

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 Pelecaniiformes. 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 liable 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 may be endangering species such as the great albatrosses.

All species feed at sea on a variety of fish, cephalopods and small marine invertebrates, either socially or alone; larger species may scavenge all sorts of offal or prey on other birds. Most, except perhaps *Pelecanoides*, can digest the complex lipids formed by some marine animals (Clarke & Prince 1976), and may eject them to soil the plumage of their enemies with lethal results (Swennen 1974). Some species can digest wax (Obst 1986). Many now take wastes from whaling and fishing operations (Fisher 1952). All have long life-cycles in proportion to their size; they disperse on fledging and then prospect for nest-sites for 2–12 years in their youth. They usually lay a single large white egg annually; though a successful breeding cycle may be completed in less than a year in at least one tropical species, *Puffinus lherminieri*, it may take 2 years in larger southern ones. Before laying, the birds court for weeks or months, then go to sea for feeding. Incubation lasts 6–8 weeks, and fledging 2–9 months. Once the fat chick fledges it fends for itself, even in species that immediately make a long migration, sometimes to the opposite hemisphere.

Tendency for failed 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: Diomedidae or large to huge aerial 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.

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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 A'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 *Diomedea*.

(3) The sooty albatrosses *Phoebastria*. 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, p10 longest, p11 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 separable but mostly not very different from adults except in *D. exulans* and *D. 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.

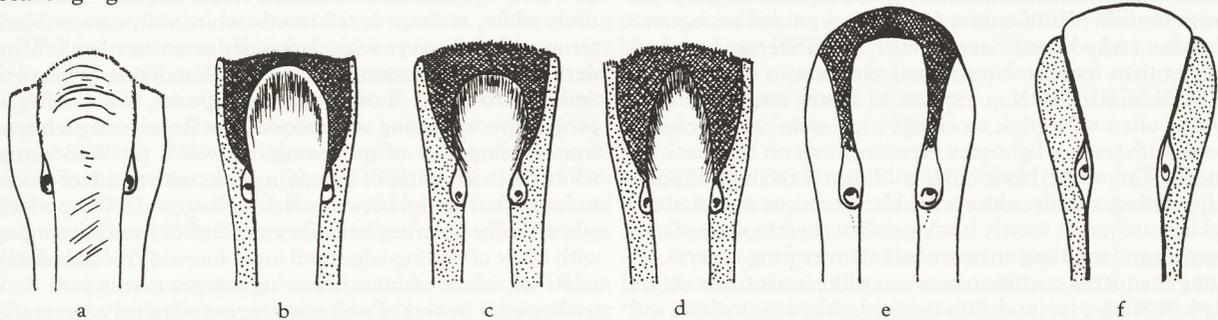


Fig. 1 Dorsal view of base of bill of small *Diomedea*

Fig. 1a Black-browed Albatross *D. melanoprys*

Fig. 1b Grey-headed Albatross *D. chrysostoma*

Fig. 1c Yellow-nosed Albatross, *D. chlorohynchos*, subspecies *chlorohynchos*

Fig. 1d Yellow-nosed Albatross, *D. chlorohynchos*, subspecies *bassi*

Fig. 1e Shy Albatross *D. cauta*

Fig. 1f Buller's Albatross *D. bulleri*

Long-lasting monogamous pair-bond. Breed colonially, pairs often returning to same site. Defend small 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

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Diomedea melanophrys Black-browed Albatross

COLOUR PLATE FACING PAGE 296

Diomedea melanophris Temminck, 1828, *Planches col. Oiseaux* 77: Pl. 456 and text; corrected to *melanophrys* Temminck, 1839, *Planches col. Oiseaux* 102: 76 — Cape of Good Hope.

The specific name is translated by the English epithet (μέλας, μέλανος black, + φρύς a brow) and refers to that physical feature of the bird.

OTHER ENGLISH NAMES Black-browed Mollymawk.

Although the name mollymawk is established in NZ and among seafarers for medium-sized white albatrosses, it is not adopted here because it is not likely to become accepted internationally; it has not always been used consistently and certainly albatross is the only name for these birds familiar to most English and American ornithologists. Mollymawk is a corruption of 'mallemuck', adopted from the Dutch *mal* (foolish) + *mok* (gull), and was the name given to the Northern Fulmar *Fulmarus glacialis*.

POLYTYPIC Nominate *melanophrys* breeds Iles Crozet, Kerguelen, Heard, Macquarie, Antipodes Is, islands off s. South America, Falkland Is and S. Georgia; *impavida* (Mathews, 1912) Campbell I., NZ.

FIELD IDENTIFICATION Length 80–95; wingspan 210–250; weight 3–5 kg. Medium-sized albatross of s. oceans, very similar in size and shape to Grey-headed Albatross *D. chrysostoma*. Adult has distinctive combination of white head with neat black brow, bright yellow-orange bill and broad black leading-edge on underwing (broadest behind elbow, forming dark wedge midway along innerwing). Two subspecies, separable in field. Sexes alike. No seasonal changes. Juveniles and immatures separable.

DESCRIPTION Nominate *melanophrys*. **ADULT.** Head and neck, white with neat black brow over and behind eye, giving frowning look; thin white crescent behind and below eye. Mantle, back and scapulars, blackish, with greyish bloom when fresh. Upperwings, uniform blackish; white bases of outer primary shafts visible. Rump and upper tail-coverts, white; tail, grey becoming darker with wear. Underwing, white with black tip (wholly blackish primaries), narrow black trailing-edge (blackish tips of secondaries), and broad black leading-edge about one-third width of wing,

narrowest at carpal joint; thicker towards body, broadening abruptly at elbow to form dark wedge midway along innerwing; a few short black streaks jut off wedge, giving fuzzy appearance; leading-edge broadens outside carpal joint, with black streaks radiating across white median primary coverts. Bill, bright yellow-orange with brighter rosy-pink tip; thin strip of skin round base of bill, black; cheek-stripe (exposed during display), orange. Iris, dark brown. Legs and feet, bluish white. **JUVENILE.** Head and neck, white except for greyish black brow (slightly paler, narrower and more diffuse in front of eye than on adult) and pronounced greyish-brown collar tapering from hindneck to midline of foreneck; varying smudgy pale greyish-brown wash extends from collar onto nape, crown, forehead, rear of ear-coverts, sides of neck and lower throat; on darkest birds, wash and collar can give hooded appearance, especially on bird flying away in dull light, but collar, always much darker than wash; wash lost through wear. Greyish brown of hindneck merges into greyish black mantle. Rest of upperparts and underbody, as adult.

Underwing, blackish with diffuse greyish-white stripe down centre of innerwing and, on some, discrete greyish white patch in centre of wing-pit. Bill, dark olive-brown with contrasting black tip; narrow pale band separates dark tip from rest of bill; blackish saddle over culminicorn extending onto latericorns; cheek-stripe, black. Iris, dark brown. Legs and feet, dark grey. Juvenile appearance retained for first year or more, during which collar may become narrower, smudgy and incomplete; tip of bill remains black but base may become paler brownish-horn with dark saddle still showing. **IMMATURE.** Changes in plumage and colour of bill with age not fully understood; youngest immatures retain partial collar of juvenile but show immature characters as below. Plumage gradually becomes more like adult but differs by: (1) black margins of underwing slightly broader and less sharply demarcated from white central stripe (because of greyish-black tips to coverts bordering stripe); blackish streaks across white median primary coverts heavier; series of bold blackish streaks (greyish-black outer webs of subhumeral) run off elbow-wedge across white central stripe to join dark trailing-edge, giving messier wing-pit. Gradually lose dark tips to coverts bordering stripe, then streaking on subhumeral, till adult pattern attained. (2) Colour of bill gradually develops from that of juvenile; at first, base paler yellowish horn with contrasting black tip; later, base dull yellow-orange and black reduced to dusky subterminal band. Full adult plumage attained before bill-colour definitive; thus older immatures often recognizable from adult only by slightly duller yellow-orange bill, with some dusky shadowing on base of unguis.

D.m. impavida. **ADULT.** Differs from nominate by (1) heavier black brow (more extensive in front of eye) and honey-coloured (not dark-brown) iris; (2) slightly broader black leading-edge on underwing; (3) series of bold dark streaks (formed by greyish black subhumeral) run off elbow (nearly reaching trailing-edge) and extend inwards to base of wing, isolating white patch (formed by white subhumeral coverts) in centre of wing-pit. Most juveniles have darker underwings than nominate; best distinguished by extent of brow and colour of iris though many juvenile *impavida* not safely separable as iris dark and brow little different. Immatures readily distinguished by heavier black brow and developing pale iris; underwings usually darker.

SIMILAR SPECIES Adult readily distinguished from other small albatrosses by white head, neat black brow, bright yellow-orange bill and underwing broadly and irregularly margined black (leading edge broadest of any small albatross). Immatures, by brownish, yellowish or dull-orange bill, with contrasting black tip, and by broad irregular black margins of underwing. Juveniles, by white head, dark brow, pronounced greyish-brown collar, dark olive-brown bill with contrasting black tip, and mostly dark underwing. Juveniles can be confused with Grey-headed Albatross; *q.v.* for distinctions.

