

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.

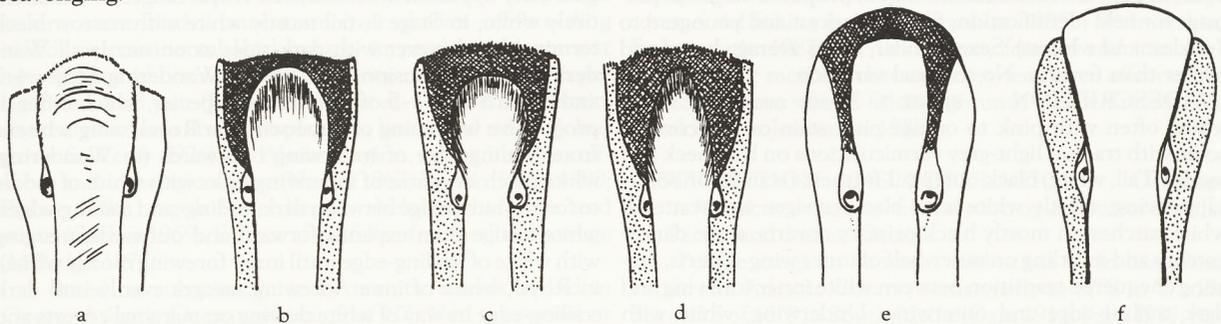


Fig. 1 Dorsal view of base of bill of small *Diomedea*

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

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 bulleri Rothschild, 1893, *Bull. Br. Orn. Club* 1: 58 — New Zealand.

Named in honour of Sir W.L. Buller FRS, 1838–1906, author of *Birds of New Zealand*.

POLYTYPIC Nominate *bulleri* breeds Solander and Snares Is; *platei* Reichenow, 1898, on Chatham and Three Kings Is.

FIELD IDENTIFICATION Length 76–81 cm; wing-span 205–213 cm, males averaging slightly larger; weight: 2.4–3.1 kg. Small, rather lightly built albatross with long slender striking black-and-yellow bill. Between Yellow-nosed *D. chlororhynchos* and Grey-headed *D. chrysostoma* Albatrosses in shape. Adult superficially similar to several other grey-headed albatrosses; has neat grey hood, prominent white or silvery-white forecap, black patch before eye, and thin white crescent to rear of and below eye; underwing mostly white, with moderately broad, fairly straight and sharply defined black leading-edge. Bill pattern, striking and diagnostic. Two subspecies (see Geographical Variation). Sexes alike. No seasonal plumage differences. Juveniles and immatures separable.

DESCRIPTION (Nominate *bulleri*). **ADULT.** Forehead and forecrown, white, forming pronounced white cap sharply defined at sides by dark patch before eye and merging at rear into light grey of rear crown and nape. Small oval-shaped greyish-black patch before and, narrowly, over eye; extends slightly more than halfway across upper lores towards base of upper mandible before merging into light grey of anterior lores. Narrow white crescent encircles rear and bottom of eye. Rest of head and neck, uniform light grey, forming neat grey hood sharply demarcated from white of upper breast; hood appears pale grey in bright sunlight, much darker in overcast conditions or at distance; slightly paler pearly grey with wear and fading; merges into light grey mantle. Inner scapulars and back show greyish cast which combines with mantle to form subtle grey saddle contrasting with darker wings. Outer scapulars and upperwings, uniform brownish-black, wearing browner; white bases of primary shafts visible in outer primaries. Rump and upper tail-coverts, white. Tail, light grey, wearing darker. Underbody, from upper breast to under tail-coverts, white; underside of tail, blackish. Underwing, white, with moderately broad, fairly straight black leading-edge, thin blackish trailing-edge and blackish tip. Leading-edge narrowest between base of outermost primary and carpal joint; broadens gradually inward from carpal towards body,

attaining maximum width between elbow and base of wing; at widest point, occupies about one-third width of wing; inner edge runs nearly parallel with leading-edge of wing and is sharply demarcated from white of lining. Blackish trailing-edge much thinner than leading-edge; also sharply demarcated from white lining. Primaries, blackish, merging into paler greyish on bases of inner webs. Bill: maxillary unguis and culminicorn, bright yellow, forming broad yellow stripe down top of bill, broadest at base where culminicorn noticeably expanded and square-ended; thin strip of skin round base of upper mandible, and narrow strip of skin between culminicorn and latericorn, extending from base of bill to nostrils, black; nostrils, black; latericorn and upper half of ramicorn, dull black, becoming paler greyish-black towards base of bill; many show diffuse paler greyish area at base of latericorn; lower half of ramicorn, bright yellow, forming thick yellow stripe of constant width along bottom of bill, from base to gonys; extreme tip of mandibular unguis, bright yellow; cheek stripe (exposed during display) and transverse strip of bare skin at base of lower mandible, bright orange. In profile, stripes show as thick yellow outline to bill, conspicuous at some distance; in close view, stripes combine with orange strip of skin at base of lower mandible to confer distinctive snarling expression. Legs and feet, bluish flesh; webs, paler flesh. **JUVENILE.** Differences from adult: (1) White cap more extensive, includes rear crown. (2) Blackish eye-patch slightly smaller and paler on some. (3) Grey of head and neck, slightly paler, less bluish in tone, but extent and strength of grey on head and neck varies greatly: darkest have uniform light-grey hood with white cap (similar to that of adult); others, paler grey to nearly whitish on cheeks and ear-coverts and whitish on chin and throat, shading into light grey on nape, hindneck, sides of neck and foreneck and appear collared rather than hooded. During first year or more at sea, grey much reduced by wear to pronounced hindneck collar (incomplete on some). (4) Grey of hindneck merges into light grey of mantle, inner scapulars and back which form paler and more pronounced grey saddle, contrasting with blackish upperwings; outer and longest scap-

ulars and coverts of innerwing, have pronounced light-grey fringes producing scaled appearance to edges of saddle and innerwing, unique among small albatrosses; scaled appearance lost rapidly with wear. (5) Underwing as adult but some have a few short black streaks jutting from rear margin of leading-edge, behind elbow. (6) Bill, mostly brownish-horn with dark tip of varying extent; on some, unguis mostly black, showing as large dark tip contrasting with brownish-horn base and small pale area on very tip of bill; on others, pale tip larger, confining dark on maxillary unguis to smaller, dull-blackish area on basal half of nail, which combines with black mandibular unguis to form dark subterminal band, contrasting with brownish-horn base and pale tip. Fledgelings typically have black saddle of varying extent over base of culminicorn, extending onto basal latericorns; sometimes only dusky wash over base of bill. Bare skin round base of bill and forward in strip to nostrils, and cheek stripe, black. During first year at sea, culminicorn and (later) ramicorn stripes become paler creamy-horn, giving slight contrast with duller brownish-horn side-plates. **IMMATURE.** Changes in plumage and colour of bill with age not well understood; effects of wear on head and neck appear to be more marked in immatures than adults. Plumages very similar to adult but (1) on some, hood much paler pearly-grey after initial wear, becoming increasingly patchy, especially on chin, throat, cheeks, ear-coverts and nape; some also develop larger white cap, recalling juvenile; grey of hindneck, sides of neck and foreneck wears less than rest of head, showing as subtly darker rear-half of hood, shading forward into paler rest of head. Unknown if immatures develop whitish head backed with pronounced grey hindneck collar. (2) Gradually develop adult bill-colour: tip of bill, culminicorn and ramicorn stripes gradually become paler, more contrasting and yellow; sides of bill gradually darken, turning blackish and transverse strip of bare skin at base of inner mandible brightens. Younger immatures typically have brownish-horn side-plates with contrasting dark subterminal spot; older immatures have paler greyish-black side-plates. Age at which fully adult bill colour attained unknown; older immatures often recognizable from adult only by slightly duller yellow bill-stripes and, in some, by trace of dusky mark on base of maxillary unguis.

