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 PROCELLARIIDAE fulmars, petrels, prions, shearwaters

The family Procellariidae represents the main radiation of medium-sized 'true petrels', characterized by having united nostrils with a median septum and the outer functional primary at least as long as the next. It tends to be dominant among the birds of the Southern Ocean, though in the n. hemisphere the Charadriiformes are more numerous. The giant-petrels *Macronectes* have also developed as large scavengers and predators, showing some convergence in appearance and behaviour with the Diomedeidae. The Procellariidae may be divided into four main groups with some intermediate species, which makes it hard to draw distinctions between them.

(1) The fulmars *Macronectes, Fulmarus, Thalassoica, Daption* and *Pagodroma* consist of seven species of surface predators and filter-feeders of rather varying structure and appearance (Voous 1949) that breed in high latitudes but may migrate along cool currents into much lower ones. *Fulmarus* appears to have colonized the n. hemisphere in the Tertiary. Six of the seven species are essentially confined to our region.

(2) The gadfly-petrels *Pterodroma* are a large series of some 30 agile species; 16 breed in our region and another six occur rarely or rather rarely. Their short sturdy bills are adapted for seizing soft prey at the surface, and their twisted intestines, for digesting marine animals with an unusual biochemistry, which are also found throughout the warmer oceans (Imber 1985). They show complex markings of face and wings that must serve as interspecific recognition-marks (Murphy & Pennoyer 1952). Some species placed in this group have an intermediate structure and intergrade with all other groups distinguished here: *Pterodroma* (*Lugensa*) *brevirostris*, which moves S in winter, has distinctly big eyes like *Pagodroma*; *Halobaena caerulea* has a plumage similar to that of prions; *Bulweria* has some structural resemblance to shearwaters. At present it is difficult to determine their precise relationships.

(3) The prions *Pachyptila* are a specialized group of six (perhaps five) very numerous species, all in our region, that show a progressive adaptation of a small, agile, cryptically coloured, fulmarine form for filter-feeding on zooplankton. There has been dispute over their classification (Cox 1980; Harper 1980) but the arrangement discussed by Fleming (1941) seems best except that the Broad-billed Prion *P. vittata* appears to intergrade with Salvin's Prion *P. salvini* through *macgillivrayi* of Ile St Paul; so they may be better treated as subspecies of the same species.

(4) The shearwaters *Procellaria, Calonectris* and *Puffinus* include some 20 agile species with long bills adapted to catch prey more or less under water throughout the warmer seas (Kuroda 1954); 13 species breed in our region, some migrating into the n. hemisphere; six others are chance or perhaps regular visitors. From the fossil record (Brodkorb 1963; Olson 1975); they seem to have been particularly common in the great Tethys Ocean of the middle latitudes of the n. hemisphere in the Tertiary, so this development of aquatic habits may have occurred there without competition from penguins with a subsequent return S by the more successful forms.

General features of the family are: body, ovate, or elongate in shearwaters; wings, long and narrow, 11 primaries, p10 longest, p11 minute; 20–29 secondaries, short, diastataxic; tail, short, 12 feathers; bill, heavy (*Macronectes*), slender (shearwaters), broad (prions) or stubby (gadfly-petrels), hooked, formed of several horny plates; nostrils in dorsal tube of varying length; legs set far back, laterally flattened but round in gadfly-petrels; three toes, webbed, hind toe vestigial, raised. Oil-gland feathered. Peculiar musky odour. Sexes similar, male usually larger than female. Plumage, black or grey above, white below, or all dark; light and dark morphs in some species. Juveniles and immatures usually like adults.

Cosmopolitan throughout the oceans, essentially pelagic; more abundant in cool or cold waters rich in plankton and mostly away from ice. Swim well but usually aerial except when feeding or resting. Fly with alternate swooping and flapping action close to the surface but often arcing high in some gadfly-petrels. Gait on land, a shuffling crouch, being unable to walk properly with feet set so far back; generally avoid open areas on land, being thus vulnerable to predators. Nest colonially; for the most part in burrows and cavities in all sorts of terrain, sometimes far from the sea and in mountainous areas but some species, e.g. *Macronectes*, nest on open ground. Hole-nesters usually nocturnal at colonies, when often extremely vocal, though generally silent at sea. Migratory and dispersive. Some species divide the year between s. and n. hemisphere, often migrating in large flocks that may settle on the sea in huge dense rafts. Feed mostly on fish, cephalopods and crustaceans obtained by flight-feeding, plunge-diving, surface feeding, surface-diving and underwater pursuit; hydroplaning (Murphy) is a characteristic method used particularly by prions.