Circumpolar in broad range of marine habitats; from pelagic to shelf-break waters, also ranging well inshore over continental shelf and entering bays and harbours; commonly seen from land; largest concentrations occur over rises along shelf-break and over outer shelf. Flight in strong winds, effortless and graceful, wheeling in broad arcs well above horizon and soaring on stiff, almost motionless wings; flap more in light winds but in calms tend to sit on water. When taking flight, patter along surface, flapping vigorously till well clear of waves. Feed by surface-seizing, occasionally by surface-plunging, pursuit-plunging and surface-diving. Associate

with cetaceans and join in mixed feeding flocks of other seabirds. Solitary or gregarious at sea; attend trawlers in large numbers, with much squabbling for trawl waste. Habitually follow ships. Breed colonially on well-vegetated Antarctic and subantarctic islands. Usually silent at sea, except when quarrelling over food. Noisy at colonies, giving variety of calls.

HABITAT Marine; in Antarctic, subantarctic and subtropical waters. In Antarctic, occur through belt of icebergs to edge of consolidated pack-ice (Murphy; Falla 1937; Hicks 1973); do not penetrate pack, perhaps because ice inhibits soaring by dampening sea swells (Ainley *et al.* 1984). Tolerate sea surface-temperatures from 0 to 24 °C (Bierman & Voous 1950; Rand 1963; Jehl 1973; Brown *et al.* 1975; Grindley 1981); but mainly subantarctic (Jehl 1973; Brown *et al.* 1975; Johnstone & Kerry 1976); in Dec., S limit in Ross Sea at 1.0 °C isotherm; in Jan. at 0.0 °C isotherm (Ainley *et al.* 1984). Salinity preferences poorly known; in Chilean fiords, concentrate over areas of high salinity (Brown *et al.* 1975); birds seen feeding on freshwater lake, Tierra del Fuego (Stiles 1974). In breeding and non-breeding seasons, specialized shelf-feeders; concentrate round breeding islands or over adjacent submarine banks (Weimerskirch *et al.* 1986; Weimerskirch *et al.* 1988). In winter, in coastal waters of continents, over upwellings or boundaries of currents (Cooke & Mills 1972; Brown *et al.* 1975; Weimerskirch *et al.* 1985). Common inshore; shelter in harbours, bays, fiords and channels (Murphy; Bailey & Sorensen 1962; Jehl 1973; Swanson 1973). Gather at sewage outfalls (Gibson & Sefton 1955). Rarely fly over land except on breeding islands, but birds reached lake in Tierra del Fuego 35 km from nearest sea (Stiles 1974).

Breed on subantarctic and Antarctic islands. Breeding populations at particular islands may be limited by area of shelf available for feeding (Weimerskirch *et al.* 1986). Nest on tussock-covered ledges and terraces of cliffs, slopes and hills, overlooking sea or valleys; also summits of rocky islets (Downes *et al.* 1959; Bailey & Sorensen 1962; MacKenzie 1968; Weimerskirch *et al.* 1986). Generally prefer steep rocky broken terrain, but in Falkland Is, use low-lying flat islands (Prince 1982).

Fly low to moderately high, using updraft from wave fronts for lift. Take food from sea surface or just below, occasionally plunging from heights of up to 9 m (Prince 1980; Voisin 1982; Harper 1987). Reach depths of 2–4 m when taking offal (Nicholls 1979; Oatley 1979).

Nesting failure at Campbell I. attributed to disturbance by feral sheep attracted to lush vegetation round colony (Bailey & Sorensen 1962). Accompany fishing boats, and recent increase in sightings at Signy I. may reflect intensification of fishing operations close to island (Rootes 1988).

DISTRIBUTION AND POPULATION Nominate race circumpolar; *impavida* restricted to South Pacific, se. Aust. waters, A'asian sector of Southern Ocean and Ross Sea. Breed on subantarctic and n. Antarctic islands between 46° and 56°S.

During summer, mostly subantarctic and Antarctic waters. Most widespread sw. Atlantic 37–46°S (Ozawa 1967; Tickell & Woods 1972; Zink 1981b; Thurston 1982); se. Indian Ocean, 39–66°S (Falla 1937; van Oordt & Kruijt 1954; Ozawa 1967; Johnstone & Kerry 1976; Mochizuki & Kasuga 1985); NZ sector and Ross Sea, 43–70°S (Dell 1960; Ozawa *et al.* 1968; Robertson & Jenkins 1981; Ainley *et al.* 1984; McQuaid & Ricketts 1984). Range more restricted elsewhere:

se. Atlantic, 42–56°S (Ozawa 1967); sw. Indian Ocean 40–55°S, where uncommon outside shelves and area of Subtropical Convergence (Jouventin *et al.* 1982; Weimerskirch *et al.* 1986); se. Pacific, 56–69°S (Gain 1914; Ozawa 1967; Zink 1981a). Rare S of Africa (Flora 1981; McQuaid & Ricketts 1984) and central South Pacific between 90 and 170°W (Dixon 1933; Holgersen 1957). Also Humboldt Current N to 32°S where not uncommon (Paessler 1914; Murphy), and present South African and s. Aust. waters, but numbers much reduced compared to rest of year (Brooke & Sinclair 1978; Aust. Atlas).

From late autumn to spring, range farther N. In May–Aug., very rare in oceanic waters of South Atlantic and s. Indian Ocean (Rand 1963; Tickell & Woods 1972; Hansen 1978; J.-C. Stahl), but numbers increase in Sept.; range in spring, South Atlantic, 35–49°S (Tickell & Woods 1972), s. Indian Ocean, 36–54°S (Duhamel 1981; Jouventin *et al.* 1982). In Tasman Sea and sw. Pacific, in subtropical waters N to 26°S even in mid-winter (Summerhayes 1969), and recoveries N to Fiji (Clunie *et al.* 1978). Autumn and winter distribution in central and e. South Pacific unknown, except for recoveries in Tuamotus (Holyoak & Thibault 1984) and observations at Pitcairn I. (Williams 1960), and possibly near Equator (Bourne 1967); in Sept., 42–56°S (Szijj 1967). Concentrate on continental shelves and slopes. South Africa, N to 15°S along w. coast, maximum abundance June–July (Sladen *et al.* 1968; Summerhayes *et al.* 1974; Liversidge & Le Gras 1981). Aust., N to 28°S along w. coast (Aust. Atlas), to 24°S along e. coast (Amiet 1958), most abundant SE and Tas. (Aust. Atlas); peak numbers s. Aust. May–Oct. (Cox 1973), NSW, May–June and Oct.–Nov. (Barton 1979), Burrewarra Pt, July–Aug. (Marchant 1977), Sept. (Milledge 1977). NZ subtropical shelf waters N of 46–48°S (Robertson & Jenkins 1981; J.A. Bartle), peak numbers Cook Str., July–Aug. (Secker 1969). Humboldt Current to 2°20'S (Paessler 1911; Murphy; Harris 1968). E. South American shelf to 20°S off Brazil (Paessler 1914), flocks of up to 10 000, c. 39°S (Jehl 1974).

Accidental n. Brazil to 2°S (Sladen *et al.* 1968), South Atlantic, N to 11°S (Bourne & Radford 1961), Kenya (Bednall

1956), ne. Madagascar (Tickell 1976), Réunion and Rodrigues (Staub 1976). N. hemisphere: Hawaii (King 1970), Martinique (one record), N. Carolina (two), Massachusetts (two), Greenland (one), Iceland (one), Spitsbergen (one), Faeroe Is (two, one present for 34 years), Norway (one). Thirteen records Britain and Ireland to 1968, regular observations of single individuals since 1969 (BWP).

Immatures have more restricted oceanic range during summer: only lower latitudes of South Atlantic (Murphy); s. Indian Ocean 42–50°S avoiding shelves (Jouventin *et al.* 1982; Stahl 1987); Ross Sea (Ainley *et al.* 1984), se. Pacific (Holgersen 1957). Common on continental shelves and Humboldt Current throughout year; predominant late spring-early autumn, but outnumbered by adults in winter NZ (J.A. Bartle), Argentinian shelf (Jehl 1974), off w. South America S of 33°S (Jehl 1973); dominant throughout year off Namibia (Summerhayes *et al.* 1974) and se. Africa (Liversidge & Le Gras 1981).

D.m. impavida ranges e. Aust. waters W to 134°E (Aust. Atlas; D.W. Eades); one record Indian Ocean, 38°05'S 99°29'E (D.W. Eades); Tasman Sea (Johnstone & Kerry 1976), A'asian sector of Southern Ocean and Ross Sea W to 133°E, S to at least 68°S (van Oordt & Kruijt 1954; J.A. Bartle), South Pacific from New Caledonia to Marquesas.