SIMILAR SPECIES Superficially similar to several other grey-headed albatrosses. **Grey-headed Albatross** slightly larger and differs in shape (recalling Black-browed Albatross *D. melanophrys*): neck appears somewhat thicker and body fuller giving slightly more robust jizz; bill, slightly shorter and thicker in profile. Adult differs from adult Buller's by: (1) Entire head and neck, grey, slightly paler on forehead and forecrown but not giving pale-capped appearance; with wear, hindneck noticeably paler pearly-grey than rest of hood (uniform with rest of hood on Buller's). (2) Yellow culminicorn stripe rounded and narrower at base; tip of bill, orange, confined to ridge of maxillary unguis, leaving sides of unguis black (maxillary unguis wholly yellow on Buller's); yellow stripe along bottom edge of lower mandible narrower, and tapers evenly from base of bill to gonys (stripe noticeably thicker and of constant width on Buller's); sides of bill, glossy black (duller greyish-black on Buller's); at distance, bill appears blacker, with yellow stripes and orange tip less conspicuous (on Buller's, thicker stripes and yellow tip give distinctive appearance of conspicuous thick yellow outline to bill; side-plates can reflect light strongly, adding to generally paler-billed appearance). At close range, strips of black skin between culminicorn and latericorn, thicker and extend

narrowly round base of culminicorn, clearly separating latter from feathering on forehead (unlike Buller's). (3) Black leading-edge of underwing slightly thicker and broadens into pronounced wedge behind elbow, with series of dark streaks or smudges running off this and merging into white lining; leading-edge broadens abruptly outside carpal, forming thicker dark margin to primary-coverts, with series of short dark streaks running off this and radiating across white median primary-coverts (on Buller's, no streaking on primary coverts); thus, rear margin of black leading-edge behind elbow and primary-coverts, not clear-cut; black trailing-edge thicker and less sharply demarcated from white lining; in general, underwing shows less white; pattern recalls that of Black-browed Albatross whereas narrower, straighter, more clear-cut margins of Buller's recall underwing pattern of Yellow-nosed Albatross. **Immature Grey-headed** differs from immature Buller's by much thicker, less sharply-defined black margins on underwing, heavy dark streaking on subhumeral and pronounced streaking on primary coverts; side-plates of bill, darker glossy-black, never with contrasting dark subterminal spot. **Juvenile Grey-headed Albatross** unlikely to be confused with juvenile Buller's; has entirely dark underwing (not white with black margins), darker blacker bill, with little contrast between blackish tip and rest of bill (Buller's shows obvious contrast), and darker slate-grey hood lacking white forecap. Adult **Yellow-nosed Albatross** *D.c. chlororhynchos* of South Atlantic slightly smaller and body more slender; has grey hood and white forecap but differs from adult Buller's in (1) slightly paler, more pearly-grey hood; in some, chin and throat paler than rest of hood; (2) eye-patch appears as large, downward-pointing triangle of black almost reaching base of culmen and extending back in diagonal line across lores to end in small tear-drop immediately below eye (eye-patch, smaller, oval-shaped on Buller's, without tear-drop); white crescent behind eye broader and squarer, fading into grey of ear-coverts and not extending fully round bottom of eye; (3) no yellow stripe on lower mandible; side-plates, glossy-black; yellow culminicorn stripe narrower; bill-tip bright orange and restricted to ridge of maxillary unguis leaving sides of unguis black; basal end of culminicorn stripe much narrower, rounded, with much thicker strips of black skin either side, extending forward to nostrils and broadly round base of culmen, clearly separating latter from feathering on forehead. (4) Upperwing and back darker, blackish; (5) dark leading-edge of underwing narrower; wing-tip darker, inky-black. Adult **Yellow-nosed Albatross** *D.c. bassi* of Indian Ocean unlikely to be confused; has mostly white head with grey flush confined to cheeks and ear-coverts when fresh; smaller and paler patch before eye, and sharply pointed basal end to culminicorn stripe in addition to differences in size, shape, bill and underwing patterns already noted. **Juvenile and immature Yellow-nosed** (both subspecies) have wholly white heads and blacker bills. **Shy Albatrosses** *D. cauta*, especially adult *salvini*, much larger; appear longer-winged, with larger head, fuller body, stouter bill, and more powerful, though less manoeuvrable, flight, combining to impart heavier, longer-winged jizz. Underwing, clean white with very narrow black margins and diagnostic black pre-axillary notch at base of leading-edge, an excellent character visible at distance.

Breed only NZ. Pelagic in subtropical and subantarctic South Pacific. In A'asian region, concentrate in some numbers over rises and along shelf breaks; regularly range into outer continental shelf-waters; except round breeding places, usually seen well inshore or from land only during rough

weather. Swim with upright erect posture, emphasizing small head and slender-necked jizz, typical of other albatrosses. Flight effortless and graceful, in strong wings wheeling in broad arcs well above horizon and soaring on stiff, almost motionless wings; flap more in light winds but in calms prefer to settle on sea. As with congeners, patter along sea-surface when taking flight, flapping wings vigorously till well clear of waves. Feed by surface-seizing, occasionally surface-diving. Nest colonially, in small loose groups or dense colonies according to habitat and site. Solitary or gregarious at sea; attend trawlers in large numbers for offal. Often follow ships. Noisy on breeding colonies during daylight hours, where main calls loud croak and loud wail.

HABITAT Marine, pelagic; in subtropical and subantarctic waters of S. Pacific Ocean. Habitat preferences poorly known. In NZ, observed in association with fishing boats close inshore and over waters of 180–360 m depth (Secker 1969; Robertson & Jenkins 1981), although not so strongly associated with fishing grounds as other albatrosses (Bartle 1974). In Aust., over inshore, offshore and pelagic waters (Rogers 1969; Barton 1977; Carter 1977; Blaber 1986); off se. Tas., prefer waters of E. Aust. Current where surface-temperature > 16.5°C (Blaber 1986).

