Order PELECANIFORMES

Medium-sized to very large aquatic birds of marine and inland waters. Worldwide distribution. Six families all breeding in our region. Feed mainly on aquatic animals including fish, arthropods and molluscs. Take-off from water aided by hopping or kicking with both feet together, in synchrony with wing-beat. Totipalmate (four toes connected by three webs). Hind toe rather long and turned inwards. Claws of feet curved and strong to aid in clambering up cliffs and trees. Body-down evenly distributed on both pterylae and apteria. Contour-feathers without after shaft, except slightly developed in Fregatidae. Pair of oil glands rather large and external opening tufted. Upper mandible has complex rhamphotheca of three or four plates. Pair of salt-glands or nasal glands recessed into underside of frontal bone (not upper side as in other saltwater birds) (Schmidt-Nielson 1959; Siegel-Causey 1990). Salt-glands drain via ducts under rhamphotheca at tip of upper mandible. Moist throat-lining used for evaporative cooling aided by rapid gular-flutter of hyoid bones. Tongue rudimentary, but somewhat larger in Phaethontidae. Throat, oesophagus and stomach united in a distensible gullet. Undigested food remains are regurgitated. Only fluids pass pyloric sphincter.

Sexually dimorphic plumage only in Anhingidae and Fregatidae. Selection of nest-site and initiation of pair-formation by male, but in Pelecanidae female first leads several males in a male-selection (or persistence) chase as in ducks. Nest built by female with material brought to nest-site mainly by male. Copulation normally on nest-site. Both sexes take turns guarding nest-site, incubating eggs, and brooding and feeding chicks. Eggs unicoloured with chalky finish except for Phaethontidae. Webbed feet used to warm eggs. Chicks hatch naked (except in Phaethontidae) and blind. Later fully covered with down for several weeks. Newly hatched chicks take fluid food from tip of parental bill. Older chicks take partly digested food from parental gullet, except in Phaethontidae, in which parent inserts bill into gullet of chick. Chicks become independent usually within a few weeks after fledging and at fledging in gannets *Sula* spp. At nesting colonies severe loss of eggs and chicks may result from human disturbance, parents being forced off nests, so that eggs and chicks become cold or overheat or are taken by predators.

Anatomical and behavioural similarities suggest close phylogenetic affinities between Pelecaniformes and Ciconiiformes, which could perhaps be united. Cottam (1957) found skeletal characters that suggest that the Shoe-billed Stork *Balaeniceps rex*, only member of the African family Balaenicipitidae, ought to be in Pelecaniformes rather than Ciconiiformes. Linnaeus (1758) included all pelecaniform birds known to him, except those in *Phaethon*, in the genus *Pelecanus*, from which Brisson (1760) removed the genera *Sula*, *Anhinga*, *Phalacrocorax* and *Fregata*. Subsequently these genera became the bases of six families in the order Pelecaniformes, formerly known as the Steganopodes. Over the last 200 years there has been debate about whether *Phaethon* and even *Fregata* ought to be included, and whether *Anhinga* ought to be in the same family as *Phalacrocorax*. There is ample behavioural (van Tets 1965), osteological and palaeontological (Olson 1985) evidence to demonstrate that there are six distinct extant families in the Pelecaniformes.

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Family PHALACROCORACIDAE cormorants and shags

Medium-sized to large aquatic birds of marine and freshwater habitats. Worldwide, 30–40 species, depending on recognition of forms as full species or subspecies. Many isolated insular forms are sensibly regarded as full species. Here we recognize 19 species occurring in our region; after Peters, placed in a single genus *Phalacrocorax*. However, latest arrangements (Siegel-Causey 1988; G.F. van Tets) are more elaborate and divide the family into two sub-families: Phalacrocoracinae (cormorants) with two genera (*Phalacrocorax* or macrocormorants and *Microcarbo* or microcormorants) and Leucocarbinae (shags) with three genera (*Stictocarbo* or cliff-shags, *Nannopterum* or island-shags and *Leucocarbo* or trek-shags). The genus *Phalacrocorax* has two sub-genera: *Phalacrocorax* (*s.s.*) of two species, *carbo* occurring in our region, and *Hypoleucos* of five species, *varius* and *sulcirostris* occurring in our region. *Stictocarbo* has seven species, *punctatus* and *featherstoni* forming a superspecies in our region. *Nannopterum* has 15 or more species, 12 of which belong to our region; their distribution and association in superspecies is most easily shown on Fig. 1. *Leucocarbo* has six species but only *fuscescens* occurs in our region. Long broad head with patterns of tuft-like crests, which are the origin of the term 'shag'; rather long serpentine neck; broad elongate body; wings broad at base, less broad in outer part, with 11 primaries (p8 and 9 longest) and 17–23 secondaries, diastataxic; stiff wedge-shaped tail, short in shags and long in cormorants, 12–14 feathers. Bill, sub-conical, strong, medium-long, hooked, laterally compressed, without serration; nostrils closed. Gular skin, bare, varying in extent and colour in different species. Tarsus, thick; long toes with outermost longest, totipalmate; middle toe, pectinate. Tibia, feathered. Oil-gland, feathered. Plumage, black, often with metallic sheen, or black above and white below. Sexes similar with some seasonal changes, mostly affecting crests and facial colours. Juveniles recognizable by colour-patterns of plumage; attain adult plumage when 1–4 years old.