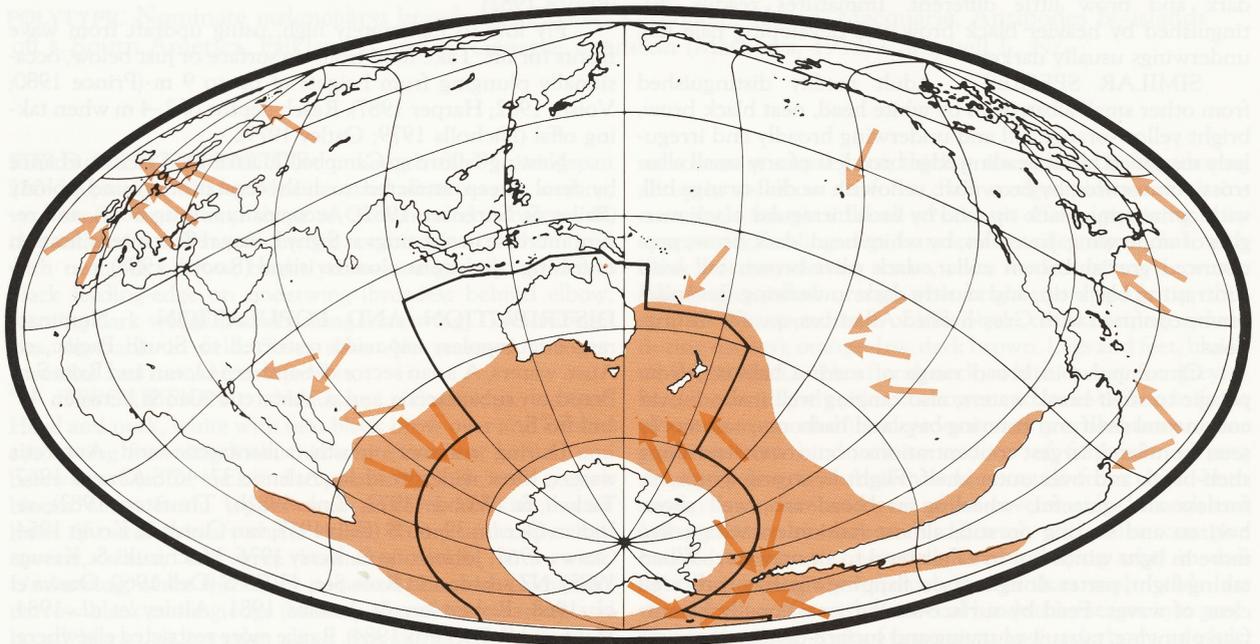
BREEDING, POPULATION

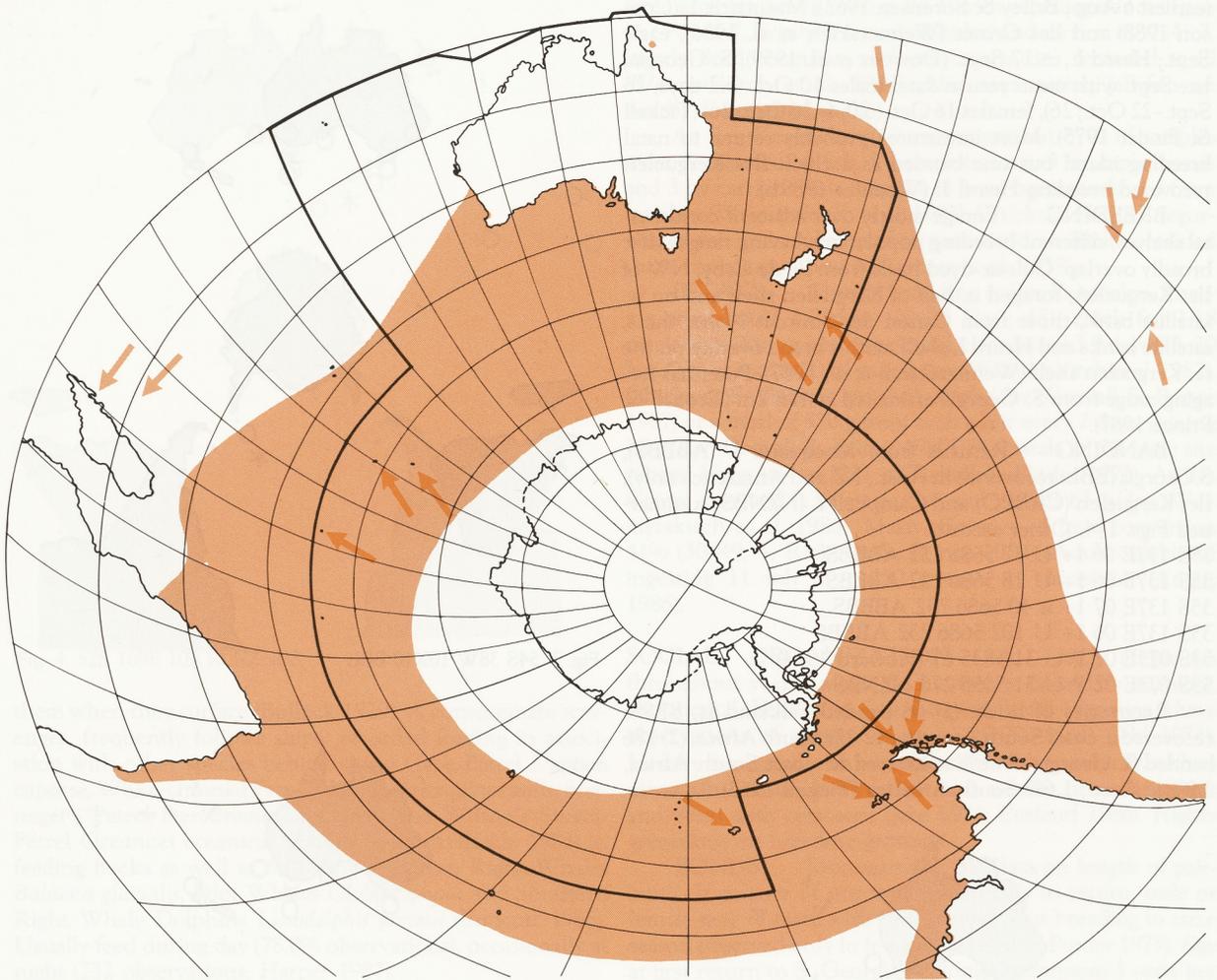
Summarized below. Populations on Iles Kerguelen decreasing: in one colony from 1200 pairs in 1978 to 905 pairs in 1987 (Weimerskirch *et al.* 1989); decrease probably due to losses of adults caused by fishing operations on Kerguelen shelf (Weimerskirch *et al.* 1987). Decrease reported also for Chilean populations (Schlatter 1984). Long-line fishing potential threat (J.A. Bartle). Population on Heard I. increased from 220 pairs 1947–54 (Downes *et al.* 1959) to 600–700 pairs in 1986–87 (Woehler 1989a). First breeding at Macquarie recorded 1949–50 (Copson 1988).

Known breeding localities:

Iles Crozet: 1981–86, 880 pairs (Jouventin *et al.* 1984; Jouventin 1990)

Iles Kerguelen: 1984–87, 3115–3215 pairs (Weimers-





kirch *et al.* 1989)

- Heard I.: 1986-87, 600-700 pairs (Woehler 1989a)
- Macquarie I.: 1977-85, 600-700 pairs (Copson 1988)
- Antipodes I.: <1985, c. 150 pairs (NZRD)
- Campbell I.: 1975-76, 74 825 pairs (Robertson 1980)
- S. Georgia: 1970-76, 65 000 pairs (Prince & Payne 1979)

Extralimittally: Chile (Diego de Almagro, Evout, Ildefonso, Diego Ramirez Is), Argentina (Isla de los Estados), Falkland Is. Total population, possibly 5×10^5 pairs.

MOVEMENTS Migratory from breeding colonies to continental shelf waters of Aust., NZ, South Africa and South America with wintering areas for different breeding colonies largely discrete.

DEPARTURE Young fledge: Falkland Is, early Apr. (Tickell 1966); Macquarie I. (Copson 1988) and Campbell I. (Bailey & Sorensen 1962), mid-Apr. with last birds leaving Campbell I., early May; mean fledging date Bird I., S. Georgia, 28 Apr. (15 Apr.-9 May; 6 years) (Tickell & Pinder 1975). Adults apparently leave colonies at about same time as young.

NON-BREEDING Movement generally N with many N of Subtropical Convergence in winter (Jouventin *et*

al. 1982). Most birds from Iles Kerguelen winter off s. Aust., a few travelling to NZ or South Africa (see Banding, Fig. 2.; Weimerskirch *et al.* 1985; six sightings of dyed birds off s. Aust.; Weimerskirch *et al.* 1987); those from Falkland Is off e. coast South America; most from S. Georgia off w. coast South Africa (Tickell 1966) though many recovered from Aust. and NZ more recently (Banding, Fig. 2); those from Macquarie I. off s. Aust. (Banding, Fig. 1). Peak numbers occur Apr.-Sept. round Tas. (D.W. Eades), off NSW, where mostly immatures (Milledge 1977), and off Stradbroke I., se. Qld (Smyth & Corben 1984). Birds from Campbell I. disperse through sw. Pacific and across s. Aust. waters (see Banding, Fig. 4). Off se. NSW, mostly absent Jan.-Feb. with highest numbers, May-July and Oct.-Nov. (Barton 1979); off Sydney, central NSW, present only May-Sept. where considered regular winter and spring visitor (Milledge 1977); off Vic. and Tas., most common Mar.-June (D.W. Eades); small numbers reach SA waters (Close 1982) and a recovery (NZNBS) and a sighting off sw. Aust. (D.W. Eades). Peak of recoveries of beachcast *melanophrys* in NZ, Apr.-Sept. and Dec.-Jan., the first coinciding with fledging of young, the second with departure of non-breeders from subantarctic colonies during summer (Powlesland 1985).