Probably all defend small nesting territories to which they return regularly while undisturbed; certainly so in some hole- and burrow-nesting forms. Agonistic and sexual behaviour of nocturnal, hole-nesting species very poorly known but generally seem to have little specialization for visual displays. Tactile actions such as allopreening and billing used but olfactory and vocal communication is probably important. Breeding is usually seasonal, generally with synchronized laying, often after a pre-laying exodus but some may not nest annually; some have shorter

cycles or nest continually. For the most part, little attempt to make substantial nests. Eggs, ovate, mat, white. Clutch-size, invariably one; single-brooded; no replacement laying. Incubation by both sexes in alternate spells of 1–11 days. Single median brood-patch. Incubation period, 45–55 days. Eggshells probably always trampled in nest. Young, semi-altricial, nidicolous; hatched in down. Rarely left alone in nest for first 1–2 weeks. Cared for and fed by incomplete regurgitation by both parents. Nestling period generally shorter in cliff- and ledge-nesting species than in hole-nesters. Young attain greatest weight, often well above that of adult, some days before fledging, by which time weight has been reduced to about the same as an adult, but no clear evidence that young are totally deserted for last few days in nest. Adults and young of most species liable to eject stomach-oil in defence. Young independent at fledging. Maturity reached at minimum of 3–4 years, in some 6–12 years.

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Puffinus gravis Great Shearwater

COLOUR PLATE FACING PAGE 592

Procellaria gravis O'Reilly, 1818, *Greenland Adjacent Seas North-west Passage*: 140, pl. 12, fig. 1 — Cape Farewell and Staten Hook to Newfoundland.

The specific name, *gravis*, means 'heavy'.

MONOTYPIC

FIELD IDENTIFICATION Length 43–51 cm; wingspan 100–118 cm. Large shearwater, with long slender dark bill; similar in shape to Flesh-footed Shearwater *P. carneipes* but slightly larger; dark greyish-brown above, with distinctive clear-cut dark cap, narrow white collar and white horseshoe on upper tail-coverts. Dark belly patch on mainly white underbody, and white collar, diagnostic among shearwaters. Sexes alike. No seasonal variation.

DESCRIPTION Forehead, crown, nape, upper cheeks and ear-coverts, dark brown, forming blackish cap extending just below eye level where sharply demarcated from white lower cheeks, chin, throat and foreneck. White of foreneck extends behind cap and across nape to form conspicuous white collar separating cap from hindneck and saddle, sometimes interrupted centrally by narrow grey-brown extension of hindneck. Hindneck, greyish brown; mantle, back, rump, short upper tail-coverts and scapulars, dark greyish-brown to blackish, with narrow paler greyish-brown to whitish fringes imparting scaled appearance to saddle; distal upper tail-coverts broadly tipped white, forming prominent horseshoe-mark above tail. Tail, blackish. Upperwing: inner wing-coverts, dark greyish-brown with fine pale fringes; contrast with blackish primaries, primary coverts and secondaries; lesser coverts sometimes appear darker than surrounding coverts, showing as ill-defined dark bar across innerwing from carpal joint to longest scapulars and, with blackish outerwing, forms subtle dark M across upperwing. Underbody, white except for short greyish-brown patch on upper sides of neck, blackish-brown belly patch, greyish-brown smudges on rear flanks, and blackish-brown under tail-coverts which combine with blackish undersides of rectrices to form dark rear-end. Underwing: undersides of remiges, black, showing as narrow dark trailing-edge and tip sharply demarcated from white of lining. Lining mostly white, with narrow black leading edge from elbow to base of outermost primary, broadest along primary coverts, with thin black streaks radiating across white ground of lesser and outer median primary-coverts. On innerwing, thin black streaks on lesser coverts and bold black tips to subhumerals form pronounced diagonal bar from carpal joint to posterior base of wing; in front of this, bold black tips to subhumeral coverts form second diagonal bar across wing-pit; both bars often broken; small black spots on wing-pit in front of second bar. Iris, brown. Bill, long and slender, with tubed nostrils inconspicuous over basal quarter of upper mandible; dark blackish-brown, with base of lower mandible, grey. Legs and feet, pale flesh to pink, except for brown to black outer tarsus and toe.