Stance upright; gait waddling, legs being set far back towards tail; cormorants, but not shags, able to perch in trees, on wire and similar thin perches. Swim well, body low in water and even partly submerged, tail flat on water; on surface use feet alternately but under water use both feet together in unison. Plumage is permeable under water and sheds air so that buoyancy is reduced; out of water, plumage repels the water, traps air and increases thermal insulation. Thus, swimming in cold water limited to less than 30 min, otherwise hypothermia sets in. Some species reduce buoyancy further by swallowing pebbles (van Tets 1968, 1976). Indigestible matter regurgitated as pellet about once a day with repetitive *gock-gock-gock...* sound that attracts gulls *Larus* spp for scavenging. In some species, distinctive posture held with wings spread on either side of body during loafing when out of water; thought to be mainly for drying wings but plumage is thoroughly waterproof and oil gland often used when preening. Some hours each day may be spent flying between colonies or roosts and feeding areas. Flight powerful with alternating periods of wing-beats and gliding as in gannets; adopt V-formation in travelling flight. Where colonies far from feeding areas, females leave to feed in mornings, males in afternoon. Much of day spent loafing and so plenty of time for courtship rituals, which take up a major part of activities all year in some species. Feed mostly on fish, caught by surface-diving or pursuit-swimming; sometimes co-operatively and often in dense flocks. Migratory and dispersive; movements probably usually by day. However, island shags seem to be entirely sedentary.

Pair-bond monogamous, maintained mostly or entirely at nest-site. Male selects site and advertises for mate; once accepted, female builds nest with material brought by male. Copulation takes place on nest. Advertising displays by male specially well developed. Movements by both sexes associated with ritualized take-off, landing and locomotion postures and include Pre- and Post-take-off postures, Kink-throating, Circle-flying, Hopping with Pre- and Post-hop postures, and Penguin-walking, which is particularly noticeable in females in search of mate and in males seeking nesting material. Allopreening and entwining of necks occur, probably to maintain pair-bond. Calls are mostly unspecialized; males generally give a variety of croaks, grunts, and groans, whereas females hiss or are relatively silent; calling usually confined to breeding colonies. Bathing in groups may be spectacular and has been misidentified as display (van Tets 1965). Comfort-behaviour consists of gular fluttering to dissipate heat; direct head-scratching; true yawning and jaw-stretching.

Typically breed colonially. Defend small nest-territory. Nests often densely packed and associated with other species such as herons, ibises and spoonbills. Season extended but least so in temperate latitudes. Nests on ground, on cliffs and in trees; used from year to year; built of any available plant material, seaweed and debris to form substantial heap but sometimes nothing more than a scrape in the ground. Tend to continue building during incubation and nestling periods. Eggs, elongate oval, pale blue or green with white chalky coating. Clutch-size, usually 2–4 (1–7 extremes); single-brooded but replacements laid after loss. Incubation by both sexes in approximately equal shares; change-overs at least once or twice a day. Incubation starts with first egg; eggs incubated on feet. Incubation period, 27–31 days. Eggshells removed from nest. Hatching asynchronic. Young

altricial, nidicolous; hatched naked but develop a single coat of dense white, brown or black down. Cared for by both parents; brooded continuously while small; fed by incomplete regurgitation; in cormorants, but not in shags, adults may bring water to young in hot weather. Nestling period, *c.* 70 days at most but usually 48–53 days. Young attended and fed by both parents for 2–3 months or more after fledging.

