consists of many different actions (Skycall, Scapular Action, Glances, Bill-pointing, Scooping, Gape, Head-shaking, Bowing Head-up, Bill-clashing, Preening and Mutual Preening, Fanned Tail, Synchronized Flight) used in several different levels of displaying (see below). Displays between partners are identical to those of Light-mantled Sooty Albatross, except that Bill-clashing replaces Bill-thrusting. Skycall: birds utter a loud expiratory syllable with head and slightly open bill pointed vertically then a softer and shorter inspiratory syllable as head and bill quickly lowered; may be performed in standing or sitting position, most often by male. Main functions are ADVERTISING ownership of territory and INDIVIDUAL RECOGNITION; often followed by Foot-looking. Scapular Action: bill placed at junction of wing and body, generally on side opposite to partner and tail fanned; given mainly by male. Used as APPEASEMENT attitude and invitation to contact. Glances: bird glances at partner, alternately with right and left eye; mainly by female. Used for establishment of visual contact and as response to Scapular Action. Bill-pointing: bird reaches forward with closed bill pointed to head or upperparts of partner; slight biting movement may be made but contact rare and gentle; performed standing but occasionally by sitting birds, mainly by female. Display not easily distinguished and grades into Bill-clashing and Mutual Preening. Female uses display as another response to Scapular Action; used by male when attempting to preen partner. Gape: similar to Bill-pointing but bill opened when neck extended; mainly by female; aggressive version of Bill-pointing. Scooping: like Gape, but head bowed and bill pointed downwards; given mainly by female. Less aggressive than Gape, as aggression apparently re-directed towards ground instead of partner. Head-shaking: a series of accentuated sideways movements of head; given mainly by male. Advertises Scapular Movement which follows immediately. Bowing Head-up: head slowly bowed then rapidly tossed upwards and backwards; given mainly by male. Fulfils same function as Head-shaking but less aggressive. Bill-clashing (Fig. 1): mutual sideways movements of heads; one bird reaches forward with closed bill pointed at head of partner who jerks head sideways, fencing bills lightly with clicking sounds; up to 15 contacts made in rapid succession. Bill-clashing is ritualized combat aimed at easing aggression between partners. At high-intensity, tail may be fanned. Bill-clashing usually first mutual display; may be followed by Mutual Preening. Preening and Mutual Preening: one bird preens partner, or mutual preening between partners; round head region, especially round eye and base of bill; performed by both sexes, either standing or sitting, birds tending to sit as Preening continues. Functions in maintenance of pair-bond. Fanned Tail: tail fanned and skewed to one side at 45° angle to ground; performed by both sexes. An excitement attitude that can last several minutes, in conjunction with most other attitudes. Synchronized Flight: both partners fly close together over colony, with movements closely synchronized. Caused by departure of female and male attempting to keep contact with female and bring her back to display site. Displacement attitudes also observed during displays: Paddle-walk: consists of quick, exaggerated up-and-down movements when walking; Belly-looking, Foot-looking: head bowed and bill placed between legs; bill may touch belly or one leg and biting movement may be performed; lasts 2-3 s and may be repeated two or three times; and Autopreening, Wing-fluffing or collection of nest material (briefly).

Establishment of pair-bond takes place through four distinct levels of displays. Displays performed in sessions of up to 20 min duration and carried out over several months at colony and over several seasons of courtship before breeding; sequence of displays evolves during this time. Session comprises a series of bouts, during which birds establish or strengthen bonds by a sequence of the displays described above. Level 1. Specific to second or earlier years before breeding (Jouventin & Weimerskirch 1984). Characterized by small variety of displays, performed independently of partner and without sexual differentiation. Displays brief, occurring only between landing of female, attracted by Skycall of male on display site, and her departure at slightest incident. In Level 2, male twice as active as female; birds start to display towards one another; male takes initiative through Head-shaking, Bowing-head-up and Scapular Action. All forms of display used, except Preening. Female still very mobile, but, when she departs, followed by male in synchronized flight. In Level 3, displays are always mutual, with all forms being used as in Level 2; more pronounced, centred round Gape and Bill-clashing, because female tends not to fly away. Female three times as active as male. In female, conflict between attraction to mate and fear generally resolved by Bill-clashing. Female still sometimes departs, followed by male in synchronized flight. Level 4 displays less complex and consist only of Bill-clashing and Skycalls (given alternately or overlapping), and Preening and Mutual Preening. Pair-bond established. In new partners, Level 4 not observed earlier than year preceding breeding (Jouventin & Weimerskirch 1984). Level 4 also only level observed between partners of established breeding pairs. Displays during establishment of pair-bond do not progress linearly from Level 1 to Level 4, but rather in loops during sessions with frequent returns to lower levels. COPULATION occurs 14.0 days before laying (5.9; 1-30; 63) (Jouventin & Weimerskirch 1984).