Breed on subtropical and subantarctic islands and rock stacks in NZ region; on sparsely vegetated slopes, cliff tops and ledges of rocky islands or stacks on Chatham and Three Kings Is (Dawson 1973; Robertson 1974; Wright 1984); and in range of coastal and inland habitats, including bare or fern- and tussock-covered cliffs, slopes or ridges, open grassy meadows, or summit plateaux under *Olearia* forest on Snares and Solander Is (Richdale 1949a; Wilson 1973; Cooper & Morrison 1984).

Fly in low or medium airspace using updraft off sea swell for lift. Take food from surface; shallow dives to depth of 1 m observed (Fenwick 1978).

DISTRIBUTION AND POPULATION NZ endemic. Distribution at sea poorly known. Pelagic range across s. Pacific Ocean, N of Antarctic Convergence, from se. Aust. to w. S. America; distribution centred on NZ waters. Non-breeding migrant to Aust.; also regular to Chile and Peru. Breed on outlying NZ islands.

Extraterritorially: recorded in Humboldt Current off coasts of Chile and Peru (Murphy; Johnson 1965; C.J.R. Robertson) but numbers and frequency unknown (Harrison 1983). Most northerly record: bird banded at Snares Is recovered at 12°25'S, 105°06'W (2000 km SW of Galápagos Is) 13 Oct. 1979 (Warham 1982).

AUST. Regular visitor to se. Aust. Formerly regarded as rare in Aust. waters (first record, 1963, NSW) but more frequent sightings recently. No records WA or Qld. **NSW.** Beachcast, 2 May 1963, Thirroul, NSW (Strong 1965); 13 Aug. 1967, near Thirroul (Rogers 1969); one, 19 Apr. 1969, off Sydney (Rogers 1969); uncommon off coast N of Eden (D.W. Eades). Most n. records in Aust: off Coff's Harbour, NSW, 19 June 1974 and 8 June 1976 (NSW Bird Reps 1983, 1986; published without supporting details). **Vic.** First sighting, 19 June 1965, C. Schanck (Carter 1977); uncommon, but several sightings in e. Bass Str. off Gippsland (D.W. Eades). More recently, numerous records published without supporting details: three birds, 1984; ≥ 15, 1985 (Vic. Bird Reps 1984, 1985). **Tas.** Regular visitor, common off e. coast and in e. Bass Str.; less frequent off w. coast and w. Bass Str. (D.W. Eades).

In six cruises round Bass Str. and e. and w. Tas. coasts, 89 birds recorded, of which 77 were in e. and 12 in w. regions (D.W. Eades). **SA.** Two sightings: off Newland Head, 10 July 1979 (Close 1982); 60 km WSW of Southend, 1 June 1980 (Parker & May 1982).

NZ. Throughout NZ waters, N of Antarctic Convergence, ranging N to at least Auckland; recorded at Kermadec Is. Common in s. regions. Seen at sea off e. coast of NI between Cook Str. and East Cape in Nov. 1978 (C.J.R. Robertson). Beachcast specimens often collected in W. Auckland (68% of all NI records, 1970–80). Highest recovery rate of beachcast birds on NI: 0.46 birds/100 km Wellington South (Powlesland 1985). Common Cook Str., mostly in E (Secker 1969) and often seen Tasman Bay (CSN 26, 29). Occasionally beachcast e. coast of SI. Very common round Southland and Stewart I. and beachcast specimens frequently collected: 86% of all beachcast birds collected on SI between 1970 and 1987 were from Southland. Highest rates of recovery: 1–5 birds/100 km; 0.43/100 km (Powlesland 1985). Most commonly seen albatross S of NZ from Otago Pen. to Snares Is and w. of Foveaux Strait (C.J.R. Robertson). Dead juvenile found 130 km inland near Alexandra, Otago (CSN 22). Generally no further S than 50° (Falla *et al.* 1978) but once observed close inshore round Auckland Is, Apr. 1943 (Oliver). One, beachcast, Raoul I., Kermadec Is, 1 July 1972 (Reed 1973).

BREEDING

Snares Is: 1969–77, 4750 pairs (Warham & Bennington 1983);

Main (North East) I., Broughton I., Alert Stack, Daption Rocks, Toru Islet (Miskelly 1984; Warham 1967; Horning & Horning 1974);

Solander Is

Solander I.: 1985, 4000–5000 pairs (Cooper *et al.* 1986);

Little Solander I.: 1985, c. 300 pairs (Cooper *et al.* 1986).

offshore stacks: unknown.

Chatham Is:

Forty Fours, Motuhara: 1973–74, 23 000–24 000 pairs (Robertson 1974); Sisters Is: 1973–74, 2000 pairs (Wright 1984);

Round Rock (Wright 1984);

Three Kings Is, Rosemary Rock: 1983, six pairs (Wright 1984); 1985: 18 birds, 15 nests (McCallum *et al.* 1985)

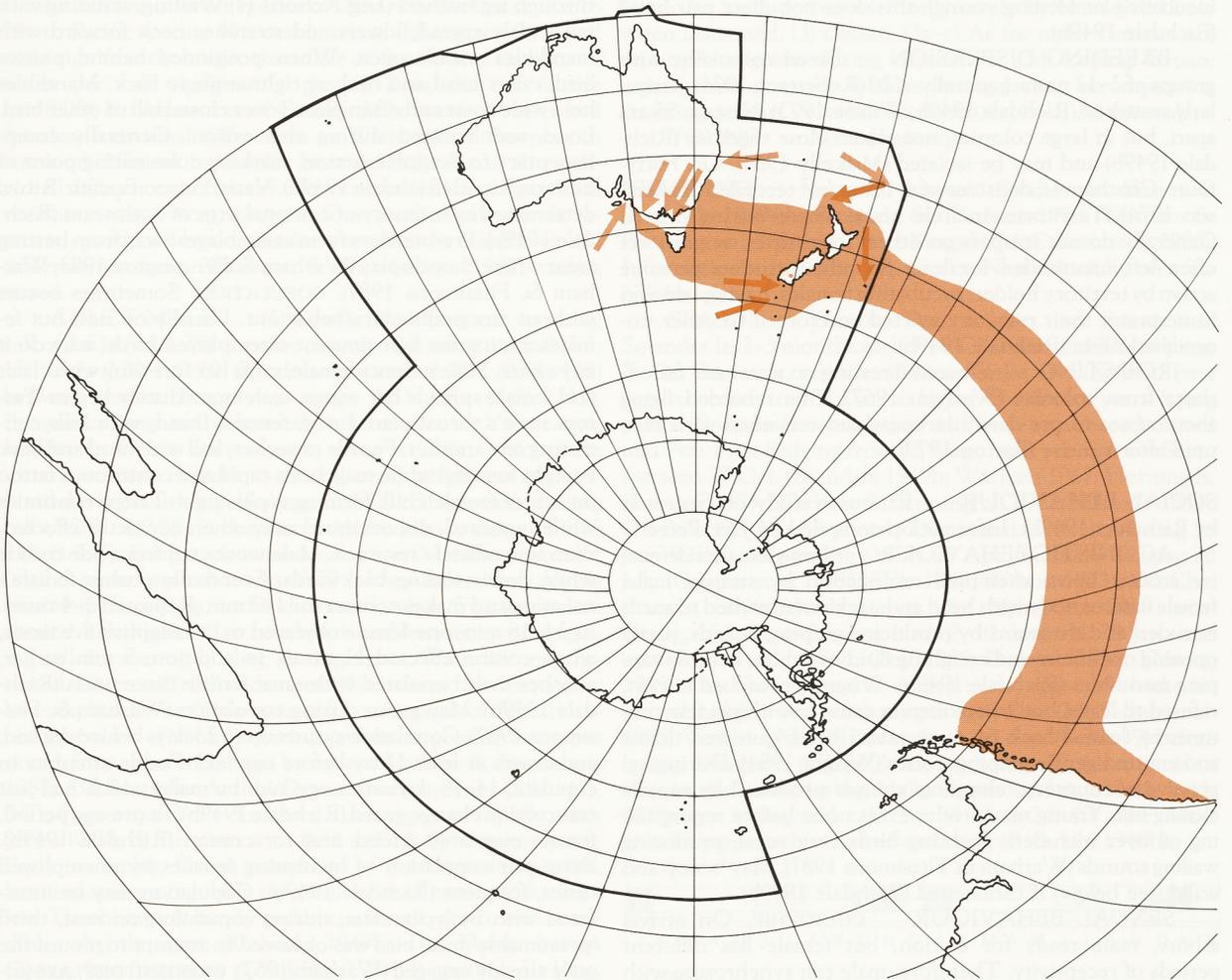
Total population estimated to be about 30 000 breeding pairs (Warham & Bennington 1983).