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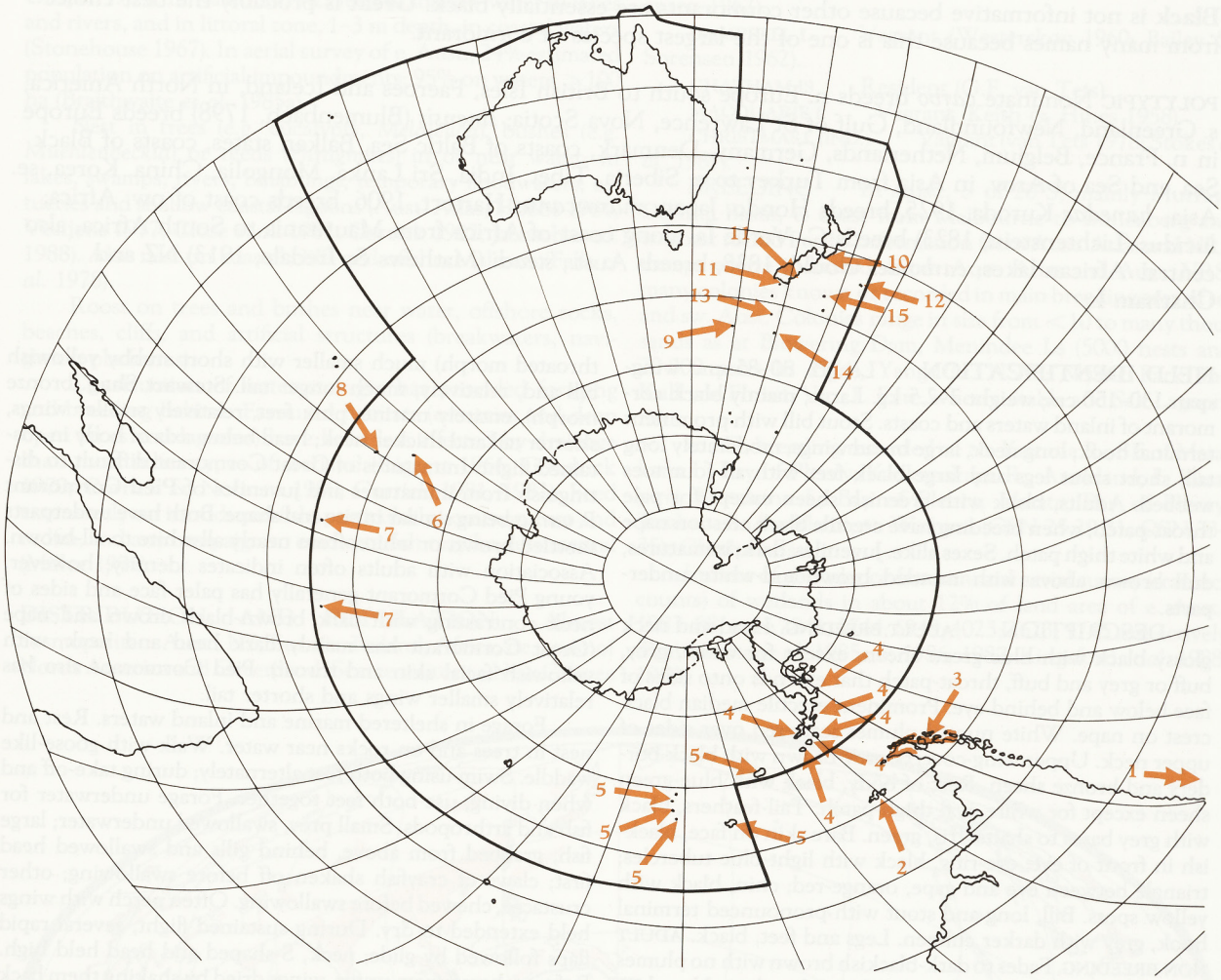


Fig. 1. Distribution of island forms of *Phalacrocorax*.

1 *harrisi* (Galapagos Is)
2 *albiventer*
3 *atriceps*
4 *bransfieldensis*
5 *georgianus*
6 *nivalis*
7 *melanogenis*
8 *verrucosus*
9 *purpurascens*
10 *carunculatus*
11 *chalconotus*
12 *onslowi*
13 *colensoi*
14 *campbelli*
15 *ranfurlyi*

Phalacrocorax purpurascens Macquarie Shag

COLOUR PLATE FACING PAGE 884

Carbo purpurascens Brandt, 1837, *Bull. scient. Acad. imp. Sci. St Péterb.* 3, col. 56 — no locality = Macquarie Island *fide* Rothschild, 1898, *Bull. Br. Orn. Club* 8: 21.

