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: Diomedeidae 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 *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, 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.

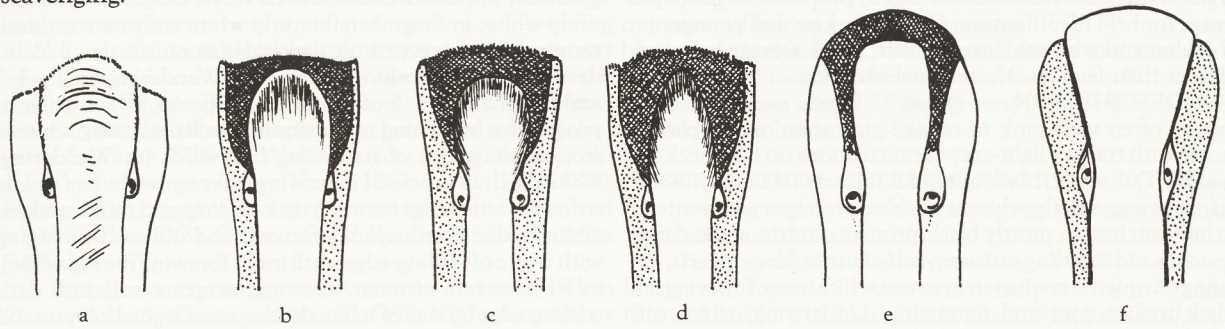

Fig. 1 Dorsal view of base of bill of small *Diomedea*

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 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.

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Diomedea epomophora Royal Albatross

COLOUR PLATE FACING PAGE 280 281

Diomedaea [sic] *epomophora* Lesson, 1825, *Annls Sci. nat. Paris* 6: 95 — 40 °S.

The specific name perhaps refers to the somewhat hump-backed appearance in flight, being apparently compounded of ἐπωμίς (neck and shoulders) and φορέειν (to bear).

POLYTYPIC Nominate *epomophora* breeds Campbell and Auckland Is; *sanfordi* Murphy, 1917, breeds NZ and Chatham Is.

FIELD IDENTIFICATION Length 107–122 cm; wingspan 305–351 cm; weight 8–10 kg. Huge full-bodied albatross with extremely long wings and short, gently wedge-shaped tail. Bill, huge with bulbous tip; pinkish horn with diagnostic black cutting edge to upper mandible. Similar only to other great albatrosses, especially Wandering Albatross *D. exulans*; much larger than black-backed albatrosses. Juveniles largely white-bodied (unlike Wandering). Two subspecies, separable at sea, for which Harrison (1979, 1985, 1987; on which account based) proposed stages of plumage for field identification: in *sandfordi*, stages 1 (juvenile) and 2 (adult); in *epomophora*, from 1 (juvenile) to 5 (oldest and whitest). In subspecies *sandfordi*, little change in plumage with age but in *epomophora* upperwing gradually whitens over long period as in Wandering. Males average larger and whiter than females. No seasonal variation.

DESCRIPTION **Nominate** *epomophora*. STAGE 5. Head, neck, body and tail, white. Upperwing, mostly white with black remiges and primary coverts; white of inner forewing merges evenly through narrow transitional zone of finely white-fringed dark greater secondary coverts into dark trailing-edge. Underwing, white with black remiges forming thin dark trailing-edge and large dark tip. STAGE 1 (JUVENILE). Head, neck and body, white with indistinct blackish mottling across lower back and rump. Tail, white with narrow black terminal band. Upperwing, mostly blackish with indistinct white patch behind elbow in centre of innerwing, and dark of inner forewing finely dusted with white; white of mantle extends narrowly onto base of leading-edge and continues to carpal joint as thin line along edge of wing; dark trailing-edge extends behind saddle, forming black pincers on either side of white back. Underwing, as Stage 5, except for thin black margin between carpal joint and base of outermost primary. STAGE 2. As Stage 1, except that dark mottling on lower back and rump, lost or indistinct. Tail, wholly white. Inner upperwing: white patch in centre, larger and more pronounced; white line on leading-edge, thicker; dark of inner forewing more heavily dusted with white. STAGES 3 AND 4. As Stage 2, but upperwing becomes progressively whiter from leading-edge of innerwing backwards: white leading-edge merges with white central patch, gradually extends outwards to carpal joint, and merges evenly through transitional zone of finely white-fringed dark lesser and median secondary coverts into dark of greater secondary coverts and trailing-edge. Extent of dark pincers, reduced. Underwing, as Stage 1, but black leading-edge between carpal joint and base of outermost primary, thinner and not continuous. **Subspecies** *sandfordi*. STAGE 2 (ADULT). Head, neck, body and tail, wholly white. Upperwings, wholly black except that white of mantle extends narrowly onto base of leading-edge and continues to carpal joint as thin line along edge of wing; black upperwings appear square-cut from white saddle; dark trailing-edge extends behind saddle, forming black pincers on either side of white back. Underwing, white except for thin dark trailing-edge and large dark tip (formed by black remiges) and black margin along leading-edge between base of outermost primary and carpal joint, which thickens abruptly near carpal joint, forming diagnostic bump (on *epomophora* margin thinner and does not thicken near carpal). STAGE 1 (JUVENILE). Like adult, except: indistinct brown mottling on crown; pronounced black mottling on lower back and rump; narrow black terminal band on tail; on upperwing, fine white fringing to greater, median and some lesser secondary coverts form thin pale tramlines down innerwing. **Bare parts of all birds**. Bill, large with bulbous tip; horn to pinkish horn, with yellowish-horn ungues forming paler tip; may flush to brighter pink, especially in breeding birds; diagnostic black cutting edge to upper mandible. Nostrils, small, on sides of bill, pointing forwards. Iris, brown. Legs and feet, pinkish to bluish-white with bluish webs; feet project well beyond tip of tail in flight; sometimes tucked forward into belly feathering.

SIMILAR SPECIES Only Wandering Albatross. In *sandfordi*, combination of white head, neck, body and tail and black upperwings, diagnostic (Wandering Albatross with upperwing as dark would have brown or black on crown, breast and back, and mostly black tail); underwing pattern also diagnostic (Wandering has thinner black margin along leading-edge of outerwing, not thickening near carpal joint). For separation of *epomophora* from Wandering Albatross, see that account.