MOVEMENTS Poorly known. Adults may move only locally but at least some, possibly only pre-breeders, move to Humboldt Current (Murphy; Warham 1982).

DEPARTURE Most young fledge from Snares Is, Sept.–Oct. (Warham & Bennington 1983), extreme dates 22 Aug.–23 Oct. (Horning & Horning 1974); young fledge Chatham Is, early-mid June.

NON-BREEDING, BREEDING Uncommon E of Cook Str., NZ, until late Apr. (Bartle 1974) and recoveries from NZ beaches peak in June, all those determined being nominate *bulleri* from s. beaches (Powlesland 1985). Movement to South American waters poorly known, timing and route taken on outward or return trips unknown. Little information. Of birds observed in Tas. waters 87.8% occurred Jan.–June with 48.6% seen Mar–Apr., possibly foraging while feeding young (138 observations; D.W. Eades).

RETURN To Solander I. (Falla 1948; Wilson 1973;



Cooper *et al.* 1986) and probably Snares Is (Warham & Bennington 1983) early Nov.–early Dec., possibly as late as mid-Dec. (Richdale 1949b). At Chatham Is, first seen 9 Sept.

BANDING Chick banded Snares Is recovered 7640 km NE (Warham 1982; not NW as in original report), i.e. 2000 km SW of Galápagos Is).

FOOD Mostly squid with some fish, krill and tunicates. **BEHAVIOUR.** Probably take most food by surface-seizing (Harper *et al.* 1985); also recorded diving to 1.0 m into swarming euphausiids at Snares Is (Fenwick 1978), shallow-plunging to catch fish off Solander Is (Wilson 1973) and following fishing boats. Only seen feeding during the day (Bartle 1974).

BREEDING At Snares Is (stomach contents of one chick; regurgitations ten adults, three juveniles) and Chatham Is (regurgitations of eight adults, four juveniles; West & Imber 1986) cephalopods 85.1% freq., fish 48.1 (Moridae *Pseudophycis bacchus* 7.7, Pentacerotidae *Pentaceros richardsoni* 3.8), crustaceans 44.4 (copepods *Trifur lotellae* 7.7, barnacles *Lepas australis* 15.4, mysidaceans *Gnathopausia* 3.8, isopods *Livoneca raynaudi* 11.5, euphausiids *Euphausia spinifera* 3.8, unident. 3.8, decapods *Munida gregaria* 3.8, unident. 7.7), tunicates 25.9 (*Pleurogona* 3.8, Pyrosomida *Pyrosoma* 7.7, Desmomyria 23.1), unident. bird remains 18.5. Of the cephalopods (172 identified) Ommastrephidae *Nototoda-*

rus 77.3% no. (lower rostral length 0.08–1.04 cm) with unident. Ommastrephidae 0.01 (0.60–0.74), Onychoteuthidae *Moroteuthopsis ingens* 2.3 (1.02–1.12), *Moroteuthis robsoni* 0.6, Enoploteuthidae *Ancistrocheirus leseuri* 0.6, Octopoteuthidae *Octopoteuthis* 0.6 (1.27), Histioteuthidae *Histioteuthis atlantica* 0.58, (0.31–0.70), *H. doffleini* 0.6 (0.51), *H. macrohista* 2.3 (0.31–0.44), *H. miranda* 0.6 (0.63), *H. sp.* 1.2, Mastigoteuthidae *Mastigoteuthis* 0.6, Chiroteuthidae *Chirotheuthis* 0.6 (0.49), Cranchiidae *Taonius* 0.6 (0.57), *Teuthowenia impennis* 0.6, Octopoda Octopodidae *Octopus maorum* 1.2 (1.19 cm lower crest length), Ocythoidae *Ocythoe tuberculata* 0.6 (1.18) and Argonautidae *Argonauta nodosa* 2.9 (0.69–0.99). The size of *Nototodarus* increased through the breeding season.

SOCIAL ORGANIZATION Away from colonies (Cook Str.) usually solitary until mid-Apr. During autumn never more than eight together (Bartle 1974). Rest offshore in groups (Warham 1967). May form feeding flocks with other seabirds (Wilson 1973); a mixed flock of 5000+ birds including Buller's recorded about fishing boats in Canterbury Bight (Jenkins 1971).

BONDS Monogamous. May retain partner for up to 23 years. Do not remate while original partner known to be alive (Richdale & Warham 1973). Unemployed males may force coition with females who are not their mates (even those

incubating or feeding young); this does not affect pair-bond (Richdale 1949b).

BREEDING DISPERSION Breed colonially, with groups of 2–12 nests, generally <20 (Robertson 1974), irregularly scattered (Richdale 1949b; Wilson 1973). Nests c. 55 cm apart, but in large colonies, not placed close together (Richdale 1949b) and may be isolated (Miskelly 1984). On Fort-yours, Chatham Is, densities of c. 1 nest/m² recorded (Robertson 1974). Territories include nests, where mating occurs. Generally do not trespass on others' territories, as nests are often left unattended for long periods; intruders provoke action by territory holder. Incubating females, having laid eggs in nests not their own, are evicted and forced to other unoccupied nests (Richdale 1949b).

ROOSTING Observed resting on water not far offshore from colonies (Warham 1967). One recorded flying about at sea in pre-dawn darkness and remained with boat until after sunrise (Barton 1979).

SOCIAL BEHAVIOUR Extensive study on Snares Is by Richdale (1949b). Information compiled by J.M. Peter.