The specific name is Latin for *purplish* referring to sheen on parts of plumage.

MONOTYPIC

FIELD IDENTIFICATION Length 75 cm; wingspan 110 cm; weight: *c.* 2.5–3.5 kg. Medium-sized, black-and-white marine shag; typical of subantarctic blue-eyed (*atriceps*) group. Only pied shag recorded from Macquarie I. Sexes alike. Seasonal plumage changes. Immatures separable.

DESCRIPTION ADULT BREEDING. Top and sides of head and hindneck, glossy black with black crest on forehead. Demarcation between black cap and white face starts at gape and extends back below ear-coverts leaving lower cheeks and throat, white, and giving dark-faced appearance. Tuft of white filoplumes above and behind eye, varying; more filoplumes dispersed over head, neck and back. Upper wing-coverts and scapulars, blackish brown with oily-green sheen and thin indistinct black borders. White alar and scapular patches prominent on some birds, poorly developed or absent in others. Primaries, brownish black, slightly glossed green. Back, rump, upper tail-coverts and thighs, glossy blue-black with purple sheen. No white patches on back. Tail, black with white bases to shafts. Throat, sides of neck and rest of underparts, white; longest under tail-coverts, black. Underwing, black with white line of varying length along humeral area. Bill, grey with horn-coloured patch near tip of lower mandible. Prominent pair of orange caruncles above base of bill. Eye-ring, blue. Rest of facial skin at base of lower mandible, orange-brown with yellow spots. Iris, dark brown. Front of legs and proximal parts of feet, pink; rest, purple-grey. ADULT NON-BREEDING. Crests and plumes absent. Dorsal plumage and soft parts, dull and faded. Caruncles, yellow. JUVENILE. Brown with slight green sheen above, white below. Extent of pale-brown alar patches varies. No crests, plumes or caruncles. Facial skin, bluish grey. Legs and feet, pink-brown.

SIMILAR SPECIES Similar to other blue-eyed subantarctic shags in *atriceps* group, but ranges do not overlap and other species unlikely to be recorded on Macquarie I. Only other cormorant recorded, vagrant **Great Cormorant** *P. carbo*, which has all-dark plumage and longer wings and tail; however, some immatures have irregular white areas below. Great Cormorant also differs in holding neck in S-shape with head held high in sustained flight (head below axis of body in Macquarie) and spreading wings to dry (behaviour not seen in Macquarie Shag). Macquarie Shag very similar to **Crozet Shag** *P. melanogenis* but latter has narrower white alar patch and usually no scapular patches. **Kerguelen Shag** *P. verrucosus* smaller with shorter bill, normally without white on upper surface of wing, and more black on cheeks. On **Heard Shag** *P. nivalis* and **Antarctic Shag** *P. bransfieldensis* demarcation between black cap and white face extends over ear-coverts and both show white mid-dorsal patch.

Forage at sea; rest and nest on bare rock. Walk with fairly rapid high stepping gait, upright body leaning slightly forward. Swim on surface using feet alternately; during take-off and when diving uses both feet at same time. Forage underwater for fish and invertebrates. Bat-like flight; in sustained flight, head held below axis of body. Fly, feed, rest and nest in small groups. Calls of males include ticks and barks; females hiss.

HABITAT Marine. Feeding grounds near shore because sea-bottom drops away steeply. Feed mainly along less steep, w. shore, where greater area of feeding grounds at suitable depth. Birds do not fly overland between coasts. During westerly storms, rough seas and heavy swells interfere with foraging on w. coast and prevent birds returning to some colonies from e.-coast fishing trips. Diet almost exclusively bottom-dwelling fish, which birds catch under rocks and in kelp beds. Most breeding colonies exposed to prevailing w. wind. Sites used between 1975 and 1979: 11 on offshore stacks, six on stacks attached to shore, and two among boulders on shoreline. Largest colonies among boulders on shore because small stacks accommodate fewer pairs (Brothers 1985).

DISTRIBUTION AND POPULATION Restricted to Macquarie I. and adjacent Bishop and Clerk Is, 33 km S (Lugg *et al.* 1978). Probably do not range more than few kilometres from Macquarie I. and populations at Bishop and Clerk Is probably forage locally (Brothers 1985). Of 23 breeding colonies recorded, 19 active 1975–79; comprising 3–320 pairs (Brothers 1985). Numbers at colonies fluctuate; birds probably move from one to another. Total population estimated 760 pairs, which includes *c.* 100 pairs on Clerk and Bishop Is though latter estimate probably not accurate (Lugg *et al.* 1978).