RETURN Arrive at Campbell I., mid-late Aug.

(earliest 6 Aug.; Bailey & Sorensen 1962); Macquarie I. (Copson 1988) and Iles Crozet (Weimerskich *et al.* 1986), early Sept.; Heard I., ≤ 17 Sept. (Downes *et al.* 1959); S. Georgia, late Sept. with mean return date: males 10 Oct. (5.2 days; 26 Sept.–22 Oct.; 26), females 16 Oct. (6.0; 6–26 Oct.; 26) (Tickell & Pinder 1975). Most immatures probably return to natal breeding island but one banded as a chick Iles Kerguelen recovered breeding Heard I. (Woehler 1989b).

BREEDING Forage mostly over adjacent continental shelves, different breeding populations having ranges that broadly overlap. Colour-dyed birds from Ile de Croy, NW of Iles Kerguelen, foraged n. half of Kerguelen shelf and on w. satellite bank, those from Canon des Sourcils Noirs, the s. satellite banks and Heard I. shelf, with a broad overlap on the se. Kerguelen shelf (Weimerskirch *et al.* 1987). Potential foraging range from S. Georgia estimated at 428 km (Croxall & Prince 1987).

BANDING Returns from Macquarie I. (ABBBS), S. Georgia (BBL: recoveries in Aust., NZ and Antarctica only), Iles Kerguelen (CRBPO) and Campbell I. (NZNBS) summarized Figs. 1–4. Other records:

35S 137E 06 1+ U 17 5686 232 ABBBS
 35S 137E 06 1+ U 18 5686 232 ABBBS
 35S 137E 07 1+ u 40 5686 232 ABBBS
 35S 137E 06 1+ U 102 5686 232 ABBBS
 53S 073E 02 P U 31 5835 67 (Howard 1954)
 53S 073E 02 P U 31 5058 270 NZNBS

Recoveries of birds: (1) 66 banded Falkland Is, 87.9% recovered e. coast South America, 12.1% South Africa; (2) 186 banded S. Georgia: 94.6% recovered w. coast South Africa, 3.8% s. Aust., 1.6% South America (Tickell 1966).

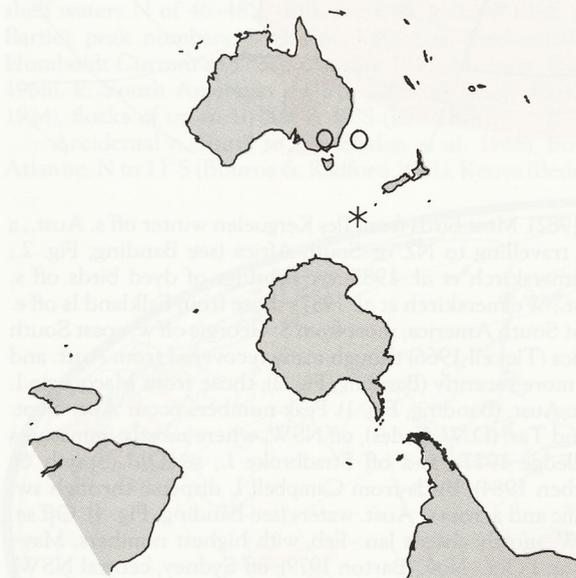


Fig. 1. 54S 158E 10X10 ABBBS

FOOD Krill and fish with some cephalopods, salps and jellyfish; an enthusiastic scavenger. **BEHAVIOUR.** Most prey taken by surface-seizing; also by pursuit-plunging, surface-plunging and surface-diving (Harper *et al.* 1985); of quantified observations surface-seizing 98%, surface-plunging 2%, pursuit-diving <1% (232 observations; Harper 1987); surface-seizing 100% (n=3; Ainley & Boekelheide 1983). On four occasions seen to plunge from 2–5 m, opening wings just

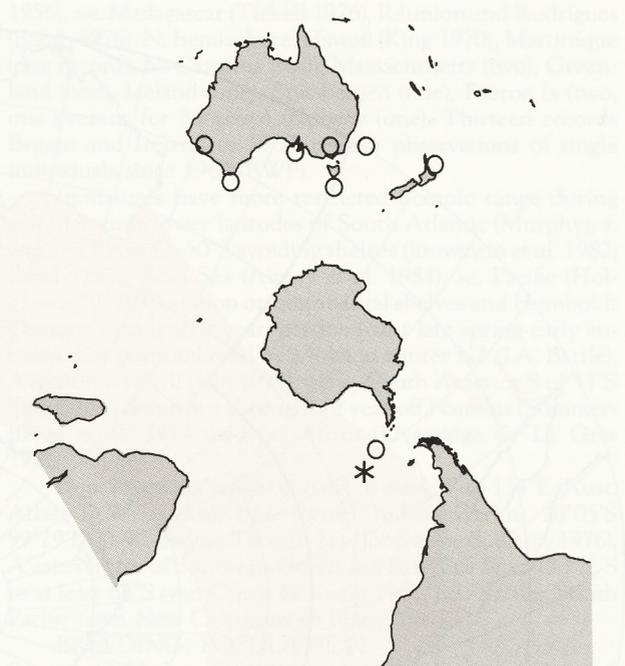


Fig. 2. 54S 38W 10X10 BBL

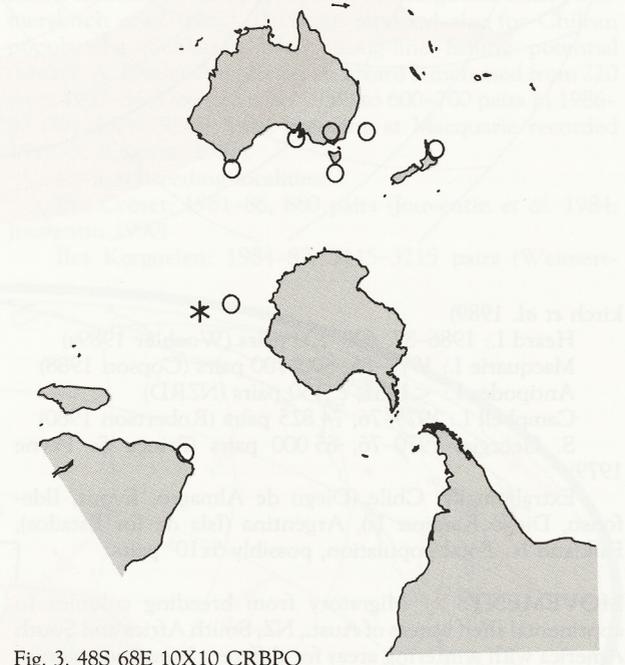


Fig. 3. 48S 68E 10X10 CRBPO

before submerging and never going completely underwater (Harper 1987) though occasionally swim beneath surface using wings for propulsion (MacGillivray 1920; Nicholls 1979; Oatley 1980); one immature (Harper 1987) dived from 6 m, swam out of sight using wings and emerged with prey about 20 s later. Often feed with other petrels and albatrosses, dominating all but the great albatrosses (Weimerskirch *et al.* 1986). Off Chile, steal fish from shags *Phalacrocorax* by chasing



Fig. 4. 52S 169E 10X10 NZNBS

them when they surface (Bullock 1929). A consummate scavenger, frequently follows ships; recorded feeding in association with other species behind ships: Cape Petrel *Daption capense*, White-chinned Petrel *Procellaria aequinoctialis*, Stejneger's Petrel *Pterodroma longirostris* and Wilson's Storm-Petrel *Oceanites oceanicus* (Ainley & Boekelheide 1983) in feeding flocks as well as following Southern Right Whales *Balaena glacialis*, Pilot Whales *Globiocephala* and Southern Right Whale Dolphins *Lissodelphis peronii* (Enticott 1986). Usually feed during day (78.0% observations), occasionally at night (232 observations; Harper 1987).

NON-BREEDING Recorded taking crustaceans, salps incl. *Pyrosoma*, jellyfish, and garbage (Harper 1987); one beachcast Auckland I. contained bill and feather of a diving-petrel *Pelecanoides* (Buller 1888) and, of three from Drake Passage, two contained cephalopods, one euphausiids *Euphausia superba* (Linkowski & Rembiszewski 1978).