SIMILAR SPECIES Readily distinguished from other large shearwaters with bicoloured plumage by clear-cut dark cap, and diagnostic prominent white collar and dark belly-patch (the latter surprisingly difficult to see in field). Distinguished from **Cory's Shearwater** *Calonectris diomedea*, **Streaked Shearwater** *C. leucomelas* and **Grey Petrel** *Procellaria cinerea* by dark bill, dark clear-cut cap, dark diagonal bars across white underwing and brown patch on belly. From **Pink-footed Shearwater** *Puffinus creatopus* by dark bill, dark clear-cut cap and white band across upper tail-coverts. From **Buller's Shearwater** *P. bulleri* by clear-cut darker cap, white band on upper tail-coverts, brown patch on belly and absence of dark M-pattern across upperwings and rump. From light-phase **Wedge-tailed Shearwater** *P. pacificus* by clear-cut cap, white band on upper tail-coverts, shorter tail and brown patch on belly. From **Barau's Petrel** *Pterodroma baraui* and **Juan Fernandez Petrel** *P. externa* by larger size, longer and more slender bill, dark forehead, different underwing pattern (noticeably broader dark trailing-edge, dark bars across wing-pit), dark under tail-coverts and brown patch on belly; also by flight and jizz, typical of shearwaters.

Flight rapid and powerful with wings held stiff and straight; usually series of fairly rapid wing-beats interspersed with glides low over water and banking. Often highly gregarious at sea, especially off breeding grounds before migration (Rowan 1952), on wintering areas in northern hemisphere and off e. S. America, where often join flocks of many other seabirds (Brown *et al.* 1975a). Mostly solitary in s. Indian Ocean (J-C. Stahl). Often follow shoals of fish and groups of cetaceans. Food obtained by plunge-diving from 6–10 m above water, or pursuit-diving from surface. Attend trawlers and fishing vessels and regularly follow ships. In s. Indian Ocean, ship-followers almost invariably stay further behind vessel than other species (J.-C. Stahl).

HABITAT Marine, in offshore and pelagic waters; rare inshore or in narrow seas (Cooke & Mills 1972; Brown *et al.* 1975a,b; Liversidge & Le Gras 1981; BWP). In s. hemisphere, mainly over s. subtropical and subantarctic waters; only occasionally S of Antarctic Convergence (Watson 1971; Tickell & Woods 1972; Harris 1982; Thurston 1982). In s. Indian Ocean, mostly near Subtropical Convergence (J.-C. Stahl). In S. Atlantic, over waters with sea surface-temperatures, 6–23 °C, in summer; greatest densities over waters of 9–16 °C; concentrations over upwellings and at boundaries of cool currents and warm coastal water (Cooke & Mills 1972; Brown *et al.* 1975a). On migration, cross Tropical Zone rapidly without stopping (BWP). Spend non-breeding season in n. Atlantic Ocean, mostly in Boreal and low Arctic waters (Brown *et al.* 1975b; Powers 1983), including those with scattered icebergs, but do not reach pack-ice (BWP). Off e. North America, greatest densities over shelf waters (Powers 1983).

In Tristan Grp, breed up to 400 m asl, wherever soil deep enough to excavate burrows; greatest densities in uniform tussock grassland and in *Phylica* woodland (Rowan 1952; Fraser *et al.* 1988).

Away from land, fly at lowest levels; approach land at

heights of few metres to 300 m and soar to 450 m (Rowan 1952). Rest and feed in rafts on surface; make shallow dives to at least 2 m depth (Brown *et al.* 1978).

DISTRIBUTION Mostly S. Atlantic and sw. Indian Ocean during breeding season (Sept.-May), breeding only on S. Atlantic islands of Tristan da Cunha Grp (Nightingale I., Inaccessible I.), Gough I. and Falkland Is (single breeding pair recorded on Kidney I.; BWP); migrate to N. Atlantic outside breeding season. Vagrant to A'asia.