Circumpolar in s. oceans. Occupy wide range of marine habitats; occur in pelagic waters but also concentrate in shelf-break and continental shelf waters; except round breeding places, usually seen from land only during gales. Graceful in flight: long sweeping glides and soaring on stiff outstretched wings, rarely flapping except in calm conditions when flight laboured with deep pliable wing-beats. On calm days, spend much time sitting on sea. Take-off and flight in light winds, laboured; long run-off before becoming airborne, heavy flapping to stay aloft. Feed by surface-seizing, occasionally by shallow plunging. Less inclined to follow ships than Wandering Albatrosses, though attend fishing vessels where voraciously squabble over offal. Solitary or gregarious at sea. No information on calls at sea; give croaking and whining calls at colonies.

HABITAT Marine, pelagic and aerial; in subantarctic, subtropical and, occasionally Antarctic, waters. Observed where surface-temperature 6–20 °C (Szijj 1967; Jehl 1973; Barton 1977, 1980); preferred range in Chilean waters 8–12 °C

(Jehl 1973). A few records Antarctic waters (Starck & Wyrzykowski 1982; Ainley *et al.* 1984). Usually recorded in Pacific Ocean near land masses, sometimes far from land (Szijj 1967); in A'asian region, occur in inshore, offshore and pelagic waters (Fleming 1939; Rogers 1970; Barton 1979), occasionally entering harbours (Secker 1969). Attracted to commercial fishing grounds off NZ (Robertson & Jenkins 1981).

Breed on mainland, islands and rocky islets of NZ. Nest on flat or gently sloping ground; on slopes of headland on mainland (Richdale 1939); on slopes, ridges, gullies and plateaux of large islands; and on summits of islets (Oliver; Bailey & Sorensen 1962; Westerskov 1963; Dawson 1973). Depressions, gullies, lee slopes and vegetation provide shelter for nests, but exposed sites needed nearby for take-off and landing; nests placed among vegetation open enough for easy access (Westerskov 1963).

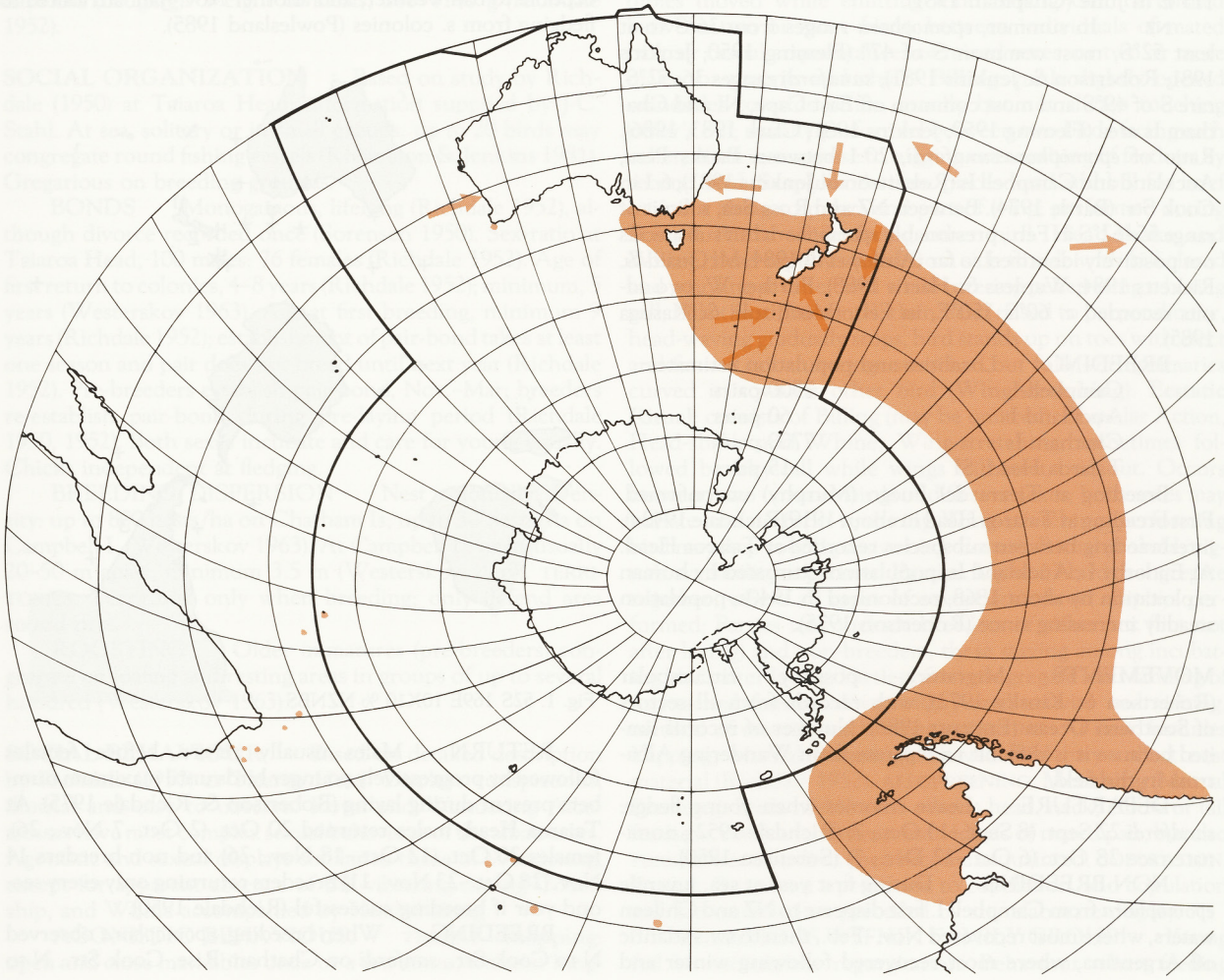
Fly low or moderately high, using updraft from wave fronts for lift.

On Campbell I., grazing by sheep in breeding areas has destroyed tussock grass and allowed *Bulbinella rossii* to spread, which may limit population (Westerskov 1963), but numbers of breeding birds have increased where density of sheep high, and nesting occurs in pure stands of *Bulbinella* (Taylor *et al.* 1970). Grazing may have opened up areas of dense tussock grassland for nesting (Westerskov 1963).

DISTRIBUTION AND POPULATION Pelagic range circumpolar, but imperfectly known because easily confused with Wandering Albatross. Apparently most common NZ and South American waters.