AGONISTIC BEHAVIOUR Lone female's defensive actions upon attempted molestation by strange male: female flattens body with head and neck outstretched towards intruder, and threatens by producing gulping sounds, partly opening mandibles and coughing fluid over him, before snapping mandibles (Richdale 1949b). When approached at nest, refused to leave, but when observer came to within a few centimetres, leaned back on tarsi, raised head, quivered throat and emitted gentle gulping noises (Wright 1984). During aggressive encounters, 'clopping' sounds produced by rapidly closing bill. Young may produce this noise before regurgitating oil over intruders. Fighting birds very vocal, producing wailing sounds (Warham & Fitzsimons 1987). May 'scoop and walk' (see below) if threatened (Richdale 1949b).

SEXUAL BEHAVIOUR **COURTSHIP.** On arrival ashore, male ready for coition, but female has different periods of receptivity. Therefore, male can synchronize with female when she is ready (Richdale 1949b). **Pre-coition Ceremony (Ecstatic Ritual)** has four phases. (1) **Scoop and Walk**, only given by male: head and bill dipped sharply to ground in front of feet; bill then stretched out in front of body in scooping action; tail fanned; action repeated, with body bobbing up and down on bent legs; male proceeds slowly and deliberately round female; stamps feet, but no sound uttered unless excessively excited, when wailing may occur. (2) **Rapier Action**: performed by two birds facing each other; male usually more active, but female may initiate action. With head, neck and bill raised slightly from parallel to ground, bill extended straight towards object of attention, gently touching it with rounded part of closed bill. If no resistance, subject bird may be preened, or bill may be withdrawn. Main type of mutual preening. If subject bird objects to Rapier Action, withdraws head from approaching bill and may repeatedly clash bills in lateral action (**Mandible Spar** of Warham & Fitzsimons 1987). May encourage **Scooping** and **Clashing** of short duration, where male **Scoops** one to four times, clashing bills with subject bird often succeeded by **Scooping and Walking**. (3) **Scapular Action**: standing with feet wide apart, wings raised to form V, with tail fully fanned. Suddenly ceasing other behaviour, momentarily looks straight ahead, then quickly turns head to one side and places it on scapulars on opposite side for maximum 3 s before straightening and facing subject bird again. Less often, bill placed at top of thigh and run

through leg feathers (**Leg Action**). (4) **Wailing**: standing with tail widely spread, lowers and stretches neck forward with mandibles widely open. When positioned behind passive bird, raises head and neck at right angle to back. Mandibles held wide apart and often placed over closed bill of other bird. Loud wail emitted during this action. Generally complementary to Scapular Action, marking culminating point of Ecstatic Ritual (Richdale 1949b). Variations to Ecstatic Ritual determined by intensity of coitional urge of both sexes (Richdale 1949b). Pre-breeders form assemblages away from nesting areas where they display (Warham & Bennington 1983; Warham & Fitzsimons 1987). **COPULATION.** Sometimes occurs without any preliminary behaviour. Usually on nest but females mating for first time, or unemployed birds, may do it anywhere. Male mounts female; grips her forewing with claws and female spreads her wings; male immediately begins **Tattoo**: male's throat placed over female's head, with bills contacting one another. Female crouches, still with head and beak straight forward while male beats rapid and continuous tattoo on side of female's bill, forming a 'plus sign'. Tattoo continues while mounted, discontinued only when contact is effected, then immediately resumed. Male works tail from side to side while slowly sliding backwards. Eventually pushes female's tail aside and makes contact for 1–2 min. Repeated 3–4 times. In 2 h 18 min, one female observed to be receptive five times, when coition effected 11 times. In addition, 5 min earlier, another male copulated with same female three times (Richdale 1949b). May groan during copulation (Warham & Fitzsimons 1987). Copulation occurs up to 23 days before egg laid, and ceases at least 1 day before egg laid. Feeble attempts to copulate, 14–15 days after egg laid, by males which had just returned to change guard (Richdale 1949b). In pre-egg period, female may only attend nest for coition (Richdale 1949b). Extra-pair copulation of incubating females by unemployed males, frequent (Richdale 1949b). Copulation may be interfered with by bystanders; during copulation on nest, third (presumably male) bird was observed to attempt to mount the male already engaged (Warham 1967). **GREETING DISPLAYS** (including change-over ceremonies). When changing guard on egg, mated pairs do not use Ecstatic Display. Instead, **Scoop**: head and bill dipped sharply to ground in front of feet; bill then pushed forward and up, straight in front of body in scooping action; tail fanned; bird bobbing up and down on bent legs. May also **Croak and Nod**: performed by both birds in unison: head and bill dipped sharply to feet (sometimes inclined between legs); simultaneously, bird croaks with mandibles slightly opened and tail fanned; rapidly repeated. May be combined with **Gawky Look** where neck fully stretched forward, with head and bill forming obtuse angle at throat. Eyes become glazed and staring, accentuated by white feathers behind eye; orange gape becomes obvious (Richdale 1949b). Croaking may be given as greeting to neighbours, who may give same display, resulting in a general chorus (Richdale 1949b; Warham & Fitzsimons 1987). Other actions: either sex may **Scoop** before taking flight (Richdale 1949b). Rarely-noted throat expansion accompanied by groans (Warham & Fitzsimons 1987).

VOICE Only detailed study at Snares Is (Warham & Fitzsimons 1987) with some information from Richdale (1949b). Generally silent at sea; most calling at breeding colonies. Three main calls described, Croak, Wail and Groan; varying from very soft to loud. Only reported to call during day. Croaks are the call most often heard at colonies. Calls

similar to those of other species of *Diomedea* but less similar to North Pacific species. Noticeable sexual differences: Croak of male significantly longer than that of female and number of notes per call significantly greater than that of female ($p < 0.05$); circumstances of Groans differ between males and females. Individual differences in Wails with differences in stress on different harmonics between individuals; also individual differences in Croaks. No information on geographical variation. NON-VOCAL SOUNDS: four mechanical sounds reported, produced by contact between bills or mandibles. All information from Warham & Fitzsimons (1987) unless stated.