During all or part of breeding season: S. Atlantic mostly between 38–52°S (Tickell & Woods 1972), further S to Le Maire Channel (*c.* 55°S) off e. S. America (Watson 1971); occasionally N to 32°S (Thurston 1982) and S of Antarctic Convergence to near S. Georgia and n. S. Sandwich Is (Watson 1971). Regular but uncommon off w. S. Africa and e. Cape (Liversidge 1959; Brooke & Sinclair 1978; Liversidge & Le Gras 1981) and S of Africa between 39–54°S (van Oordt & Kruijt 1954; Harris 1982). Abundant off Brazil and Argentina (Blake 1977). Sw. Indian Ocean: small numbers E to at least 65°E, mostly between 39–45°S, occasional N to 34°S (Stahl 1987; J.-C. Stahl) and shelf round Iles Crozet (Stahl *et al.* 1984).

In N. Atlantic mainly May–Nov. Main wintering areas, nw. Atlantic including shelf off e. North America from 40–67°N (Powers 1983; Brown *et al.* 1975b); central N. Atlantic from 40–66°N (Voous & Wattel 1963); oceanic waters off w. Europe between Iberian Pen. and Rockall Bank (BWP). Accidental N. Pacific: one record, California in Feb. (Roberson 1980).

AUST. Single birds, possibly same individual, SW of Robe (37/138; 37/139), Jan., Feb. 1989 (D.W. Eades; N.G. Cheshire).

NZ Sightings W and NW of Kermadec Is in Dec.–Jan., and in Cook Str. in July (Jenkins 1968) have been rejected (Bourne 1971).

BREEDING Breed in great numbers in Tristan da Cunha group (5 million + pairs; Williams 1984) and at Gough I. (600 000–3 million pairs; Elliott 1970); also Falkland Is (100s pairs; Croxall *et al.* 1984).

MOVEMENTS Transequatorial migrant to N. Atlantic from breeding grounds in S. Atlantic.

DEPARTURE Departure from colonies: adults mid-April, juveniles May (Rowan 1952).

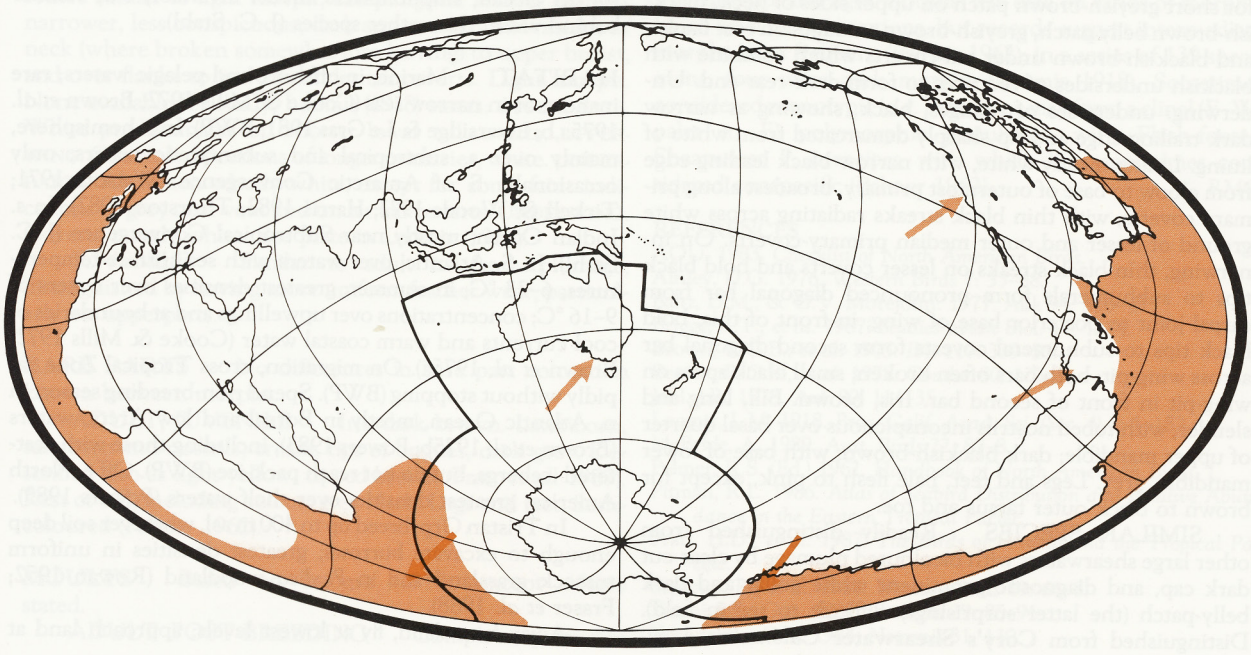
NON-BREEDING First wave of migrants (probably adults) arrives w. central N. Atlantic, late May; on Georges Bank, June (Voous & Wattel 1963; Powers 1983), which suggests migration through central Atlantic and subsequent W and N dispersal. Adults from Inaccessible I. (Tristan group) recovered Newfoundland in July (Fraser *et al.* 1988). Spread to ne. Atlantic by Aug. (Rowan 1952). Second wave of migration (probably juveniles and young immatures) observed on passage in June in E. Sargasso Sea (*c.* 17°N, 53°W; Voous & Wattel 1963) and off Senegal and Guinea (Voous & Wattel 1963), possibly including birds from se. American and S. African waters. A few birds winter off S. Africa and in sw. Indian Ocean. S migration probably on broad front across whole ocean (Rowan 1952; Bourne 1970).