Few mid-ocean records, possibly because identification is difficult; however, lack of pelagic specimens, compared with many for Wandering Albatross, may indicate preference for area nearer land (Murphy). South Atlantic: five sight-records between 39–48°S, 50–7°W, in Jan., July (two), Oct., Nov. (Bourne & Curtis 1985; Enticott 1986). S. Indian Ocean: four sight-records and five recoveries between 35–47°S, 33–100°E in Feb., Mar., Aug. (two), Sept., Oct., Dec. (three); (Robertson & Kinsky 1972; Sinclair 1981; Enticott 1986; Stahl 1987; J-P. Roux). South Pacific Ocean: recorded between 42°S and 51°-55°S, in Mar.–Sept. (Chapman 1982; Clark 1986; Szijj 1967); also one S of Tonga, 24°S 177°W, 15 May 1974 (Jenkins 1980); Wood (1923) claimed and Jenkins (1986) disputed occurrence S of Fiji; band from immature recovered Tuamotu Arch. 21°42'S, 140°38'W (Robertson 1972). Outside NZ area, range of immatures and adults apparently similar but only 9% of immatures 1–7 years old recovered off NZ (Robertson & Kinsky 1972).

Off w. South America, from C. Horn to Arica, Chile, 18°30'S (Johnson 1965); immature recovered N to 30°S Nov.–Feb., 34°S Mar.–June, 37°S July–Oct. (Robertson & Kinsky



1972); in May–June, recorded 30–50°S (Jehl 1973). Type of *sanfordi* collected off Cohral, Chile, Oct. (Murphy). Occur in Beagle Channel and C. Horn area Jan.–Mar. (Humphrey *et al.* 1970; Harris & Batchelor 1980; Harper 1987). In Feb.–Mar., compose *c.* 20% of great albatrosses in Drake Passage, normal range extends S to 63°S, but one recorded *c.* 64°20'S W of Antarctic Pen. (Starck & Wyrzykowski 1982). Common off e. South America in winter; Royal Albatross rated as dominant great albatross over Argentinian Shelf (Dabbene in Murphy), while representing *c.* 20% according to Jehl (1974). Ranges N to at least 35°S (Dabbene in Murphy); immature recovered N to 36–37°S Mar.–Oct. (Robertson & Kinsky 1972).

In summer, ranges N to Mar del Plata (*c.* 38°S) (Murphy). One adult recovered 37°S, Apr. (Robertson & Kinsky 1972). Normally the most common great albatross on Falkland Is shelf (Bourne & Curtis 1985). Seven records off South Africa, all June–July, between 30–36°S and 15–20°E (Bourne & Dixon 1975; Enticott 1986).

AUST. Regularly and commonly recorded throughout year in se. Aust. within area from s. NSW, round Tas. to se. SA (northernmost 29°S) (Barton 1979; Aust. Atlas; D.W. Eades). **Tas**. Regular, throughout year; nominate race predominant (Aust. Atlas; Tas. Bird Rep. 1984). **SA**. Recorded May–Sept., *sandfordi* predominant (Cox 1977; Parker *et al.* 1979; Close 1982). **WA**. One immature from Campbell I. recovered in Mar. at 31°S 115°E (HASB), several sighted 35°S 115°E in June (Chapman 1981).

NZ In summer, *epomophora* ranges from 36°S to at least 52°S, most common S of 47° (Fleming 1950; Jenkins 1981; Robertson & Jenkins 1981); *sandfordi* ranges 36–52°S, rare S of 49°S and most common off East Cape, NI and Chatham Is area (Fleming 1950; Jenkins 1981; Clark 1983, 1986). Ratio of *epomophora*:*sandfordi*, 20:1 between Banks Pen., Auckland and Campbell Is (Robertson & Jenkins 1981); 6:1 in Cook Str. (Bartle 1974). Between NZ and Ross Sea, s. limit of range 55–62°S in Feb., presumably *epomophora* but subspecies not positively identified so far (Ainley *et al* 1984; McQuaid & Ricketts 1984; Wanless & Harris 1988). Further W, two adults recorded *c.* 60°S 150°E, in Feb. (Mochizuki & Kasuga 1985).

BREEDING Localities and population estimates:

Campbell I.	7500 pairs
Auckland Is	60 pairs
Chatham Is	7700 pairs
Taiaroa Head, SI	15 pairs

Breeding at Tierra del Fuego (Murphy) unconfirmed. First breeding at Taiaroa Head in about 1919 (Richdale 1942a); interbreeding between subspecies recorded at Taiaroa Head. At Enderby I., Auckland Is, population extirpated by human exploitation by about 1868; recolonized in 1940s, population steadily increasing since (Robertson 1975).

MOVEMENTS Migratory, possibly circumpolar (Robertson & Kinsky 1972), with records from all sectors of Southern Ocean (Enticott 1986). Number of records limited because it is difficult to separate from Wandering Albatross in the field.

DEPARTURE Leave colonies when young fledge: *sandfordi* 22 Sept. (8 Sept.–13 Oct.; 7) (Richdale 1952); nominate race 28 Oct. (6 Oct.–12 Dec.; 7) (Sorensen 1950).

NON-BREEDING During first year at sea, juvenile *epomophora* from Campbell I. first disperse to NZ and Chilean waters, where most recovered Nov.–Feb., then to sw. Atlantic off Argentina, where most recovered following winter and spring. Movements across Pacific probably rapid because several recoveries from Chile in Dec. One recovered WA, four months after fledging, possibly indicating circumpolar movements within one year, but most immatures appear to stay in, or return to, sw. Atlantic for several years, where most 1- to 4-year-old birds are recovered. Recoveries from s. Indian Ocean suggest that birds move back to NZ in eastward direction. No recovery of immature *sandfordi* so far. Adult *sandfordi* from Taiaroa Head, NZ, recovered sw. Atlantic after successful breeding suggests long-range dispersal of adults between successive breeding seasons, at least if successful. Adult *epomophora* recovered NZ (44%; n=41); Chile (7%); sw. Atlantic (30%), probably main wintering area of breeders after successful breeding season; s. Indian Ocean (7%) and se. Aust. (12%); circumpolar movements likely (Robertson & Kinsky 1972). Latitudinal variation shows no pattern (Robertson & Kinsky 1972). However, though banding returns show a uniform longitudinal range throughout year, 10 of 13 records from African sector occurred in winter of which 80% *sandfordi* (Enticott 1986), which suggests important wintering area for this subspecies; no *epomophora* recovered there so far (Robertson & Kinsky 1972). Main wintering ground considered to be in South Atlantic off Argentina, though few banded birds recovered there (Fig. 1). Numbers beachcast on NZ coasts show little seasonal variation: a low peak in June possibly related to moult in adults, making them more susceptible to bad weather, and another Nov.–Jan. attributed to fledging from s. colonies (Powlesland 1985).