ADULT MALE (1) **Croak**. Multiple-note croaking call of 3.63 s (2.18; 25) duration; average 7.6 notes per call (3.3; 15), each 0.20 s (0.29; 56) duration with 0.20 s (0.08; 119) between notes. Frequency range 4.53 kHz (0.63; 111). Frequency range and perceived pitch increase with increasing amplitude. Given only at nest; often as duet, which male usually initiates. Infectious among compact groups of pairs. Used during courtship, Bowing. (2) **Wail**. Single-note wailing call of 2.21 s (0.98; 7) duration with frequency range of 6.65 kHz (1.3; 7). Frequency increases for first 0.2 s then constant until decrease over about last 0.07 s. Used most often during courtship, Scooping, and if distressed, when frequency rises about 1 kHz higher than usual peak and frequency varies giving call a wavering quality; during fights, Wails become distorted. Given with bill wide open. (3) **Groans**: low-frequency, low-amplitude, multiple-note calls composed of rapidly repeated pulses of sound forming grunts or groans; five types noted, four apparently used by males (Warham & Fitzsimons 1987). (3a) **Scapular Action Groan**: low frequency (1.32 kHz; 0.03; 8) groan of 2–3 s duration; notes repeated rapidly, each 0.14 s (0.08; 8) duration with 0.33 s (0.12; 8) between notes. Early in display, Groan composed of short bursts of notes, later becoming a regularly repeated series of notes producing a low Throbbing. A barely audible, soft call, given with mandibles slightly apart (Richdale 1949b). (3b) **Flank Action Groan**: low-frequency (1.55 kHz; 0.73; 14) groan 2–3 s long, composed of irregular series of clicking notes, each 0.02 s (0.05; 14) duration with 0.10 s (0.05; 14) between notes. (3c) Low-frequency call also given during Throat Expansion but not analysed by Warham & Fitzsimons (1987). (3d) **Copulation Groan**. During copulation, males utter series of grunts, composed of rapidly repeated notes, 26.7 notes per call (4.3; 4), each note 0.54-s (0.08; 4) duration with c. 0.04 s between notes. As copulation proceeds, pulse-rate increases and each call ends with more highly pitched squeak. Calls interspersed with Tattoo clicks. Given by males only; not reported by Richdale (1949b). NON-VOCAL SOUNDS. (4a) **Tattoo**: multi-frequency, very short pulses, c. 0.013 s long with c. 0.09 s (0.02; 12) between notes; produced by contact of bills of pair during copulation. (4b) **Mandible Spar**: multi-frequency pulses produced by contact of bills during Rapier Action. (4c) **Clop** (= part of Gulping of Richdale 1949b): soft, brief multi-frequency pulse produced by rapidly closing bill, usually given during aggressive interactions. (4d) **Bill Rattle**: castanet-like rattling sound produced by lateral movements of lower mandible against upper by shaking head.

ADULT FEMALE (1) **Croak**. Similar to male but significantly shorter and with significantly fewer notes per call: 2.53 s (1.7; 19) duration and 6.25 (2.1; 5) notes. Notes average 0.16 s (0.10; 56) duration with 0.20 s (0.1; 48) between notes; frequency 4.15 kHz (0.66; 55). Distinct differences between calls of individual females. All else, as for male. (2)

Wail. As for male but used only rarely by female and only when distressed. (3) **Groan**. (3a–c) As for male. Females not reported to groan during copulation. (3d) **Laying Groan**: quiet groans given by females during laying, accompanying straining actions. NON-VOCAL SOUNDS: (4a–d) As for males.

YOUNG No information.

BREEDING Not well known. Studies on Snares Is (Richdale 1949a,b; Richdale & Warham 1973; Warham & Bennington 1983) and Three Kings Is (McCallum *et al.* 1985). Information supplied by J.R. Starks. Nest colonially on a few NZ islands.

SEASON Broadly Dec. to Oct. on Snares and Solander Is; 2–3 months earlier on Chatham and Three Kings Is. On Snares Is, arrival mid-Dec., males arriving first. First eggs recorded from 31 Dec. to 16 Jan. in different years: laying period, 8 weeks from early Jan. and fresh eggs recorded until mid-Feb. First fledging from 22 Aug., most young leave Sept., last seen 27 Oct. (Richdale 1949b; Warham 1967; Horning & Horning 1974; Warham & Bennington 1983; Miskelly 1984). On Solander I., arrival early Dec.; most birds incubating 26 Jan.–9 Feb.; very young chicks 23 Apr. and near fledging 20 July (Cooper *et al.* 1986; Falla 1948; Wilson 1973). On Chatham Is, courting birds at nests, Oct.; laying Oct.–Nov.; incubating, 16 Jan.; and young birds 7–10 days old, 29 Jan.; and over 7 days old, 1 Feb. (Bell 1955; Dawson 1955; Fleming 1939). On Three Kings Is, empty nests, eggs and chicks reported mid-Jan. and incubating in early Dec. (McCallum *et al.* 1985; Wright 1984). Males arrive c. 13 days (0–32; 39) before laying; females c. 8 days (0–23; 39) before. Coition tends to stop on day before laying. Males absent for 3 days (2.25; 1–13; 60) before laying and c. 6 days (4.71; 0–24; 60) after. Most females present the day before laying (Richdale 1949b).



a) Chatham I.



b) Snares I.

SITE On Snares Is, concentrated on periphery of island among vegetation on narrow terraces overlooking sea, but also up to 400 m inland, where under forest canopy 6 m high; 26% under trees, 23% in open beside rocks, 17% on cliffs or edges of cliffs, 16% among or under rocks, 10% on tussock-covered headlands, 8% in meadows of Tatak grass. All sites near, or with easy access to, take-off spot overlooking, or steeply sloping to, sea. Sites up to 212 m asl (Richdale 1949a; Warham & Bennington 1983; Cooper *et al.* 1986). On Solander I., on steps and ledges on spurs and hillsides, often surrounded by scrub and under dense canopy, among tussocks of *Poa foliosa* and *Hebe* bushes; from 15 to 210 m asl (Falla 1948; Cooper & Morrison 1984). Nests on ledges and in holes in cliffs, steep faces at top of cliffs on The Sisters, Chatham Is (Bell 1955). On Three Kings Is, near top of cliffs (Wright 1984). Established breeders use same site year after year (Richdale & Warham 1973).

NEST, MATERIALS Cylindrical column of mud with depression on top; nests also made in grass tussocks and on bare ground. Made of dried mud and plant material; 203

mm (65; 0–305; 74) high (Richdale 1949a); or 90 mm (60–180) high, outside diameter 310 mm (290–340), inside diameter 220 mm (200–240) (McCallum *et al.* 1985). Building usually by male, finishing touches by female before laying; bird sits on chosen site, reaches out and loosens soil round it; nearby vegetation plucked into strips; debris gradually placed under bird as nest built up; material added by beakful and patted down with sides of bill. Nests used in successive season (67% of 122 in colony at Snares Is). Heights of nests vary according to ability of birds to reach material, its availability and time occupied in building before laying (Richdale 1949a). May excavate ledges and trim over-hanging vegetation to manoeuvre and spread wings (Falla 1948). Nests often clumped in distinct subgroups (2–12) in a colony (Richdale 1949b; Warham & Bennington 1983). Nests sometimes made in tussocks, as rough hollows of plucked plant stems (Richdale 1949a).

EGGS Nearly elliptical; chalky texture; white with brownish red speckles, mostly merged at larger end; chalky white; pinkish white or tinged pink (Cooper & Morrison 1984; Wilson 1973; Oliver).

MEASUREMENTS: 103.15 (3.72; 93–111; 64) x 65.38 (1.98; 61–70); 102.16 (3.55; 95–112; 64) x 66.34 (1.55; 61–70) (Richdale 1949a).

WEIGHTS: 246.3 (17.9; 205–283; 64) (Richdale 1949a) or 8.3% of ad. weight (Richdale & Warham 1973). Dimensions of eggs may change with age of adults, becoming more spherical from 13 years of age (Richdale & Warham 1973).