BREEDING At Bird I., S. Georgia (138 regurgitations by adults; Prince 1980) liquid matter 47.7% vol., unidentifiable solids 1.3%. Of identifiable solids crustaceans 39.9% wt., 84.0% freq., euphausiids *Euphausia superba* 35.9, 87.0, amphipods *Themisto gaudichaudii* 16.6% freq., decapods *Acanthephyra* <2.0% freq.; fish lampreys *Geotria australis* 1.5, 4.3, other fish 38.0, 47.8 incl. Myctophidae 5.7% freq.; cephalopods 20.6, 39.1. Of the cephalopods (100 beaks; Clarke & Prince 1981) most were *Todarodes* 75.9% wt., 68.0% no. with remainder *Ancistrocheirus lesueurii* 6.6, 1.0, unident Enoploteuthidae 1.2, 1.0, *Kondakovia longimana* 1.2, 1.0, Gonatidae *Gonatus antarcticus* 1.2, 1.0, *Chiroteuthis veranyi* 1.2, 2.0, Cranchiidae 12.0, 25.0, Octopodidae 0.6, 1.0. Also at Bird I. regurgitations by chicks (n=170, Prince 1980; n=109, Tickell 1964) had similar composition to those of adults: crustaceans euphausiids *Euphausia superba* 91.7% freq. (Prince 1980), 69.5 (Tickell 1964), amphipods 4.7, 6.4, decapods 2.9, 17.4; fish 67.6, 68.8, lamprey 4.7, 0; salps, incl. *Salpa thompsoni*, 0, 16.5.

At Iles Crozet fish predominated in 58% of 12 regurgi-

tated samples (actual % freq. 58.3) with cephalopods doing so in 25% (41.7, largely Ommastrephidae) and carrion in 17 (41.7, largely dead penguins) with no crustaceans recorded at all (Weimerskirch *et al.* 1986). Also seen eating jellyfish on nearby continental shelf.

At Iles Kerguelen (43 regurgitations) 87% of samples were dominated by fish, 7 by crustaceans, 3 by cephalopods and 3 by carrion. Fish thought to have been scavenged from trawlers (Weimerskirch *et al.* 1987). Chicks at Heard I. regurgitated fish and cephalopod tentacles and an adult contained three cephalopod beaks (Downes *et al.* 1959).

INTAKE During brooding at Iles Kerguelen, foraging trips lasted 1.7 days (26–28 Dec.; 45), chick fed 1.18 meals/day; during nestling period, trips lasted 3.9 days (28–30 Jan.; 39), chicks fed 0.51 meals/day (Weimerskirch *et al.* 1987). Chicks at S. Georgia get 0.84 meals/day (Croxall & Prince 1987) or a meal of 570 g from each adult every 2 days, gaining 70 g/day (Croxall & Prince 1980); five meals at the same site ranged from 469 to 1221 g (Tickell & Pinder 1975). At Iles Crozet received 0.38 meals/day and gained 63 g/day (Weimerskirch *et al.* 1986). Mean efficiency of food conversion 41% (30–49; 4; Ricketts & Prince 1984). Adult capable of ingesting 11 fish of ≤ 250 g each in succession (Angus 1986).

SOCIAL ORGANIZATION At sea, gregarious throughout year. Largest flocks over e. boundary currents, continental shelves and slopes, especially off Argentina where observations of groups of up to 10 000 birds (Jehl 1974). Usually associated with mixed flocks of other seabirds, such as other albatrosses, giant-petrels and smaller procellariiforms and often with cetaceans (Jehl 1974; Enticott 1986). Highly gregarious on breeding grounds.

BONDS Monogamous. No data on length of pair-bond. If partner of previous season fails to return, male or female may re-mate with new partner, but breeding in same season observed only in females (Tickell & Pinder 1975). Age at first return to S. Georgian colonies, minimum 3 years but much greater proportion at 5 years old (Tickell 1969). Incubation and chick-rearing shared by both sexes; chicks independent at fledging.

BREEDING DISPERSION Colonial. Size of colonies: Iles Crozet, groupings of up to 22 nests (Weimerskirch *et al.* 1986); Iles Kerguelen up to 1200 pairs (Thomas 1983); Heard I. 22–110 pairs (Downes *et al.* 1959); Macquarie I. 10–31 pairs (Copson 1988); Campbell I. av. 8314 pairs (125–35 000; 9) (Robertson 1980); Falkland Is up to c. 102 000 pairs (Prince 1982); S. Georgia, average nest density 4290 nests/ha, nests 1.56 m (0.36; 0.76–2.28; 58) apart (Tickell & Pinder 1975). At Beauchêne I. (Falklands), densities of nests 0.61–0.72 nests/m² (Prince 1982). At Campbell I., average distance between nests 1.09 m (Robertson 1980).

ROOSTING No data.

SOCIAL BEHAVIOUR Account based on detailed study at S. Georgia (Tickell 1984). Displays easy to observe; only difficulty is in sexing birds in field. Social behaviour similar to that of other small albatrosses. Aggressive and sexual displays, except **Scooping**, and functions identical to those described for Grey-headed Albatross (Tickell 1984).

AGONISTIC BEHAVIOUR **Croaking, Gulping, Ground-stabbing and Wailing** as in Grey-headed Albatross (Tickell 1984).

SEXUAL BEHAVIOUR **Aerial Activity, Croak-**

ing (and Mutual Croaking), Gawkly Look, Scapular Action (and variants Wing Action and Leg Action), Rapier Action, Bowing (and variants Sub-belly Bow, Nod), Bill-clashing, Jabbing, Allopreening/Mutual Preening and Tattoo as in Grey-headed Albatross (Tickell 1984). In addition, courtship includes **Scoping**: head and bill repeatedly dipped sharply to ground, then pushed forward and up straight in front of body; often, but not always, performed while walking round nest; may precede Bill-clashing, stepping down from nest or taking off (Tickell 1984). Aerial activity seen mostly early in breeding season; Wailing more frequent than in Grey-headed Albatross (Tickell 1984).

RELATIONS WITHIN FAMILY GROUP Behavioural sequences during nest-relief as in Grey-headed Albatross (Tickell 1984). Behaviour of chicks similar to that of Grey-headed Albatross. Aggressive displays include, with increasing threat: sitting up facing intruder, bill snapping (or **Clopping**); ejection of stomach oil and sometimes whole stomach contents (Tickell 1984). Before feeding, displays include **Gruff Calls** (food begging call), submissive **Head-away** and **Bill-rattling**; also allopreening of chick by parent (Tickell 1984). Cross-fostering experiments (between Black-browed and Grey-headed Albatross) suggest that parents do not recognize chicks (Tickell 1972).

VOICE Most detailed study by Warham & Fitzsimons (1987); also description for nominate race in Tickell (1984). Usually silent at sea, except when quarrelling over food; fairly noisy at breeding grounds, mostly during pre-laying period. Vocalizations of adults include loud strident monosyllabic Wail; harsh cackling Croak; low guttural repeated Throbs; low Grunt. No pattern of individual differences described. Sexual differences in intervals between harmonics of Wail (Warham & Fitzsimons 1987), but sexual characteristics not specified. No geographical differences in vocalizations described, but possible because subspecies do not respond to each other's calls. Repertoire of vocalizations similar to that of other small albatrosses. **Non-vocal sounds**: 'mandible-spars' during Rapier Action: 'bill-clops' when Gulping; muted 'clicks' during Scapular Action; serial 'bill-tapping' during Bill-clashing; Tattoo or in chicks begging for food: castanet-like 'Bill-rattle' when bird shakes its head from side to side (Tickell 1984; Warham & Fitzsimons 1987).

ADULT Croak: harsh, rapid, cackling *aahaahaa-haaha* accompanied by vibration of bill. Emitted during Croaking display, in bursts of 3-4 separated by regular or varying pauses: territorial and identificatory signal (Tickell 1984). Call of *D.m. impavida*: total length 2.9 s, individual notes of 0.05-0.19 s at intervals of 0.16-0.28 s, frequency range c. 0.1-5.9 KHz (one sonagram; Warham & Fitzsimons 1987). **Wail**: aggressive braying *mbaaaa* (Tickell 1984). Call of nominate *melanophrys*: total length 2.6 s, frequency c. 0.2-5.8 KHz (one sonagram; Warham & Fitzsimons 1987). Warning signal when landing or taking off, also stress call while charging or being charged (Tickell 1984). **Throbbing (Groan)**: low-frequency (less than 0.4 KHz), low-amplitude, guttural crooning, usually beginning with trisyllabic throbs (c. 5/s) (Warham & Fitzsimons 1987). Total length of one series of throbs: 1.2 s (Warham & Fitzsimons 1987). Emitted during Rapier Action (Tickell 1984). Also low **Grunt** sometimes uttered during Scapular Action (Matthews 1929).

YOUNG Before being fed, chick emits **Gruff Call**, repeated *wa-wa-wa* (Tickell 1984).

BREEDING Studied at S. Georgia (Tickell & Pinder 1975; Ricketts & Prince 1981; Astheimer *et al.* 1985). Also partial data from Iles Crozet (Weimerskirch *et al.* 1986), Iles Kerguelen (Weimerskirch *et al.* 1989), Heard (Downes *et al.* 1959), Macquarie (Copson 1988) and Campbell Is (Bailey & Sorensen 1962; Robertson 1980). Breed in colonies of up to 100 000 pairs. On coastal areas of subantarctic and n. Antarctic islands; sometimes associated with Grey-headed Albatross, Rockhopper Penguin *Eudyptes chrysocome* or Magellanic Penguin *Spheniscus magellanicus*.