RELATIONS WITHIN FAMILY GROUP During pre-breeding period, male spends nearly ten times as long at nest-site as female. Incubation, brooding and feeding of chicks shared equally by both sexes. Chicks independent of parents after fledging.

VOICE No detailed studies; descriptions from Marion I. (Berruti 1981) and Iles Crozet (Jouventin & Weimerskirch 1984). Silent at sea (A. Berruti) except Threat Call while feed-
ing which is rare as birds mainly feed alone (J-C. Stahl). Calling
restricted to breeding periods and mainly to nest-site; usually
only during day (A. Berruti). Calls similar to those of Light-
mantled Sooty Albatross. Sexual differences: Sky-calling of male
longer than that of female; also individual differences in form
and number of harmonics (Jouventin & Weimerskirch 1984).
No geographical variation reported. Non-vocal sounds: clicking
sounds when bills make contact during Bill-clashing.

ADULT Sky-calling. A characteristic two-syllable call
given during Sky-calling Display. A loud expository syllable,
initially shrill but becoming more trumpet-like, given with
head and bill pointed vertically; bird then utters quiet nasal
inspiratory syllable as head and bill are lowered; first syllable
louder and longer than second. At Iles Crozet, duration of
expository syllable 1.30 s (0.12; 1.10-1.47; 9) for males, 1.03 s
(0.13; 0.85-1.20; 9) for females (Jouventin & Weimerskirch
1984). Calls given by sitting birds noticeably softer. Sound of
call reflected in common names Piew, Pea-arr, Pio. Members of
a pair often duet with alternate or overlapping calls (Berruti
1981; Jouventin et al. 1981). Sky-calling is an integral part of
the display (see Social Behaviour); used in mate attraction, indi-
vidual recognition and sometimes in agonistic actions. Threat
Call. Harsh, throaty gaaau, similar to that of Light-mantled
Sooty Albatross.

YOUNG Begging Call and gulping noise when
threatened similar to that of Light-mantled Sooty Albatross.

BREEDING Fairly well known. Detailed studies on
Marion I. (Berruti 1979a) and Iles Crozet (Jouventin &
Weimerskirch 1984; Weimerskirch et al. 1986); extralim-inally
and partially on Tristan da Cunha, Gough I. and Ile Amster-
dam (Elliott 1957; Hagen 1952; Swales 1965; Richardson
1984; Segonzac 1972). Information supplied by A. Berruti,
J-C. Stahl. Breeds colonially on steep slopes of coastal cliffs and
inland cliffs, in association with Light-mantled Sooty Albat-
ross on Price Edward Is and Iles Kerguelen, to some extent
with Sooty, Grey-headed Diomedea chryosotoma and Black-
browed D. melanophris Albatrosses on Iles Crozet, and with
Yellow-nosed Albatross D. chlororhynchos on Tristan da
Cunha.

SEASON Broadly from mid-July to early Sept.
through to May to mid-June according to locality. At Marion
I. and Iles Crozet, first arrivals mid-Aug. At Iles Crozet, breed-
ing males arrive first (mean 16 Sept.; 5 days; 3-26 Sept.; 37),
breeding females later (mean 21 Sept.; 6 days; 10 Sept. -2 Oct.;
34); immatures (<7 years old) in Dec. onwards (Jouventin &
Weimerskirch 1984). No pre-laying exodus. At Iles Crozet,
males at nest-site for 15.5 days (5.7; 2-24; 39) pre-laying only
1.8 days (1.1; 0-5; 38); laying, 7 Oct. (30 Sept.; 16 Oct.;
109) (Jouventin & Weimerskirch 1984). At Marion I., laying
finished by 14 Oct. (Berruti 1979a). At Tristan da Cunha,
most eggs laid 2-4 Oct. (Richardson 1984). Fledging, with
immediate departure of successful breeders: at Marion I., Apr.
(Rand 1954) to late May (Berruti 1979a); at Iles Crozet, 31 May
(9 days; 11 May-15 June; 31) (Jouventin & Weimerskirch
1984). Failed breeders leave at once; latest non-breeders
(occasionally) leave in June (Berruti 1979a; Jouventin &

SITE On vegetated ledge on cliff or steep slope, with
drop of ≥3 m in front; often on areas of grey lava at Marion I.;
a few to 100s m asl. Coastally at Marion I., Iles St Paul and
Crozet; also inland at Tristan da Cunha and Gough I. and only
inland at Ile Amsterdam. Usually in groups of up to 50-60,
occa.sionally singly, density depending on terrain; at three col-
onies on Marion I., 94% of nests had two or more nests within
3 m. At Iles Crozet, 74% of previous nests (n=142) re-used
next season but 94.3% of breeding pairs (n=145) returned to
same locality. Site selected by male (Jouventin & Weimers-
kirch 1984).