Fig. 1. 52S 169E 10X10 % NZNBS

RETURN Males usually return before females followed by progressively younger birds until maximum numbers present during laying (Robertson & Richdale 1975). At Taiaroa Head, males returned 20 Oct. (2 Oct.–7 Nov.; 26), females 20 Oct. (12 Oct.–18 Nov.; 26) and non-breeders 14 Nov. (28 Oct.–23 Nov.; 11) breeders returning only every second year if breeding successful (Richdale 1950).

BREEDING When breeding, *epomophora* observed N to Cook Str., *sanfordi* on Chatham Rise, Cook Str., N to

East Cape (C.J.R. Robertson).

BANDING Returns from Campbell I. summarized Fig. 1. (NZNBS).

FOOD Mostly cephalopods with some fish, crustaceans and salps, diet varying with locality. BEHAVIOUR. Most food taken by surface-siezing; rarely shallow plunging (Ainley 1977; Harper *et al.* 1985). Feeding in association with Shy Albatross *D. cauta*, Cape Petrel *Daption capense*, White-chinned Petrel *Procellaria aequinoctialis*, Black Petrel *P. parkinsoni*, Fairy Prion *Pachyptila turtur*, Great-winged Petrel *Pterodroma macroptera* (Ainley & Boekelheide 1983) and near fishing boats.

BREEDING At **Campbell I.** diet consists of cephalopods 75% wt. (incl. *Moroteuthis ingens, Kondakovia longimana, Taonius pavo*), fish 21 (incl. *Macruronus novaezelandiae*), crustaceans 3 and salps 1 (C.J.R. Robertson). Fish (incl. *Notothenia* 29 cm) appears to dominate diet of young chicks with cephalopods provided only to older young (Sorensen 1950). At **Chatham Is** takes cephalpods 85% wt. (incl. *M. ingens*, immature *Architeuthis, Histioteuthis atlantica*), fish 14, salps 1. At **Taiaroa Head**, cephalopods 80 (*M. ingens* 16, *Nototodarus sloani* 24, *H. atlantica* 16, *Octopus maorum* 24), fish 15, crustaceans 3 and salps 2 (C.J.R. Robertson). Young fed on 48% of days between end of guard-stage and 100 days old; 79% of days between 101–200 days old; 55% of days at 201 days old (fledging). Weight of meals, 340–1140 g (Richdale 1952).

SOCIAL ORGANIZATION Based on study by Richdale (1950) at Taiaroa Head; information supplied by J-C. Stahl. At sea, solitary or in small groups; up to 20 birds may congregate round fishing vessels (Robertson & Jenkins 1981). Gregarious on breeding grounds.

BONDS Monogamous, lifelong (Richdale 1952), although divorce recorded once (Sorensen 1950). Sex-ratio at Taiaroa Head, 100 males: 76 females (Richdale 1952). Age of first return to colonies, 4–8 years (Richdale 1952); minimum, 5 years (Westerskov 1963). Age at first breeding, minimum 9 years (Richdale 1952); establishment of pair-bond takes at least one season and pair does not breed until next year (Richdale 1952). Pre-breeders establish pair-bond, Nov.–Mar; breeders re-establish pair-bond during pre-laying period (Richdale 1950, 1952). Both sexes incubate and care for young equally. Chicks independent at fledging.

BREEDING DISPERSION Nest colonially. Density: up to 800 nests/ha on Chatham Is; up to 30 nests/ha on Campbell I. (Westerskov 1963). At Campbell I., nests usually 20–50 m apart, minimum 3.5 m (Westerskov 1959). TERRITORIES. Territorial only when breeding; only defend area round nest.

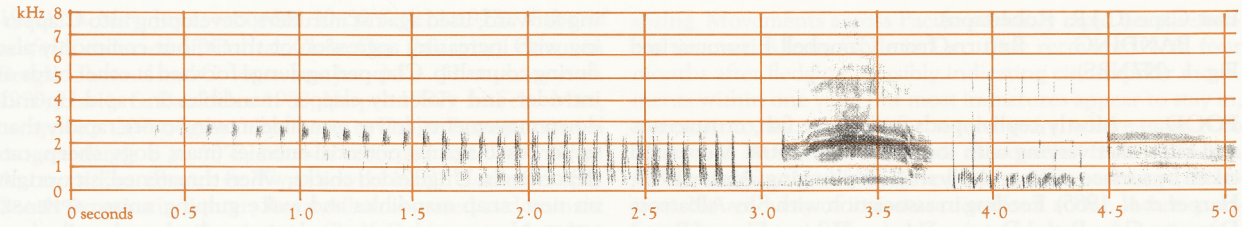
ROOSTING Older immatures (pre-breeders) congregate on loafing and resting areas in groups of up to several hundred (Westerskov 1963).

SOCIAL BEHAVIOUR Based on detailed description by Richdale (1950) at Taiaroa Head. Displays conspicuous, diurnal and easy to observe. Royal and Wandering Albatrosses have most complex sexual behaviour of the albatrosses. Agonistic and sexual displays similar to those of Wandering, except for apparent absence of Bill-vibrating during Courtship, and Whine accompanied by Head-shaking.

AGONISTIC BEHAVIOUR THREAT. **Snapping**: open and close mandibles once or a few times, without lunging forward; used against intruders, developing into Clappering with increasing aggression or threat, but commonly also during courtship. **Clappering**: lunge forward at other birds or intruder and violently clapper mandibles in rapid up-and-down movements, lower mandible moving more rapidly than upper; used against potential enemies (man, dogs, sheep, cattle) or rivals. Unguarded chicks, when threatened, sit upright on nest, snap mandibles and make gulping noise. APPEASEMENT. No appeasement or submissive displays described.