SEASON Sept.-Apr. Arrival at colonies: Iles Crozet, early Sept. (Weimerskirch *et al.* 1986); Heard I., 17 Sept. (Downes *et al.* 1959); Macquarie I., 3 Sept. (Copson 1988); Campbell I., early Aug.; S. Georgia, males 10 Oct (5 days; 26 Sept.-22 Oct.; 26), females 16 Oct. (6 days; 6 Oct.-26 Oct.; 26) (Tickell & Pinder 1975). Pre-laying exodus of female 10.3 days (3.3; 1014) (Astheimer *et al.* 1985). Copulation 11 Oct.-10 Nov., last seen 2 days before laying (Tickell & Pinder 1975). Departure of successful breeders and fledging of chicks: Iles Kerguelen, starts mid-Apr., peak 27-28 Apr. (Weimerskirch *et al.* 1986); Heard I. starts second half Apr. (Downes *et al.* 1959); Macquarie I., starts second week of Apr. (Copson 1988); Campbell I., mid-Apr.-7 May (Bailey & Sorensen 1962); S. Georgia, 28 Apr. (18 Apr.-8 May) (Tickell & Pinder 1975). At S. Georgia, failed breeders visit colony for up

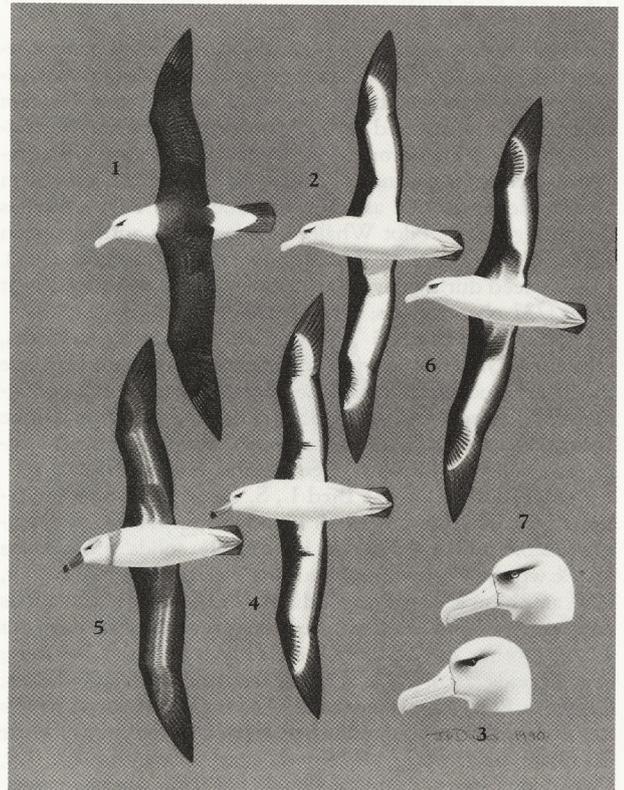
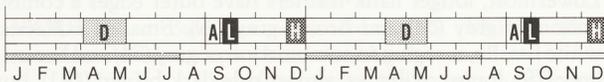


Plate 17

Black-browed Albatross *Diomedea melanophrys*

1. Adult, subspecies *melanophrys*, dorsal
2. Adult, subspecies *melanophrys*, ventral
3. Adult, subspecies *melanophrys*, head
4. Immature, subspecies *melanophrys*, ventral
5. Juvenile, subspecies *melanophrys*, ventral
6. Adult, subspecies *impavida*, ventral
7. Adult, subspecies *impavida*, head

to 8 weeks following failure, last non-breeders seen 12 Mar. (Tickell & Pinder 1975).



(Macquarie I.)

SITE Usually on terraces on top of coastal tussock-clad cliffs or steep slopes up to 300 m asl (Downes *et al.* 1959; Bailey & Sorensen 1962; Tickell & Pinder 1975; Woods 1975). Largest known colony (Beauchêne I., Falkland Is) established on gently sloping, rocky terrain without vegetation (Prince *et al.* 1981).

NEST, MATERIALS Column of packed soil, grass and roots, with parallel sides and depression on top; pedestals of tussock-grass sometimes converted into nests (Tickell & Pinder 1975; Woods 1975). Nest measurements: height 10–45 cm; diameter at base c. 30 cm (Tickell & Pinder 1975). At S. Georgia, 93.5% (n=31) of pairs use same nest in successive seasons (Tickell & Pinder 1975); renovation at start of breeding season, nest maintained by incubating bird or chick (Tickell & Pinder 1975; Tickell 1984).

EGGS Elongate, blunt; rough textured, mat; dull white or slightly pinkish, with varying ring of fine red-brown

spots at broad end (Downes *et al.* 1959; Tickell & Pinder 1975).

MEASUREMENTS.

Iles Kerguelen: 102.5 (3.8; 46) x 66 (2.1)

S. Georgia: 104 (3.9; 95–113; 117) x 66 (1.1; 62–71)

Campbell I.: 102.6 (4.0; 124) x 66.1 (2.0)

WEIGHTS. S. Georgia: 257 (17.4; 210–310; 117); Campbell I.: 206–256 (n=12).

CLUTCH-SIZE One. No replacement laying.

LAYING Synchronized. Iles Crozet: 19 Oct. (12–30 Oct.; 19); Iles Kerguelen, 11–30 Oct. (Thomas 1983; Weimerskirch *et al.* 1989); Heard I., starts 20 Oct.; Macquarie I., starts 26 Sept., peak early Oct.; Campbell I., 24 Sept.–8 Oct.; S. Georgia 27 Oct. (4 days; 19 Oct.–11 Nov.; 302). Fundamentally an annual breeder (Tickell & Pinder 1967), but important year-to-year variation in breeding frequency. At S. Georgia, during seven seasons an average of 71.9% of birds bred again next year, but proportion varied from 52.7 to 86.4% (Prince 1985).

INCUBATION Incubation shared by both sexes. At S. Georgia, 5–10 shifts, shortest first by female, 4.5 days, longest second by male 13.9 days. At Iles Kerguelen, mean length of shifts during second half of incubation, 4.5 days (Weimerskirch *et al.* 1988). **INCUBATION PERIOD.** S. Georgia 68.1 days (1.2; 65–72; 72). Hatching, from chipping to emergence, c. 4 days (Tickell & Pinder 1975).

YOUNG Hatching covered with pale grey down (Tickell & Pinder 1975). At S. Georgia, chick brooded for 21.6 days (2.8; 16–26; 49) in shifts of 2.5 days (1–7; 145), shifts of male slightly longer than those of female. At Iles Crozet, brood- and guard-stage, 22 days. At Iles Kerguelen, length of brooding shifts, 1.7 days (Weimerskirch *et al.* 1988). Chicks fed by both parents until fledging; by incomplete regurgitation, chick inserting open bill crosswise between mandibles of parent (Tickell 1984). **NESTLING PERIOD.** Iles Crozet, c. 125 days, S. Georgia, 117 days (3.4; 110) (Croxall *et al.* 1988).

GROWTH At S. Georgia, weight at hatching, 180.9 (110–241; 29) (Ricketts & Prince 1981), maximum weight 4963 (4700–5140; n=3 years) (Tickell & Pinder 1975; Prince & Ricketts 1981) or 139% adult weight after 85–88 days; weight at fledging 3505 g or 98% adult weight. Chicks independent after fledging.

FLEDGING TO MATURITY Age at first return to colonies: Macquarie I. 6.4 years (5–8; 7); S. Georgia, among 76 recoveries of birds up to 5 years old, one (1%) was 3 years old, four (5%) 4 years, 71 (94%) 5 years (Tickell 1969); at Campbell I., recoveries at 3 years old. Age at first breeding: Iles Kerguelen, 9.8 years (6–13; 50) (Jouventin & Weimerskirch 1988); Macquarie I., 7.3 years (7–8; 3); S. Georgia, minimum 8 years, mean 11 years (Croxall *et al.* 1988).