NEST MATERIALS Low mound of mud mixed with
plant material; cup lined mostly with grass; 35-40 cm
wide at base, 10-20 cm high, with inner cup 6-8 cm deep
(Hagen 1952). Both sexes build by sitting on nest, collecting
earth, vegetation within reach, adding to sides of mound; by
shifting round, mound is formed on all sides. Old nests, even
overgrown with short vegetation, may be renovated at start of
season.

EGGS Oval, broader at one end; coarse-shelled, not
glossy; white with reddish brown speckles at broad end.

MEASUREMENTS:
Marion I.: 103.1 (3.1; 96.0-110.7; 67) x 65.1 (1.8; 59.3-68.7)
Iles Crozet: 101.8 (3.2; 95-108; 74) x 65.3 (2.1; 59-69.5)
Tristan da Cunha: 101.7 (2.9; 93.6-196.2; 40) x 65.2 (2.1; 58.9-69.7)
Gough I.: 102.2 (4.6; 91.7-110.8; 26) x 64.8 (2.6; 60.0-71.4)

WEIGHTS:
Marion I.: 243 (14.1; 204-270; 31) or c. 9.6% ad. mass
Iles Crozet: 227 (17.7; 185-265; 74)
Tristan da Cunha: 240 (16; 216-274; 40)

CLUTCH-SIZE One. No replacement laying.

LAYING Synchronized (for dates, see above). At Iles
Crozet, no significant difference in three seasons (Jouventin &
Weimerskirch 1984). Breed once in 2 years. At Iles Crozet,
successful breeders (n=72) all laid again in second year after
success; of failed breeders (n=176), 89.2% laid again next year,
9.7% in second year after failure and 1.1% in third year
(Weimerskirch 1982).

INCUBATION By both sexes in alternate shifts. At
Marion I., female took first shift; total number of shifts, 6-9;
male’s share 47% in 3-4 shifts, each 2-17 days long; female’s,
53% in 3-5 shifts, each 3-17 days long; female’s third shift
longest on average but second and fifth almost equally long;
shifts shorter as hatching approached. Eggs that failed to
hatch incubated for 10-12 shifts. At Iles Crozet, 6-10 shifts,
lasting 1-21 days; male’s share 49.2%; female’s, 50.8%; fe-
nale’s third shift longest, 12.6 days (3.9; 6-21; 13) (Jouventin
& Weimerskirch 1984; Weimerskirch et al. 1986). INCUBA-
TION PERIOD: at Marion I., 70.1 (1.8; 69-73; 15); at Iles
Crozet, 70.7 (1.5; 65-75; 40) days.

YOUNG Semi-altricial, nidicolous. Pipping of egg
to emergence, 4.2 days (3-6). At Marion I., brooded continu-
ously by both parents in alternate shifts; total number of shifts,
6-11, each 1-4 days long. Brood-stage lasts 21 days (2.1;
17-28; 23), almost equally shared by sexes. At Iles Crozet,
mean length of brood-stage 21.3 days (2.4; 16-28; 42), equally
shared by sexes; mean length of shifts 2.3 (1.0; 1-6; 181)
(Weimerskirch et al. 1986). NESTLING PERIOD: Marion I.,
149-163 days (n=6); at Iles Crozet, 164 d (9; 145-178; 28). Chick
fed by both parents at an average interval of 2.3 days, appar-
ently only during daytime, at least after brood-stage; fed by incom-
plete regurgitation. If threatened, chick regurgitates oil at
intruder. Fed less often as fledging approaches but not aban-
GROWTH  Weight of one chick at hatching, 240 g (Richardson 1984). At Marion I., peak weight, c. 112% of adult mass at 100 days old, declining to fledging at 2274 (148.7; 2050-2420; 5) (Berruti 1979a). At Iles Crozet, maximum weight 115% of adult mass; mean daily gain from 8-68 days old (or between 10 and 90% of maximum weight), 37g/day (Weimerskirch et al. 1986).