SEXUAL BEHAVIOUR ADVERTISING AND COURTSHIP. **Aerial activity**. Birds keep landing and taking off; usually in threes or more (especially Parties, see below); preliminary to pair-formation. **Sky-call**: head and neck held vertically or at least 45° above horizontal, with mandibles wide-open; mandibles and head not moved once neck outstretched; semi-musical notes uttered simultaneously; head lowered and bill closed as soon as calling stops. Sometimes performed in flight, with open mandibles and head pushed forward in line of flight; performed on ground as others fly overhead or land nearby, and when two birds together at nest; also by parent before feeding chick. **Gawky-look**: push head forward, giving an unusual 'gawky' look; performed by passive bird during Ecstatic Ritual, perhaps to communicate interest in action of other; often precedes Scapular Action and Ecstatic Ritual. **Yapping**: open mandibles fully, neck at angle of 45° from body, head moved up and down vertically, mandibles moved while emitting loud trilling call. Performed between two or more birds: between individuals of mated pair, or casual acquaintances of mixed sexes, or two or more males, or parents and chick. **Billing**: push slightly opened mandibles towards other, usually but not always touching other's bill; usually performed between two birds facing each other, often in response to tugging or mouthing of feathers by second bird. **Scapular Action**: places head and bill for brief moment along scapulars and part of wing; performed during Ecstatic Ritual while facing other bird. **Head-shake and Whine**: head rapidly waved from side to side with bill closed and pointing at other bird while uttering penetrating whining call; bill at first horizontal, then head raised to perpendicular, head-waving gradually stops, bird stands up on toes with erect and fanned tail and wings stretched out fully with primaries curved in towards other bird (**Wing-stretching**). **Ecstatic Ritual**: consists of Billing (may be omitted), Scapular Action, Head-shake and Whine, Wing-stretching, sometimes followed by Sky-call while wings still stretched out. Occurs between two or more birds of different sexes; both sexes may initiate and perform it; during Wing-stretching, performing bird may step round passive bird. Ecstatic Ritual probably signals availability as partner. **Parties**. Up to 13 birds congregate together, where all types of sexual and threat displays performed; Parties may include breeders of either sex (but not after laying) and non-breeders, these staying among incubating birds after laying. Parties often congregate after landing of unattached female; along with Aerial activity and visiting, method of meeting each other. GREETING. At nest, includes Yapping, Mutual Preening; relieved bird may collect nest material (Richdale 1952). ALLOPREENING. **Mouthing** (Mutual Preening): birds nibble each other's head, neck, elbow or tail feathers; common between individuals of mated pair, but also seen between birds as they become acquainted. COPULATION. Ecstatic Ritual not a precursor to copulation, and copulation not accompanied or preceded by any elaborate display.

RELATIONS WITHIN FAMILY GROUP Young fed by incomplete regurgitation. Behaviour when feeding



A J. Kendrick; P100

chick varies between sexes: after landing, male Clappers bill for some minutes, followed by Yapping and Sky-call, and fondling chick when nest reached; female circles before landing, chick approached and fed without preliminary ceremony except bill-claps. Before being fed, chick vehemently nibbles side of adult's bill and utters food-begging call. Chick inserts bill crosswise into that of parent (Richdale 1952).

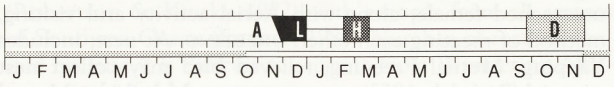
VOICE Account based on description by Richdale (1950); no detailed study so far. Noisy on colonies during pre-laying period, incubation and guard-stage. No sexual, individual differences or regional variations reported. Calls similar to those of *D. exulans*, but Croak (Yapping) apparently less harsh, more musical. NON-VOCAL SOUNDS. Include bill-snaps, bill-clappering during threat displays.

ADULT **Croak** (Warham & Fitzsimons 1987). Loud, somewhat musical ratchet-like call, uttered during Yapping display, often in duet. **Whine**. Penetrating cry audible at considerable distance. Sonagram A shows a Croak, a Whine, bill-clapping and a subdued Whine.

YOUNG Squeaky note, may be emitted as soon as hatched. Biting sound uttered when nibbling itself with its bill; piping food-begging call.

BREEDING Detailed studies at Taiaroa Head, NZ (Richdale 1950, 1952) and Campbell I. (Sorensen 1950). Breed colonially on tussock-covered ridges, peat bogs and leeward side of slopes on SI, NZ Subantarctic islands and Chatham Is.

SEASON Arrival at colonies: at Taiaroa Head, breeding males av. 20 Oct. (20 Oct.–7 Nov.; 26), females av. 30 Oct. (12 Oct.–18 Nov.; 26), non-breeding birds 14 Nov. (28 Oct.–23 Nov.; 11). Interval between arrival and first egg 33.9 days (29–45); female on nest at least 2 days before laying; copulations 2–27 days before laying, fertilization probably *c.* 9 days before laying (Richdale 1950). During pre-laying period, male spends 44% of time on nest, female 26% (C.J.R. Robertson). Departure: from Taiaroa Head, av. 22 Sept. (8 Sept.–13 Oct.; 17); from Campbell I., 28 Oct. (6 Oct.–12 Dec.; 7). At Taiaroa Head, failed breeders leave soon after failure and non-breeders, Mar.; at Campbell I., last non-breeders seen Apr.–May.



(Campbell I.)

SITE Usually sheltered from dominant winds on leeward side of slopes, in gullies, corries among tussock or behind *Dracophyllum* bush; usually some distance from exposed take-off sites, which birds reach along well-established paths (Westerskov 1959, 1963). New nests built every season near previous nest-site. Nest-site selected by male, which usually arrives first.

NEST, MATERIALS Circular mound of tussock, moss, fern and other vegetation; diameter at base 60–90 cm, height 8–30 cm, diameter of cavity 40 cm, depth of cavity *c.* 10 cm (Richdale 1952; Sorensen 1950); at Chatham Is, also of low bushes, small stones and peat (C.J.R. Robinson). Building usually started by male soon after arrival, finished by female just before laying (Richdale 1950); maintained during incubation by parents and later by chick. At Campbell I., chick may build up to three new nests besides original (Sorensen 1950). At Taiaroa Heads, chicks not seen to gather material (Richdale 1952).

EGGS Oval to elliptical; surface slightly pitted; white with some red spotting at larger end or with pale pinkish-brown indiscriminate blotching (Sorensen 1950). MEASUREMENTS. Campbell I., 126.5 (118.0–131.0; 15) x 78.5 (73.5–82.0); Auckland Is, 129 (121–136; 16) x 79 (73–83) (Robertson 1975). Taiaroa Head, 123.6 (3.6; 117.0–132.0; 54) x 77.9 (2.4; 73.0–84.0). WEIGHTS. Campbell I., 425 (376–467; 15). Taiaroa Head, 416.5 (19.1; 378–475; 41).