SUCCESS Hatching: Macquarie I., 74.4% (52.4–95.5; 7 years, 141 eggs); S. Georgia, 39.4% (1 year, 142 eggs). Fledging: Heard I., 67% (1 year); Macquarie I. 91.4% (81.8–100; 7 years, 106 chicks); S. Georgia 82.3% (1 year, 564 chicks). Total success: Iles Kerguelen 58% (51–63; 4 years), 0.49 chicks per female per year (Jouventin & Weimerskirch 1988); Heard I. 17–44% (2 years); Macquarie I. 66.9% (17.4; 42.9–86.4; 7 years, 141 eggs); S. Georgia 36.7% (22.8; 0–66.8; 11 years) (Croxall *et al.* 1988). Mean annual survival of adults: Iles Kerguelen, 88.1% (Weimerskirch *et al.* 1987), S. Georgia, 92.0% (Croxall 1982). Survival of immatures: Iles Kerguelen 35% (Weimerskirch *et al.* 1987). At S. Georgia, breeding success fluctuates with availability of krill (Croxall *et al.* 1988). At Iles Kerguelen, reduced adult survival probably because birds are

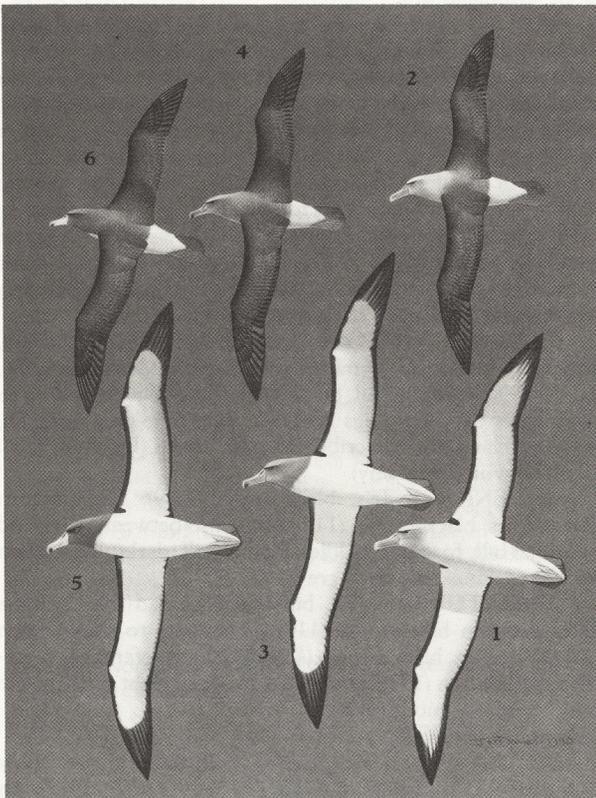


Plate 18

Shy Albatross *Diomedea cauta*

1. Adult, subspecies *cauta*, ventral
2. Adult, subspecies *cauta*, dorsal
3. Adult, subspecies *salvini*, ventral
4. Adult, subspecies *salvini*, dorsal
5. Adult, subspecies *eremita*, ventral
6. Adult, subspecies *eremita*, dorsal

destroyed during fishing operations (Weimerskirch *et al.* 1987).

PLUMAGES *Nominate melanophrys*

ADULT Age of first breeding, at Iles Kerguelen, c. 7 years (Pascal 1979); at S. Georgia, minimum 8 years, mean 11 years (P.A. Prince); at Iles Crozet, 9.8 years (Weimerskirch *et al.* 1987). Plumage attained c. 4–5 years old (Tickell 1969). In fresh plumage: **HEAD AND NECK**, mostly white. Lores, white anteriorly, merging to grey-black (82) posteriorly, where form supra-orbital stripe that extends short distance past eye, to above ear-coverts, where feather tips, suffused light-grey (85); stripe varies in extent, and may only be a trace (Condon 1936; Barton 1979). Under lower eyelid, a narrow line of short pure-white feathers. **UPPERPARTS**. Upper mantle, rump and upper tail-coverts, white. Lower mantle and back, grey (84), broadly fringed light-grey (85); basal half of feathers, white; rachis, white basally, merging to brown-grey (79) distally; feathers when worn become dark brown (121), fringes, dark brown (119A). Demarcation between back and rump sharp; at demarcation, feathers, white and diffusely tipped brown-grey (79). Scapulars, black-brown (119); base of rachis, light grey-brown (119C) merging to grey-black (82). **TAIL**, grey (84); inner webs of rectrices slightly paler; rachis, dull cream (c54). When worn, tail, dark brown (121). **UPPERWING**. Remiges, black-brown (119); inner webs, pale dark-brown (121); rachis of primaries, cream (54) basally, merging to grey-black (82) distally; cream (54) primary-shafts of p10–7, obvious when wing outstretched. All coverts, dark brown (121), fringed slightly paler; rachis, grey-black (82). Alula, dark brown (121). Largest tertials, broad with rounded webs. **UNDERPARTS**, entirely white, including axillaries. **UNDERWING**. All marginal coverts and first row of lesser coverts, dark brown (121), forming broad dark band on margin of underwing. Second row of lesser primary coverts and humeral coverts, variably suffused a combination of brown-grey (79) and dark brown (121) on outer webs; inner webs largely white, or slightly mottled brown-grey (79) and dark brown (121); junction of humeral coverts and greater coverts evident when wing outstretched, by contrast in colour of feathers; often tertial covert suffused dark brown (121), forming distinct 'notch'. Rest of coverts, largely white, or slightly mottled brown-grey (79) on webs; rachis, white.

DOWNY YOUNG Protoptile, grey with shorter white down on sides of face, forming 'mask'. Mesoptile, thick, curly and white, with slight brown-grey (80) shade. At Heard I., down lost Mar.–May.

JUVENILE Differs from adult in: **HEAD AND NECK**. Distal half of feathers, dark brown-grey (79) with feathers basally white except on forehead, malar region, chin and throat, which are entirely white. Supra-orbital stripe, grey-black (82) but more diffuse, without sharp contrast as in adult. Birds sometimes have dark grey-brown (79) collar across base of foreneck, which may be incomplete. **UPPERPARTS**. Mantle-feathers, combination of grey (84) and brown-grey (79), merging at lower margins to dark brown (121); fringes on mantle, pale dark-brown (121). Concealed three-quarters of feather, white and sometimes exposed; rachis, white in those areas. Distal halves of feathers on back, close to dark brown (121) with pale dark-brown (121) fringes; concealed bases, white. At demarcation between back and rump, feathers are combination of grey (84), brown-grey (79) and white. **UPPERWING**. All coverts, dark brown (121) fringed brown-grey (79). **UNDERPARTS**. Fringes of feathers on upperbreast, a combination of

grey (84) and brown-grey (79); fringes narrow at centre of upper breast; upper flanks, slightly tipped similar colour. Lowermost, longer flank-feathers have outer edges a combination of grey (84) and brown-grey (79). Smaller axillaries, white basally, merging to combination of grey (84) and brown-grey (79); longer axillaries, almost pale dark brown (121), but similar to smaller ones; rachis, basally light brown (223D), merging to dark brown (121). **UNDERWING**. Greater primary coverts and greater coverts a combination of grey (84) and brown-grey (79); tips slightly paler; concealed bases, white. Innermost greater coverts, tipped dull-white. Outer median coverts, pale dark brown (121); rachis, grey-black (82). Rest of coverts, grey (84) with dark brown (121) shade and white bases. Generally underwing appears lighter in colour than in adult.

SUBSEQUENT PLUMAGES Plumage gradually becomes whiter on crown, hindneck and foreneck; often narrow collar on lower foreneck is present. By 3 years old (n=1), head almost indistinguishable from adult; at 4 years (n=4), and 5 years (n=71), indistinguishable from adult (Tickell 1969).

BARE PARTS Based on photos in NZRD and Lindsey (1986), except where stated.

D.m. melanophrys.

ADULT Iris, dark brown (219). Proximal bill, dark orange-buff (118) merging to salmon (106) at nares; unguis, dull orange (94); bill colour reached at five years of age. Colour of bill apparently varies from pale horn with unguis yellow to bright yellow with unguis orange (Barton 1979). Inside of mouth, pinkish-violet (Murphy). Fleishy skin narrow along margins of proximal bill, grey-black (82). Narrow fleishy strip of pink skin from gape across malar region, slopes upwards to ear-coverts; exposed during display (Matthews 1929). Legs and feet, light blue-grey (88); joints and webs, grey (87); pink veins often visible on webs and tarsus. Foot colour apparently varies, from whitish to dark purplish red (Murphy).

DOWNY YOUNG Iris, black-brown (119). Bill, grey-black (82). Inside of mouth, bright pink (Matthews 1929). All fleishy skin round bill, black (89); fleishy skin extending to ear-coverts exposed. Legs and feet, pale blue-grey (NZRD); feet and claws also described as pale cream (Downes *et al.* 1959) or white (Murphy).

JUVENILE Iris, black-brown (119). Culminicorn and unguis, black-brown (119); often also between nares and proximal bill, forming 'saddle'. Rest of bill, dark olive-brown (129). Legs and feet, dark grey.

IMMATURE Iris, bill and legs and feet become lighter. Often bill, brown (119B), changing to pink-brown (221D); unguis, black-brown (119). Without reference to subspecies, Condon (1936) states that tongue bright pink, palate pinkish; inside mouth white.

Subspecies *impavida*.

ADULT Iris, pink-buff (121D), amber, light-yellow or honey-coloured (Harper & Kinsky 1978; Barton 1979). An adult has also been recorded as having white iris, a character attributed to juveniles and immatures (Barton 1979). Bill, vivid yellow with unguis, orange (Barton 1979).

DOWNY YOUNG Iris, dark greyish-brown; eyelids, bluish grey; bill, black slightly suffused with bluish grey towards base of tomia; feet, very pale bluish-grey; nails, greyish brown (Bailey & Sorensen 1962).

JUVENILE, SUBSEQUENT PLUMAGES Iris,

white, not brown as stated in Harper & Kinsky (1978) and Barton (1979).

MOULTS Based on data from D.S. Melville (from museum skins), except where stated.