RETURN Most adults return to breeding grounds second half of Sept. (Rowan 1952; Fraser *et al.* 1988). Non-breeding birds remain numerous in nw. and ne. Atlantic until late Oct.–mid-Nov. (Voous & Wattel 1963; BWP).

BREEDING In s. summer, dispersed across S. Atlantic with concentrations off S. Africa, Oct.–Jan. Non-breeding birds in moult, Jan.–Feb., in Le Maire Channel off Tierra del Fuego (Watson 1971) and shelf of Iles Crozet (Stahl *et al.* 1984).

PLUMAGES

ADULT Definitive basic. Age of first breeding unknown. HEAD AND NECK. Top of head to below eye, dark brown (121), contrasting with white chin, throat and hind-neck to form dark cap. Some white mottling below eye. UPPERPARTS. Mantle, pale grey-brown (c119C). Back, rump, most scapulars and lateral upper tail-coverts, dark brown (121)



with pale-brown to off-white scalloping. Feathers, dark brown (121) with pale-brown (119C–119D) fringes, narrower on edges. Longer scapulars, blackish brown (119) with white fringes, narrowest on edges. Longer upper tail-coverts, white. TAIL, black-brown (119) with narrow white tips lost with wear. UPPERWING. Outer webs, tips and inner edge of inner webs of primaries, brown-black (119); rest of primaries, white. Secondaries and secondary coverts, grey (84) with white fringes and proximal two-thirds of inner web. Other upperwing feathers, dark brown (121) with pale-brown (119C–119D) to off-white fringes, narrowest on edges. UNDERPARTS, mostly white with brown (119C) patch on belly; extent varies. Sides of breast, grey-brown (c119C). Feathers of lower flanks and under tail-coverts, grey-brown (119B but greyer) with pale-brown (119D) to white tips. Other flank-feathers, white with large brown (119B) mark near tip of outer web. Axillaries, white with dark-brown (c119A) tips. UNDERWING. Predominantly white with narrow dark trailing-edge, narrow dark leading-edge, and broken diagonal bars from tips of tertials to carpal joint. Visible parts of remiges, brownish grey. Marginal coverts, dark brown (c119a) fringed white. Outermost primary greater, primary median and primary lesser under wing-coverts, dark brown (c119A) with concealed white bases to inner webs. Remaining under wing-coverts, white; subhumerals and inner secondary median under wing-coverts have grey-brown (greyish 119A) rosethorns; primary lesser under wing-coverts have dark-brown shaft-streaks; and inner secondary lesser under wing-coverts have dark-brown (c119A) tips.

JUVENILE Fresh plumage has grey bloom (Palmer 1962).

ABERRANT PLUMAGES Complete and partial albinism reported (Elliott 1957; Richardson 1984; Lee & Grant 1986).

BARE PARTS Based on Elliott (1957), Murphy, BWP.

ADULT, JUVENILE Iris, dark brown (-). Bill, dark horn-grey (c88); lower part of lower mandible, blue-grey; whitish spot on maxillary unguis. Outer toe and outer side of tarsus, black (-). Rest of feet and legs, usually flesh, ranging from white to deep pink (especially in juveniles).

MOULTS Based on Stresemann & Stresemann (1970) except where stated.