CLUTCH-SIZE One. Two eggs in nest result from laying by two females (Richdale 1952). At Campbell I., successful breeders do not lay in next season; failed breeders lay in next season after loss; at Taiaroa Head, no successful breeders laid in next season; 88% laid in second season after success; all unsuccessful breeders laid in next season after loss of eggs and may lay also in next season if chick lost before early Apr.

LAYING Campbell I., start *c.* 27 Nov., peak first week Dec.; Auckland Is, start 27–31 Nov. (Robertson 1975). At Taiaroa Head, 13 Nov. (6; 31 Oct.–6 Dec.; 57). Same females tend to lay at similar dates in successive seasons, which suggests date of laying determined genetically (Richdale 1952). Most laying during daytime (Sorensen 1950).

INCUBATION Shared equally by both sexes on average, although pairs differ markedly. Shortest shift first by female 1.6 days (1–4; 16); longest sixth by male 9.4 days (3–17; 15) (Richdale 1952), average number of shifts 12.1 (2.0; 9–16; 12). INCUBATION PERIOD. On Campbell I., 79 days (78–80, 5); at Taiaroa Head, 79.3 (1.0; 77–81; 35).

NESTLING Semi-altricial, nidicolous. Cheeping starts some days before hatching; hatching lasts 1–4 days (Richdale 1952). Protoptile, short and entirely white. Brooded and guarded by both parents. At Campbell I., brood plus guard-stage 35–42 days; brooding shifts, males 6.2 days (2–11; 5), females 6.9 days (2–15; 7). At Taiaroa Head, brood-stage 34.6 days (28–43; 9), guard-stage 6.0 days (0–16; 9); brooding shifts, males 2.1 (1.8; 1–14; 57), females 1.8 (1.4; 1–8; 51). Fed by both parents; by incomplete regurgitation; chick inserts bill crosswise into that of parent; 4–14 regurgitations per bout

(Richdale 1952). At Taiaroa Head, male provided 53% (n=111) of feeds. Feeds by female lasted *c.* 8 min, by male, much longer, always over 15 min. NESTLING PERIOD. On Campbell I., 241 days (224–253; 4); at Taiaroa Head, 236 (11; 216–252; 17).

GROWTH At Campbell I., maximum weight 11.44 kg (135% adult weight) after *c.* 170 days, weight at fledging 8.54 kg (100% adult weight); at fledging, tarsus 91% full grown, wing 95%, culmen 96%; at Taiaroa Head, weight at hatching 305 g, max. weight 11.35 kg after 201–204 days, weight at fledging 8.74 kg (Richdale 1952). Chick independent at fledging.

FLEDGING TO MATURITY Age at first return to colonies: at Campbell I., at least 5 years (Westerskov 1963); at Taiaroa Head, 4–8 years (Richdale 1952). Age at first breeding: at Taiaroa Head, one female at 9 years old, one male at 11 years old (Richdale 1952).

SUCCESS At Taiaroa Head, over 17 years, hatching 59–86% (64 eggs) when loss through human interference eliminated; fledging 52.6–100% when loss through human interference and predation by mustelids (38 chicks) eliminated; total success 31.3%. At Campbell I., hatching 80.9% (71.4–100; 21 eggs) over 3 years; fledging 58.6% (57.1–60.0; 12 chicks) over 2 years; total success 58.1% (42.9–74.3; 122 eggs) over 3 years (Sorensen 1950; Westerskov 1963). Survival: adult 98.9% (Richdale 1952). Controlling factors: main cause of loss of eggs, desertion and infertility and, at Taiaroa Head, flooding and human interference; main causes of chick loss, predation by skuas and, at Taiaroa Head, human interference and predation by ferrets (Sorensen 1950; Richdale 1952).

PLUMAGES Nominate *epomophora*. Gradually attain adult plumage and five plumage stages proposed (Harrison 1979, 1985); these stages, 1 (juveniles) to 5 (oldest birds) (see figure in Harrison 1979, 1985) described here, beginning at oldest stage.

ADULT **Stage 5**. HEAD AND NECK, entirely white apart from occasional small varying patch of brown (119B) to dark-brown (119A) tipped feathers at centre of crown, giving mottled appearance; patch apparently prominent in males, but not likely to increase with age as stated in Westerskov (1960). UPPERPARTS, mostly white; outer mantle-feathers, irregularly vermiculated dark brown (121); concealed bases of feathers, white; vermiculations become broader and darker, approaching black-brown (119), towards lower margins. Larger, lowermost scapulars, white, broad, and narrowly tipped dark brown (121); rachis, dull white. Smaller scapulars, white at base for one-quarter length of feather, rest, dark brown (121), narrowly tipped white; when worn, white tips largely lost or narrow, tips becoming dark brown (119A). TAIL, white; rachis, dull-cream (c54). UPPERWING. Remiges, including humerals, black-brown (119); concealed bases, white, narrowly extending along margin of inner web; rachis, dull white basally, merging to grey-black (82); dull-white rachis on primaries obvious when wing outstretched. Two rows of marginal coverts, and single row of lesser coverts, entirely white. Median and greater coverts, dark brown (121), narrowly fringed white; fringes become broader towards greater coverts; concealed bases of feathers, white. Alula, dark brown (121). Marginal and lesser humeral coverts, white; rest, dark brown (121) with white bases for one-quarter length of feather, and narrowly fringed white. UNDERPARTS, entirely white, including axillaries. UNDERWING, entirely white except for black-brown remiges.

DOWNY YOUNG Protoptile, dull white. Mesoptile, thicker and white; down shorter on side of face. Sorensen (1950) states that in third week, mesoptile appears on head; in fourth week, down on wings and tail appears sooty; in eigth week, protoptile almost all lost; mesoptile complete by thirteenth week. Various ages of chicks illustated in Richdale (1942b), Sorensen (1950) and Robertson & Wright (1973). For full details of plumage development to juvenile, see Sorensen (1950).