ADULT Complete; primaries moult outwards in staffelmauser; moult Jan.-July (Palmer 1962; Watson 1975). Observations of moult by month are: May (Falla 1937), Apr, June and Nov. (Brooke 1981). Moult of feathers of mantle on skins observed in Jan., Mar., July and Nov. (Lowe & Kinnear 1930); at S. Georgia, moult of breast, belly and under tail-coverts, Jan.-Feb. (Tickell 1969). Duration of feather replacement unknown; based on feather wear, moult may not be completed in one season. Tail-moult normally symmetrical (Brooke 1981). Brooke (1981) also reports presumably aberrant tail-moult in June, where moult was almost simultaneous. Some birds may show evidence for moulting of primaries inwards (Brooke & Furness 1982). Tickell & Pinder (1975) observed moult during breeding season at Bird I., S. Georgia, but type of moult not specified. Failed breeders may moult earlier than successful breeders (Brooke 1981). Not known whether subspecific differences in moult-strategies.

POST-JUVENILE Complete; at Valparaiso, Chile, bird undergoing outwards primary moult in Feb. (Murphy).

MEASUREMENTS Nominate *melanophrys*: (1) S. Georgia, live birds; methods unknown (Tickell & Pinder 1975). Subspecies *impavida*: (2) (Robertson 1980; C.J.R. Robertson). (3) Campbell I., Courrejolles Pt; bill depth at base (Westerskov 1960).

	MALES	FEMALES
WING	(1) 540.9 (11.24; 520-560; 11) (2) 526.0 (490-540; 26) (3) 520.1 (6.71; 515-534; 8)	529.8 (10.73; 510-545; 12) * 514.0 (495-530; 19) 504.0 (14.00; 490-518; 2)
TAIL	(1) 219.7 (8.30; 207-236; 11) (2) 213.0 (205-229; 26) (3) 215.6 (6.66; 207-229; 8)	212.5 (5.09; 202-221; 12) * 208.0 (200-225; 19) 215.0 (1.00; 214-216; 2)
BILL	(1) 118.9 (1.70; 116-122; 12) (2) 111.8 (105-118; 26) (3) 111.1 (2.09; 109.4-116.3; 8)	116.3 (1.92; 114-121; 12) * 109.6 (105-114; 19) 108.0 (2.45; 105.6-110.5; 2)
BILL D	(1) 28.5 (1.44; 25.6-31; 12) (3) 45.8 (1.75; 42.7-47.5; 8)	26.4 (0.86; 24.9-27.9; 12) * 42.9 (2.70; 40.2-45.6; 2)
TARSUS	(1) 83.2 (1.58; 80-85; 12) (2) 84.6 (77-88; 26) (3) 85.1 (1.26; 82-86; 8)	81.9 (2.69; 76-88; 12) 82.0 (75-88; 19) 82.0 (1.00; 81-83; 2)
TOE	(1) 137.4 (3.47; 132-143; 12) (2) 126.0 (120-135; 26) (3) 146.7 (3.18; 141.5-152.5; 8)	133.7 (4.24; 125-142; 12) * 121.0 (116-129; 19) 140.0 (4.00; 136-144; 2)

(4) Nominate *melanophrys*, Iles Kerguelen; methods unknown (Weimerskirch *et al.* 1989).

	UNSEXED
WING	(4) 520.5 (11.5; 501-550; 30)
BILL	(4) 118.1 (3.7; 108-123.8; 29)
TARSUS	(4) 83.2 (3.7; 76-89; 28)

Additional measurements in Lowe & Kinnear (1930), Murphy, Condon (1936) and Weimerskirch *et al.* (1986). Some details of growth rates of chicks in Prince & Ricketts (1981) and Ricketts & Prince (1981).

WEIGHTS Nominate *melanophrys*. At S. Georgia, Mar.-Feb.: males 3710 (0.45; 3300-4700; 11); females 3170 (0.26; 2800-3800; 10) ($P < 0.05$) (Tickell & Pinder 1975). At Iles Crozet, unsexed birds 3660 (0.50; 2700-4400) (Weimerskirch *et al.* 1986). At Iles Kerguelen, unsexed birds: 3740.0 (450; 2900-4500; 35) (Weimerskirch *et al.* 1989).

Subspecies *impavida*: males 3100 (2750-3300; 15); females 2700 (2200-3150; 18) (Robertson 1980; C.J.R. Robertson). Weight loss during incubation of birds at S. Georgia: males c. 47 g/day; females c. 44 g/day (Prince *et al.* 1981). Full details of weight changes in chicks in Tickell & Pinder (1975), Ricketts & Prince (1981) and Weimerskirch *et al.* (1986). No data on seasonal changes in adults.

STRUCTURE Wing, long and narrow. Eleven primaries: p10 longest, p9 7-12 mm shorter, p8 29-40, p7 68-82, p6 106-124, p5 151-169, p4 194-214, p3 237-250, p2 272-285, p1 c. 310. No emarginations. Tegmen on p10 c. 10 mm wide. Eight humerals. Eighteen secondaries. Tail rounded; 12 rectrices; t1 longest, t6 27-33 mm shorter. Under tail-coverts end c. 20 mm short of tip of tail. Interramal space feathered. Bill deep at base; laterally compressed and tapering distally; culmen slightly curved in profile; maxillary unguis hooked. Nares operculate; pointing slightly upwards and one-quarter along bill in groove of culminicorn and latericorn. Naricorn very thin and largely lacking; see bill illustrated in Fig. 1a, Diomedidae. Bill mostly smooth in adults, though slightly scaly at base of latericorn; bill rough and scaly in juveniles. Tarsus, slender and rounded in cross-section; feet, webbed. Claws long and slightly curved. Outer toe almost equal in length to middle toe, inner c. 83% of middle; hind toe, absent.

SEXING, AGEING Possibly sexed on length of middle toe; males longer but more data required (Westerskov 1960).

RECOGNITION Downy young of *D.m. impavida* and Grey-headed Albatross *D. chrysostoma* are indistinguishable (Westerskov 1960). Juvenile and immature Black-browed and Grey-headed Albatross distinguishable on sequence of change of colour of bill; see Harrison (1983) for details. Other differences from *D. chrysostoma* and Shy Albatross *D. cauta* discussed in Cox (1973), HASB, Keiser (1982), Mackrill (1982) and Harrison (1983).

GEOGRAPHICAL VARIATION Two subspecies in A'asia, *melanophrys* and *impavida* (Peters); *melanophrys* breeds Staten I, Argentina, and San Ildefonso, Diego Ramirez Is, Isla Diego de Almagro (Clark *et al.* 1984), off C. Horn, Chile; Falkland Is, S. Georgia, Iles Kerguelen, Iles Crozet, Macquarie, Antipodes, Heard Is (Murphy; Peters); *impavida* breeds only on Campbell I., NZ (Tickell 1976); not Antipodes Is, as stated in Lindsey (1986). Subspecific separation based mainly on colour of iris, extent of supra-orbital stripe and measurements. Adult *melanophrys* has dark-brown iris; *impavida* a pale pink or honey-coloured iris (see Bare Parts); *impavida* has more prominent supra-orbital stripe. Further subspecific characters discussed in Cox (1973), Warham & Bourne (1974) and Barton (1979). In NZ, *impavida* fledgelings beachcast mainly Apr.-June; *melanophrys* fledgelings, July-Sept. (Powlesland 1985).

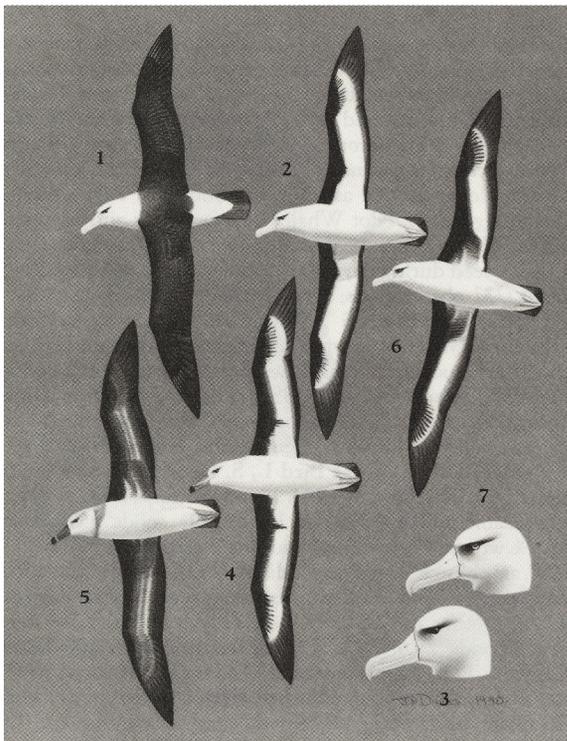
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J.P. Davies 1990



Volume 1 (Part A), Plate 17

Black-browed Albatross *Diomedea melanophrys*

- 1. Adult, subspecies *melanophrys*, dorsal
- 2. Adult, subspecies *melanophrys*, ventral
- 3. Adult, subspecies *melanophrys*, head
- 4. Immature, subspecies *melanophrys*, ventral
- 5. Juvenile, subspecies *melanophrys*, ventral
- 6. Adult, subspecies *impavida*, ventral
- 7. Adult, subspecies *impavida*, head

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