No direct threat to survival; population naturally small. Some birds killed by collisions with radio aerials at ANARE base (Brothers 1985).

MOVEMENTS Local movements confined to Macquarie I. Inability to make headway against winds >40 knots (Brothers 1985), small wings, heavy bones and water-permeable plumage (which prevents long rests on water) restrict long-range movements.

FOOD Largely fish; some crustaceans and other benthic invertebrates. BEHAVIOUR. Food taken entirely by pursuit-diving possibly to 50 m (Brothers 1985). During breeding season at Macquarie I. fed solitarily but from late Mar. to Aug. flocks of ≤40 fed together, diving simultaneously several times, then flying about 50 m and feeding again (Brothers 1985).

ADULT, NESTLING Entirely benthic fish (47 regurgitations; Brothers 1985): *Paranotothenia magellanica* 47.3% wt., 61.6% freq., 26.5 g (2.2–115.5; 37; mean possibly larger as big fish tended to be broken), *Harpagifer bispinis* 8.3, 17.0, 3.4 (1.0–10; 27). Rest of material probably Nototheniidae. One stomach contained crustaceans and fish (QM; G.F. van Tets).

INTAKE Mean mass of regurgitated food samples 77 g (11–198; 47) (Brothers 1985).

SOCIAL ORGANIZATION Information from Brothers (1985) and G.F. van Tets. Forms small and large groups for foraging, breeding and roosting. Much competition for nest-sites.

BONDS Varying; tend to be sustained monogamous, retained from season to season. Some birds paired and bred in second year but seemingly nested late in season; most do not breed until fourth year or even later, even if paired and holding nest-site. Birds retain nest-sites from year to year. Both parents incubate and tend young until contact lost after fledging.

BREEDING DISPERSION Nest in small groups and colonies. Defend nest site only. Nests about 1–2 m apart.

ROOSTING Solitary or in small to large (600–800 birds) groups on bare ground. During breeding season, most adults, while not incubating, roost together at seaward edge of colony; some birds slept or preened beside nest when not incubating (Brothers 1985). Large foraging flocks left roosting and nesting areas before 10:00 and returned about 16:00 (W.J.M. Vestjens).

SOCIAL BEHAVIOUR Not well known; information supplied by G.F. van Tets, W.J.M. Vestjens and N.P. Brothers from personal observations. Displays obvious. Individual distance just out of pecking reach of other birds. At site, feathers on upper hindneck, crown and forehead crest erected.

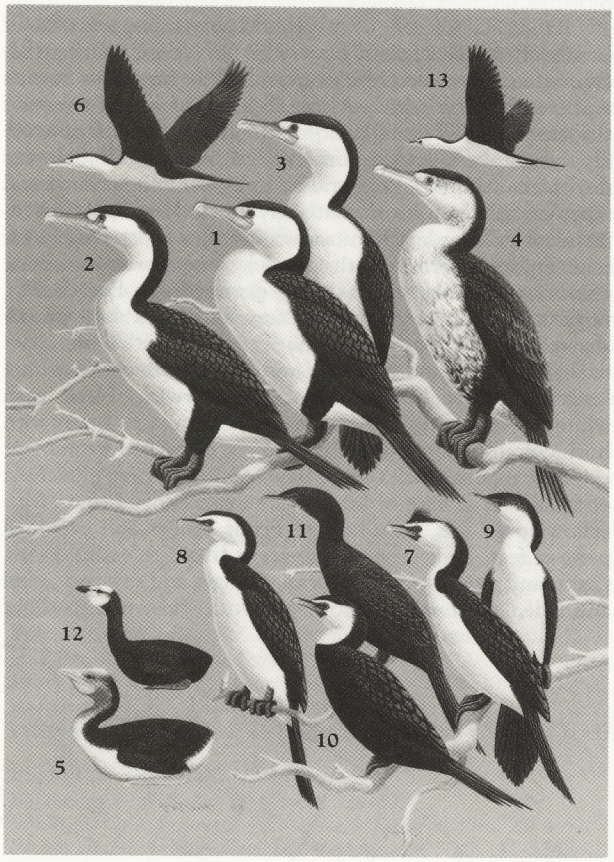


Plate 61

Pied Cormorant *Phalacrocorax varius*
1. Adult breeding, subspecies *hypoleucos*
2. Adult non-breeding, subspecies *varius*
3. Adult non-breeding, subspecies *hypoleucos*
4. Juvenile, subspecies *hypoleucos*
5. Downy young, subspecies *hypoleucos*
6. Adult non-breeding, subspecies *hypoleucos*