JUVENILE **Stage 1**. HEAD AND NECK, entirely white apart from small varying patch of dark-brown (119A) tipped feathers at centre of crown, giving mottled appearance. UPPERPARTS, mostly white; outer mantle-feathers, irregularly vermiculated dark brown (121); concealed bases of feathers, white; vermiculations broader and darker, approaching black-brown (119), towards lower margins. Feathers of lower back, irregularly vermiculated dark brown (121), narrowly fringed white; concealed bases, white. Scapulars, white at base for a quarter of length; rest, dark-brown (121) narrowly tipped white; when worn, white tips mostly lost or narrow, tips then dark brown (119A); rachis, dull white basally, merging to grey-black (82). TAIL, white, varyingly tipped black-brown (119); rachis dull-cream (c.54), grey-black (82) at tips. UPPERWING. Remiges, including humerals, black-brown (119); concealed bases, white, narrowly extending along margin of inner web; rachis, dull white basally, merging to grey-black (82); dull-white rachis on primaries obvious when wing outstretched. All coverts, dark brown (121), narrowly fringed white; white fringes become broader towards greater coverts; concealed bases, white. Alula, dark-brown (121). UNDERPARTS, entirely white. UNDERWING, white except for black-brown (119) remiges and some innermost greater-coverts have pale dark-brown (121) spot on inner web.

IMMATURE TO ADULT **Stage 2**. Age at which plumage attained unknown. Differs from Stage 1 in: HEAD AND NECK. Some loss of dark-brown (119A) tips to feathers of crown. UPPERPARTS. Feathers on back become entirely white. UPPERWING. Innermost marginal humeral-coverts, white, together with small patch of white on lesser humeral coverts and lesser coverts at elbow, the latter forming two distinct patches on upperwing, when wings spread. Some marginal coverts, white on leading edge of wing. With increasing age, whitening of coverts extends posteriorly on wing. **Stages 3 and 4**. Age at which plumage attained unknown. Differs from Stage 2 in: UPPERWING. Two rows of marginal coverts white at leading-edge of wing, with distal subterminal dark-brown (121) vermiculations on webs. Most of rest of coverts, except greater coverts, varyingly vermiculated dark brown (121), or mostly white. Greater coverts, dark brown (121), fringed white.

D.e. sanfordi. Two plumage stages recognized as birds attain adult plumage (Harrison 1979, 1985): Stages 1 (juvenile) and 2 (older birds to adults).

ADULT **Stage 2**. Age at which plumage attained unknown. HEAD AND NECK, mostly white; some feathers on crown varyingly tipped dark brown (119), forming small patch. UPPERPARTS, mostly white; outer mantle-feathers, broadly vermiculated dark brown (121) to black-brown (119), or without vermiculations and fringed white; concealed bases, white; vermiculations where present become broader towards lower margins of mantle. Scapulars, broad, dark brown, (121) to black-brown (119), narrowly tipped white; when worn, white tips mostly lost or narrow, tips then dark brown (119A); rachis, dull white basally, merging to grey-black (82); concealed bases, white. TAIL, white; rachis, dull cream (c54). UPPERWING. Remiges, including humerals, black-brown

(119); concealed bases, white, narrowly extending along margin of inner web; rachis, dull white basally, merging to grey-black (82); dull-white rachis on primaries obvious when wing outstretched. All coverts, dark brown (121), narrowly fringed white with concealed white bases; fringes become broader towards greater coverts. Alula, dark brown (121). All humeral coverts, except at leading margin, dark brown (121), white basally for one-quarter length of feather and narrowly fringed white. UNDERPARTS, entirely white, including axillaries. UNDERWING, mostly all white, except for dark-brown (121) marginal primary-coverts, which form dark leading-edge, extending from base of primaries to carpal joint and black-brown (119) remiges.

DOWNY YOUNG Similar to nominate *epomophora* (see above).

JUVENILE **Stage 1**. Differs from adult in: HEAD AND NECK. More dark-brown (119A) mottling on crown. UPPERPARTS, mostly white; outer mantle-feathers, black-brown (119) fringed white. Feathers of lower back, irregularly and broadly vermiculated dark brown (121) to black-brown (119) and narrowly fringed white; concealed bases, white. TAIL, white, varyingly tipped black-brown (119); rachis, dull cream (c54), grey-black (82) at tips.

BARE PARTS Based on photos in Lindsey (1986) and at NZDOC Library except where stated. Sorensen (1950) suggests sexual dimorphism in colour of bare parts, but further study required.

ADULT Iris, dark-brown (219). Eyelid, grey-black (82); sometimes spotted white in older birds. Bill, pink (108D); flushes when rearing chick (NZRD); ungues, buff-yellow (53); tomia of upper mandible grey-black (82). Tarsus, pink (108D) to bluish-white; flushes to pink during nesting period (NZRD). Toes and webs, grey (84), pink veins often visible on webs and tarsus; claws, cream (54), tipped grey-black (82).

DOWNY YOUNG Iris, black-brown (119). At 8 weeks, eye-lids, greyish brown to black on inner edges, shading to dark bluish-grey on outer; bill has pinkish tinge at this time (Sorensen 1950). At 19 weeks, eye-lids black in advanced chicks, brown-black in others (Sorensen 1950). Bill, grey-black (82), lightening to dull-pink with age; black margin along tomia of upper mandible, faint at 32 weeks old; ungues, cream (54); Archey (1923) states bird in mesoptile has bill, pale flesh-pink; tip, yellowish with dull-pink flush; these birds estimated at 6–7 weeks old (Sorensen 1950). Legs and feet, pale grey (86) with light-grey (85) webs; during eighth week, feet darken to bluish-grey (Sorensen 1950).

JUVENILE Similar to adult, but bare parts paler as suggested by descriptions of Sorensen (1950; *q.v.* for full details).

MOULTS Based on skins (NMNZ), except where stated.

ADULT Complete; body-moult begins during last few weeks of incubation or during first weeks of guard-stage. No shed primaries found at breeding colony (Sorensen 1950). Apparently, remiges moulted at sea. Primaries moult outwards in staffelmauser; duration of moult, unknown; tail-moult, staffelmauser. Beachcast birds on NZ coasts in heavy wing-moult during Apr. and prone to die during storms (Kinsky 1968); high frequency of beachcast birds in NZ in May–June may be related to moult (Powlesland 1985). Not known whether there are subspecific differences in moult-strategies. Skins of beachcast adults in NZ (NMNZ): *epomophora* moulting primaries June, Aug. and Sept.; *sanfordi*, Apr. and May. Failed breeders likely to moult earlier than successful breeders (Brooke 1981); unsucessful breeders begin leaving colony during incubation period and have left colony by the end of the guard-stage by successful breeders.

POST-JUVENILE A juvenile *epomophora* recovered in Chile had lost mottling on crown at *c.* 13 months (Sorensen 1954). Rest, undescribed.

MEASUREMENTS Nominate *epomophora*: (1) Campbell Is, adults, recently dead; methods unknown (Westerskov 1960). (2) Campbell Is, breeding adults; methods unknown (Robertson 1980).