ADULT POST-BREEDING Pre-basic. Complete, in winter quarters; wing-moult between end of May and mid-Aug. Primaries outwards; as many as six may grow at one time; duration 90 days; estimated growth rate of primaries, five mm/day. Secondaries moult at same time as primaries, in 4 groups; s1–s4, s5–s12/13/14 and s19/20–s21/22 inwards, and s18/19–s13/12 outwards (Mayaud 1949/50). Never flightless during moult (*contra* Meinertzhagen 1956), although moulting birds can have difficulty taking off (Voous 1970). In early stages of moult, white wing-bar formed when loss of coverts exposes white bases of secondaries and greater primary coverts. Body and wings moult at same time; tail somewhat later.

POST-JUVENILE Partial; body-plumage replaced in July–Aug. of first year (Stresemann & Stresemann 1970).

SUBSEQUENT PRE-BASIC MOULTS Second-year birds growing p1–p4 reported off coast Tierra del Fuego in Jan. (Watson 1971). Non-breeders of unknown age reported moulting at sea in Aug. (Voous 1970).

MEASUREMENTS Full-grown, skins (BWP). Longest-winged male and female in this sample are fledgelings; newly fledged birds with remnant down may have longer wings than adults (Elliott 1957).

	MALES	FEMALES	
WING	332 (8.61; 318–348; 10)	318 (11.3; 301–334; 6)	*
TAIL	117 (3.66; 113–126; 10)	113 (4.37; 109–120; 8)	
BILL	46.0 (1.71; 43–50; 12)	44.0 (1.14; 43–47; 8)	*
TARSUS	59.8 (1.48; 58–63; 12)	59.0 (1.20; 57–60; 8)	
TOE	71.6 (2.67; 68–77; 10)	69.4 (1.34; 68–71; 5)	

Other measurements in Hagen (1952), Swales (1965), Brown *et al.* (1981).

WEIGHTS Breeding adults at Tristan da Cunha: 834 (59.1; 715–950; 14; Hagen 1952). Sex difference negligible.

STRUCTURE Eleven primaries, p11 minute, p10 longest, p9 2–9, p8–16–26, p7 31–50, p6 50–75, p5 84–88, p4 111–117, p3 138–160, p2 161–176, p1 162–193; 20–22 secondaries (Mayaud 1949–50). Tail strongly rounded; t1 *c.* 25–30 longer than t6. Bill powerful with strong terminal hook. Nasal tubes one-fifth to one-quarter length of bill; oval nostrils separated by broad septum; point forwards and upwards. Tarsus stout, laterally compressed. Middle and outer toes about equal, inner *c.* 85–90%, hind toe rudimentary.

GEOGRAPHICAL VARIATION None. Bourne (in Palmer 1962) suggested *P. gravis*, *P. carneipes* and *P. creatopus* form circumpolar superspecies.

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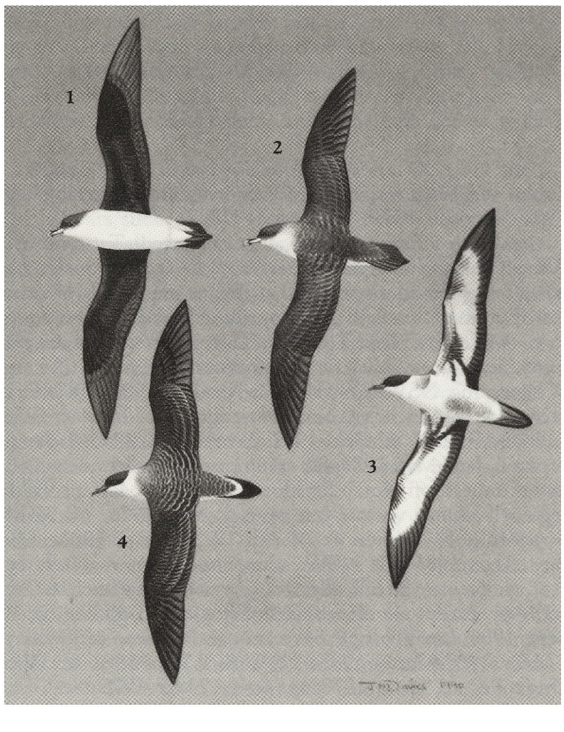

Volume 1 (Part A), Plate 43

Grey Petrel *Procellaria cinerea*
1. Adult, ventral
2. Adult, dorsal

Great Shearwater *Puffinus gravis*
3. Adult, ventral
4. Adult, dorsal