FLEDGING TO MATURITY  Independent of parents on fledging. First return to land at 8.4 years old (2.3; 5-14; 63). Pair-bond established after 3.4 years old (2.0; 17) (Jouventin & Weimerskirch 1984). First breeding at 11.9 years old (1.5; 9-15; 22). At Iles Crozet, survival of immatures from fledging to first breeding attempt at 9 years old, 51%; mean annual survival of adults, 1975-82, 95% (n=185) with no significant variation annually (Weimerskirch et al. 1987).

SUCCESS  At Marion I., for one season 13% (61 eggs laid, 35 hatched, 8 chicks fledged); for next, 25%; determined from three colonies only in both seasons but, in first, success probably better (possibly 35%) for all colonies on Island. In first season, losses: of eggs: six (9.8%) infertile, 20 (32.7%) lost, probably after desertion; of nestlings: five (14.3%) starved or diseased, 18 (15.4%) lost, probably after desertion. At Iles Crozet, for seven seasons, mean total success 42.1% (12.3-60.2; 50.1% (31.7-70.2) eggs hatched, 50.1% (31.7-70.2) chicks fledged. Total breeding success increased with age: for birds <15 years old, 28.1% (n=32); >15 years old, 42.4% (n=171) (Jouventin & Weimerskirch 1984). Average chicks fledged/pair/year, 0.26 (Weimerskirch et al. 1987). Chief losses caused by local mass desertions in parts of colonies for unknown reasons, occurring throughout incubation and brood-stage, followed by predation of chicks by skuas and sheathbills (Jouventin & Weimerskirch 1984).

MOULTS  Largely undescribed. 

ADULT  In 234 breeding and non-breeding birds, during Oct.-June, one replacement of ‘wing feather’ and tail feather (see Berruti 1979a for full details). Wing and tail moult occurs at sea; moult may start late in breeding cycle and reach completion early in following breeding cycle (Berruti 1979a). Primaries probably moulted in staffmouler. Moult strategy presumably similar to that of Yellow-nosed Albatross (see Furness 1988 for details).

MOULTS  Largely undescribed.

JUVENILE  Similar to adult, but wear of head and neck feathers exposes bases of feathers, producing light grey-brown (119D) nape and lower neck. Rachis of tail and primaries, dark brown (Watson 1975; Berruti 1979b).

MEASUREMENTS  Live birds: (1) Marion I., adults; methods unknown. BILL D = bill depth at gonys (Berruti 1979a); (2) Iles Crozet; methods unknown (Jouventin & Weimerskirch 1984).

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<th>FEMALES</th>
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<tr>
<td>BILL</td>
<td>523.6 (12.02; 490-540; 19)</td>
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<tr>
<td>BILL D</td>
<td>114.9 (1.8; 112.4-116.5; 5)</td>
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<td>TARSUS</td>
<td>263.3 (2.72; 109-117; 20)</td>
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<td>TAIL</td>
<td>275.0 (4.5; 269-280; 5)</td>
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Unsexed birds: (3) Marion I., adults; sexes combined (Berruti 1979a)

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<tr>
<td>WING</td>
<td>516.5 (12.9; 490-551; 101)</td>
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<tr>
<td>BILL</td>
<td>112.1 (3.5; 99.9-120.2; 212)</td>
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<tr>
<td>BILL D</td>
<td>27.0 (1.0; 198)</td>
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<tr>
<td>TARSUS</td>
<td>82.7 (2.3; 77.5-90.0; 212)</td>
</tr>
<tr>
<td>TAIL</td>
<td>265.5 (10.6; 245-294; 118)</td>
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WEIGHTS

(1) Marion I., adults, Oct.-June (Berruti 1979a); (2) Iles Crozet (Jouventin & Weimerskirch 1984).

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<tr>
<td>(1) 2600 (200, 2300-2700; 5)</td>
<td>2400 (200, 2300-2600; 4)</td>
</tr>
<tr>
<td>(1) Sexes combined: 2500 (200; 2100-3400; 176)</td>
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<tr>
<td>(2) 2730 (330; 2200-3250; 18)</td>
<td>2440 (250; 2100-2800; 12)</td>
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</table>

At Marion I., breeding birds significantly heavier than non-breeding birds (Berruti 1979a; A. Berruti).

SEXING, AGEING

Discriminant function analysis of 203 unsexed and nine sexed birds was unable to separate sexes (Berruti 1979a).

REFERENCES

Goodall, J.D., A.W. Johnson & R.A. Philippi. 1951. Las Aves de Chile, 2.

Volume 1 (Part A), Plate 23

Sooty Albatross, Phoebetria fusca
1. Adult, ventral, fresh
2. Adult, dorsal, fresh
3. Adult, dorsal, worn
4. Adult, ventral, worn
5. Adult, head
6. Juvenile, head

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