CLUTCH-SIZE One.

LAYING Not synchronized, laying over a period of 7–8 weeks from about mid-Jan. to late Feb., with 80% of eggs laid during 24-day period from late Jan. to mid-Feb., on Snares Is (Richdale 1949a,b); also, first eggs 5 Jan., 22% of occupied nests had egg by 16 Jan., 80% by 3 Feb. (Warham 1967). On Chatham Is, laying from 26 Oct. to 23 Nov. with 96% eggs laid during 12 days (4–16 Nov.) (Robertson 1974).

INCUBATION By both sexes alternately. First shift by female after laying, for 5.92 days (4.71; 0–24; 60). Length of shifts both sexes combined 10.8 days (3.94; 5–21; 55) (Richdale 1949a). **INCUBATION PERIOD:** 69 days (Robertson 1974).

NESTLING Semi-altricial, nidicolous. Hatched with long pale smoky-grey down, short on chin and face; eyes closed. Bill, dark brown, tip dark horn; feet, yellow; claws, ivory (Oliver). Nestling period not determined but Oliver claimed young fledged 4–5 months after hatching. Fed by both parents by incomplete regurgitation, beak to beak with beak of young at right-angle to that of parent; 3–4 deliveries during each feeding bout of a parental visit, when chicks well developed (Falla 1948). No further information on growth or from fledging to maturity but independent of parents when fledged.

SUCCESS No information except that 1000–2000 fledgelings left Snares Is in one season (Horning & Horning 1974). Skuas *Catharacta* and giant-petrels *Macronectes* spp take young on Snares Is and some small colonies lose all their chicks in this way (Horning & Horning 1974).

PLUMAGES Nominate *bulleri*.

ADULT Age of first breeding unknown. **HEAD AND NECK.** Forehead and forecrown look white in all lights, merging to light grey in nape; sharply defined at sides by supercilium. Feathers of forehead white, merging to narrow pale-grey tips, which do not cover white bases. Small supercilium grey-black (82); extends from about an eye-width behind eye to about half-way across lores, where it merges to grey (84) strip

that meets base of bill. Rest of head and neck, light grey (c85), merging to pale grey (c86) on chin and throat. Foreneck white. **UPPERPARTS.** Mantle, light grey (c85). Back and scapulars, brown-black (c119). Lowermost back, rump and upper tail-coverts, white. **TAIL,** grey-black (82) with grey (84) gloss reduced by wear; when fresh, tail appears dark grey (83). **UPPERWING,** brown-black (c119) with slightly brownish (119A) tinge, particularly to coverts. Primary shafts mostly white, merging to brownish (33) near tip. **UNDERPARTS** white, save for pale-grey wash to tips of under tail-coverts of some birds. **UNDERWING,** mostly white, with boldly defined blackish leading-edge, slightly wider at base of wing, about twice width of blackish trailing-edge, and one-quarter to one-third of width of wing. Marginal coverts, and coverts on leading-edge of wing between carpal joint and p10, brownish black (c82). First row of secondary lesser coverts, and innermost feathers in second row of secondary lesser coverts, dark grey (83) to grey (84). Other under wing-coverts, white. Remiges, grey-black (82) merging to grey in basal half of inner webs; this lighter area exposed in outer primaries, but concealed elsewhere by under wing-coverts. Dark remiges form trailing edge, apparent width of which varies with lie of greater underwing coverts.

DOWNY YOUNG Protoptile long and filamentous, shorter on chin and face; pale brownish grey, slightly longer on head, with white centre to belly. Down fades to off-white. Mesoptile similar.

JUVENILE Differences from adult: chin and throat mostly whitish, merging to pale ashy grey (c86) at sides. White forehead patch smaller than in adult, merging to pale ashy grey (c86) on hindcrown, neck and mantle. Hindneck and mantle have slightly patchy pigmentation, appearing less smooth than adults. Foreneck white, supercilium as extensive as in adults. Mantle and back feathers have open pennaceous light grey-brown tips.

IMMATURE Unknown when juvenile plumage replaced. Non-breeding 8-year-olds at Snares lacked white cap, and head was as dark as in subspecies *platei* (C.J.R. Robertson), suggesting immature plumages may be distinctive.

BARE PARTS

ADULT Iris, brown (23) to dark brown. Culminicorn, maxillary unguis, lower half of ramicorn and small tip to mandibular unguis, usually yellow (157), ranging from cream (54) to orange-buff (118). Bare skin at base of ramicorn, and ridge of skin running behind rictus range from orange-buff (118) to orange-red (15). Rest of bill grey-black (82) to dark grey (83). Feet and legs, pale bluish grey to grey-mauve (77), with pink tinge strongest on webs and upper half of tarsus. Birds with light-pink feet have been photographed (Lindsey 1986).

DOWNY YOUNG Iris, black-brown. Bill, grey-black (82) with orange-buff (118) tip to maxillary unguis. No information on colour of feet.

JUVENILE At fledging: iris, dark brown; dark blue-grey (78) recorded in three *platei* fledgelings (NMNZ). Culminicorn, cream (54) to buff-yellow (53) with varying black shading sometimes causing brownish-grey (79) appearance. Latericorn and ramicorn, brownish grey (80–79); lower half of ramicorn has varying yellow wash. Ungues and bare skin at base of ramicorn, dark grey (83) to grey-black (82); base of mandibular unguis is usually darkest part of bill. Feet and legs, as adult.

Photos of birds from Snares Is (D.S. Horning & P. Sagar)

show: bill, mostly brownish-horn with dark tip of varying extent; on some, unguis mostly black, with terminal hook of maxillary unguis, yellowish; on others, pale tip larger: tip of unguis, yellow, merging through dull orange to blackish on basal half of unguis; blackish area combines with black mandibular unguis to form dark subterminal band. Fledgelings typically have black saddle of varying extent over base of culmicorn, extending onto basal latericorns; sometimes only dusky wash over base of bill. Bare skin round base of bill and forward in strip to nostrils, and cheek stripe, black.

IMMATURE Yellowing of culmicorn and lower half of ramicorn gradual; maxillary unguis last area to develop yellow.

At intermediate stage in transition to adult, bill-pattern duller version of adults (based on field observations by D.W. Eades): paler yellow stripes and tip; paler grey-black side-plates, often with tinge of brownish (juvenile) colour; contrasting, pronounced blackish subterminal spot, formed by blackish mandibular unguis, distal end of latericorn and basal cutting edge of maxillary unguis; some show dusky mark on base of maxillary unguis; bare skin at base of lower mandible, yellowish.

MOULTS

ADULT POST-BREEDING Primaries replaced in staffelmauser, interrupted during breeding season. One to three moult-foci in primaries, 2-8 primaries per wing in adults at breeding grounds.

POST-JUVENILE No information. Beachcast immature *bulleri*, aged on colour of bill, showed pattern consistent with staffelmauser.