		MALES	FEMALES	
WING	(1)	696.4 (11.56; 674–707; 5)	673.0 (14.73; 647–686; 5)	*
	(2)	698.0 (17.5; 11)	666.0 (15.7; 7)	
BILL	(1)	184.0 (2.89; 179–188; 5)	170.6 (4.78; 163–177; 5)	*
	(2)	185.8 (5.2; 11)	171.7 (5.2; 7)	
BILL D	(1)	68.1 (1.90; 65.8–71.2; 5)	63.0 (0.62; 62.3–64; 5)	*
TARSUS	(1)	136.2 (1.46; 134–138; 5)	124.8 (1.16; 123–126; 5)	*
	(2)	129.2 (2.7; 11)	121.8 (1.8; 7)	
TAIL	(2)	217.4 (4.54; 211–224; 5)	205.2 (4.87; 196–210; 5)	*
TOE	(1)	212.5 (3.05; 209.3–216.4; 5)	195.3 (6.17; 185.7–202.1; 5)	*
	(2)	178.4 (3.1; 11)	166.1 (4.7; 7)	

D.e. sanfordi: (3) Chatham Is, unknown status; methods unknown (Murphy). (4) Tairoa Head, NZ, breeding adults, live; methods unknown (Richdale 1942b).

		MALES	FEMALES
WING	(3)	615.0 (590–630; 5)	616.0 (593–639; 12)
	(4)	654.2 (11.82; 634–669; 5)	622.4 (4.80; 614–627; 5)
BILL	(3)	162.6 (156–168; 5)	160.8 (151–170; 12)
	(4)	169.2 (2.48; 165–172; 5)	158.2 (2.22; 154–160; 5)
TARSUS	(3)	117.4 (112–120; 5)	113.6 (111–120; 12)
TAIL	(3)	191.0 (186–195; 5)	189.0 (175–197; 12)
TOE	(3)	157.0 (151–162; 5)	150.5 (146–158; 12)
	(4)	170.0 (4.93; 164–176; 5)	161.0 (2.09; 159–165; 5)

Additional measurements in Murphy, Falla (1938) and Sorensen (1950). Some measurements of chicks in Richdale (1942b). Full details of growth rates of chicks in Sorensen (1950) and Richdale (1952).

WEIGHTS In kg. Nominate *epomophora*: at Campbell Is, recently dead adult breeders, Jan.–Feb.: males 8.9 (0.4; 8.2–9.5; 5), females 7.6 (0.8; 6.6–9.1; 5) (Westerskov 1960); at Campbell Is, live adult breeders, no date: males 10.3 (0.74; 11), females 7.7 (0.59; 7) (Robertson 1980). Subspecies *sanfordi*: at Chatham Is, adult breeders 6.53–6.80 (Murphy). Full details of changes of weights in chicks in Sorensen (1950), Richdale (1952), Tickell (1968) and Robertson & Wright (1973).

STRUCTURE Largest Albatross. Wing, long and narrow. Eleven primaries, p10 longest, p9 c.16 mm shorter, p8 56, p7 101, p6 155, p5 213, p4 276, p3 323, p2 370, p1 402, p11 reduced and concealed by greater primary coverts. Twenty humerals, *c.* 36 secondaries, including six tertials. Humerals of similar length to secondaries. Tail, short and rounded; 12 rectrices, t1 longest. Inter-ramal space, feathered. Bill, long and solid, moderately laterally compressed; maxillary unguis, ro-

bust and hooked; bill, deep at base. Nares operculate, pointing forwards with well-rounded lumen and situated near base of bill, in groove of culminicorn and latericorn. Naricorn, broad and well rounded proximally. Arcuate growth-lines visible at proximal naricorn, base of ungues and base of ramicorn. Tarsus, slender and moderately rounded in cross-section; feet webbed. Claws long and curved. Outer and middle toes about equal in length, inner *c.* 86% of middle; hind toe absent.

SEXING, AGEING Westerskov (1960) discusses various methods for sexing *epomophora*; toe seems most accurate. At Campbell Is, toe measured: adult males, 24.8 mm (24.0–24.7; 5), females 21.3 (20.7–22.1; 5); considered male if toe >24 mm; female <24 mm. For full details see Westerskov (1960).

RECOGNITION Confusion possible with Wandering Albatross. Differ in plumages; structure of nostril and shape of naricorn: nostril points obliquely upwards in Wandering Albatross and naricorn less rounded (Murphy); bare parts: Royal has black line along tomia of upper mandible, horn coloured in Wandering Albatross; eyelids black in Royal Albatross.

GEOGRAPHICAL VARIATION Subspecies *sanfordi* smaller than *epomophora* (Murphy 1917; Falla 1938) with darker wing, without white on upper wing-coverts; dark-brown (121) greater under wing-coverts; development of plumages also differ (Harrison 1979, 1985).

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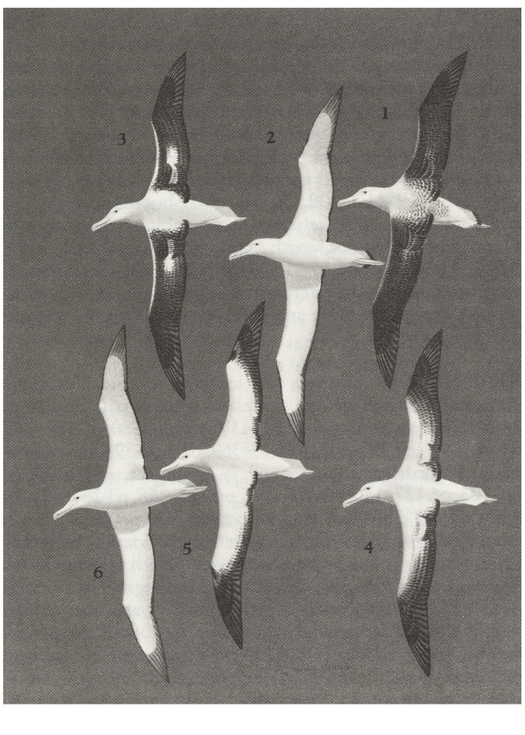

Volume 1 (Part A), Plate 15

Royal Albatross *Diomedea epomophora epomophora*
1. Juvenile, dorsal, Stage 1
2. Juvenile, ventral, Stage 1
3. Dorsal, Stage 2
4. Dorsal, Stage 3
5. Adult, dorsal, Stage 5
6. Adult, ventral, Stage 5