MEASUREMENTS Nominate *bulleri*: (1) Recently dead, juveniles excluded (NMNZ). (2) Adult skins; bill width at junction of upper tomia and feathering (NMNZ). (3) Snares Is; methods unknown (C.J.R. Robertson).

	MALES	FEMALES
WING	(1) 523 (5.37; 517-535; 7) (3) 529 (515-540; 6)	519.2 (8.06; 506-529; 5) 508 (490-525; 6)
8TH P	(2) 302 (7.27; 286-312; 9)	298 (4.32; 291-304; 5)
TAIL	(1) 203 (10.9; 188-224; 7) (3) 202 (195-210; 6)	203 (3.162; 200-207.5; 5) 196 (189-211; 6)
BILL	(1) 117.7 (7.07; 105.5-125.3; 7) (3) 120.7 (115-128; 21)	117.6 (112.8-120.6; 5) 118.4 (114-123; 21)
BILL W	(2) 27.2 (0.69; 26.3-28.8; 9) (3) 28.5 (26.7-30.2; ?)	26.6 (0.86; 25.1-27.8; 5) 27.0 (25.5-28.1; ?)
TARSUS	(1) 82.9 (6.96; 67.8-92.4; 7) (3) 85.4 (81-90; 21)	84.0 (79.8-89.5; 5) 83.4 (79-86; 21)
TOE	(1) 119.2 (7.50; 107.8-130; 7) (3) 123.8 (118-132; 21)	114.9 (3.47; 108.5-118.6; 5) 120 (116-125; 21)

Subspecies *platei*: (1) Chatham Is; methods unknown (C.J.R. Robertson).

	MALES	FEMALES
WING	(1) 522 (507-543; 18)	500 (474-531; 18)
TAIL	(1) 210 (201-222; 18)	200 (193-209; 18)
BILL	(1) 122.8 (117-129; 18)	117.9 (113-124; 18)
BILL W	(1) 32.6 (30.7-34.5; ?)	30.6 (28.7-32.4; ?)
TARSUS	(1) 85.1 (82-88; 18)	81.3 (78-85; 18)
TOE	(1) 120.8 (117-125; 18)	116.4 (109-120; 18)

Subspecies *platei*: (2) Chatham Is, adult, skins (NMNZ). (3) Chatham Is, recently dead (NMNZ).

UNSEXED		
WING	(3)	519 (8.43; 505-532.5; 6)
8TH P	(2)	297 (5.79; 291-305; 6)
TAIL	(3)	199.3 (3.73; 195-206; 6)
BILL	(3)	121.3 (4.94; 110.8-125.5; 6)
BILL W	(3)	27.7 (0.83; 26.9-29.1; 6)
TARSUS	(3)	85.7 (2.69; 81.5-88.6; 6)
TOE	(3)	120.1 (2.70; 117.1-125.2; 6)

WEIGHTS From C.J.R. Robertson, except where stated. Nominate *bulleri* from Snares Is: males: 3120 g (2850-3350; 21), females: 2780 g (2050-3100; 21). NZ beachcasts, emaciated to very fat, 2218 (338; 1795-2760; 8) (NMNZ). Race *platei* at Chatham Is: males: 2840 g (2500-3300; 18), females: 2430 g (2150-2800; 18).

STRUCTURE Wing, long and narrow. Eleven primaries; p10 longest, p11 minute. In six *platei*, p9 6-13, p8 31-42, p7 65-82, p6 108-123, p5 154-196, p4 200-217, p3 241-254, p2 271-287, p1 295-309. In six *bulleri*, p9 12-18, p8 40-52, p7 76-86, p6 114-122, p5 164-175, p4 209-220, p3 246-259, p2 280-290, p1 303-318. Thirty secondaries, five of tertial form; three outermost shaped like inner primaries. Seven humerals. Tail, strongly rounded, 12 feathers. Bill, shaped as other small albatrosses, but base of culmicorn broad and square; naricorn narrow. Tarsus, rounded. Middle and outer toes longest, inner c. 80%.

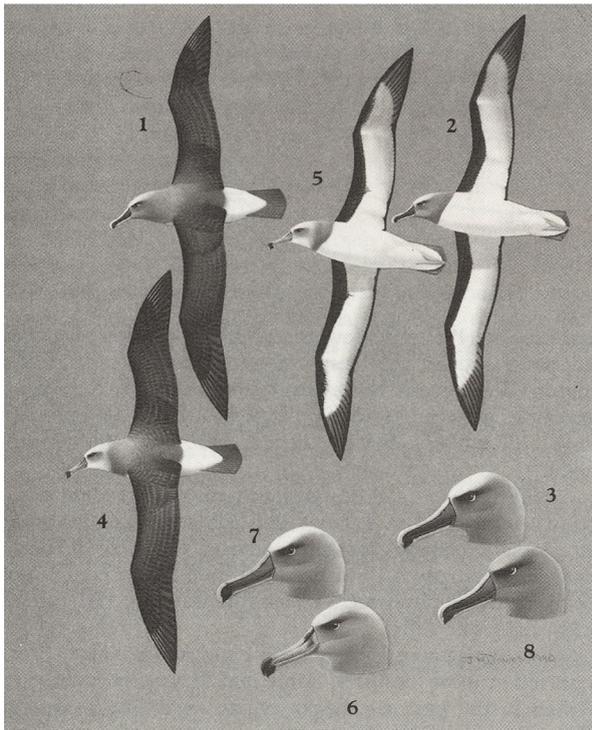
GEOGRAPHICAL VARIATION Nominate *bulleri*, described above, breeds Snares and Solander Is. Subspecies *platei* breeding Chatham and Three Kings Is differs in having bill significantly wider; adults have forehead and forecrown silvery grey, appearing white in direct light, pale pearly grey in diffuse light; grey-black (82) supercilium extends two-thirds of distance across lores before merging to dark grey (83) at base of bill; head and neck darker than adult *bulleri*; hindneck, mantle, sides of neck and face, and ear-coverts, grey (c84), merging to light grey (85) to pale grey (86) on chin and throat. In life, bare parts similar to *bulleri*; yellow stripe on mandibular rami said to be narrower in *platei* (less than half width of lower mandible, cf. half width or more in *bulleri*); McCallum *et al.* (1985) state that width of stripe varies, and some show broader stripe, like *bulleri*. When dried, feet and legs tend to be paler in *bulleri*. Juvenile *platei* have supercilium as extensive as in adults. Otherwise similar to juvenile *bulleri*; head and hindneck perhaps slightly darker. Immatures undescribed.

DIR

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Volume 1 (Part A), Plate 22

- Buller's Albatross *Diomedea bulleri*
1. Adult, subspecies *bulleri*, dorsal
 2. Adult, subspecies *bulleri*, ventral
 3. Adult, subspecies *bulleri*, head
 4. Juvenile, subspecies *bulleri*, dorsal
 5. Juvenile, subspecies *bulleri*, ventral
 6. Juvenile, subspecies *bulleri*, head
 7. Immature, subspecies *bulleri*, head
 8. Adult, subspecies *platei*, head

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