Little Pied Cormorant *Phalacrocorax melanoleucos*
7. Adult breeding, subspecies *melanoleucos*
8. Adult non-breeding, subspecies *melanoleucos*
9. Juvenile, subspecies *melanoleucos*
10. Adult non-breeding, subspecies *brevirostris*
11. Juvenile, subspecies *brevirostris*
12. Downy young, subspecies *melanoleucos*
13. Adult non-breeding, subspecies *melanoleucos*

AGONISTIC BEHAVIOUR Much competition for nest-sites. Males defend nest-site, retaining site from season to season; male bond to site greater than pair-bond; females approach males on site (N.P. Brothers). THREATENING: birds crouch and lean forward, bill held open and head and neck waved; males utter raucous barking or honking calls; females hiss. Threat can lead to FIGHTING: birds jab with bills, grasp opponent round head with bill or lock bills together; will roll round on ground locked together; males growl as bills lock. Fights can be very persistent and drawn-out, with much blood and dirt on birds. Aggression noted between shags and Royal *Eudyptes schlegeli* and Rockhopper *E. chrysocome* Penguins where nests intermixed (Brothers 1985). During incubation, tenacious in defence of eggs against intruders; if forced from nest, will retreat about 1 m before returning to nest (N.P. Brothers).

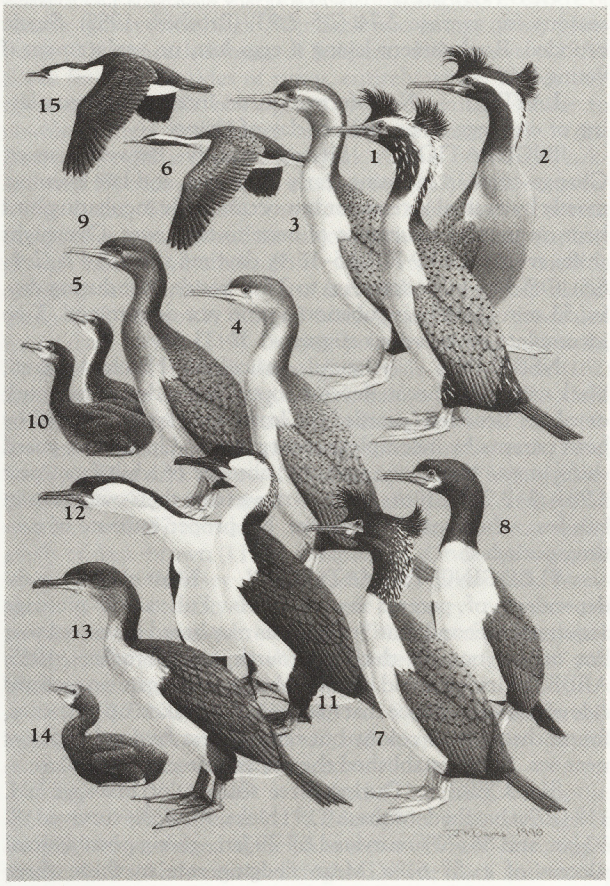


Plate 62

Spotted Shag *Phalacrocorax punctatus*
1. Adult breeding, courtship
2. Adult breeding, subspecies *oliveri*
3. Immature
4. Juvenile
5. Downy young
6. Adult

Pitt Shag *Phalacrocorax featherstoni*
7. Adult breeding
8. Adult non-breeding
9. Juvenile
10. Downy young

Black-faced Shag *Phalacrocorax fuscescens*
11. Adult breeding
12. Adult non-breeding
13. Juvenile
14. Downy young
15. Adult

SEXUAL BEHAVIOUR Similar to displays of Antarctic Shags. ADVERTISEMENT by males at nest-sites consists of **Gargling** (Fig. 1): body held upright and head swung back through vertical arc until crown and nape touch rump; tail cocked; wings drooped beside body and feathers of head and neck, sleeked. Sometimes performed in sitting position with breast raised; at other times, standing on one or both feet; bill wide-open and birds may be silent or give disyllabic calls: first syllable as head moved back, second as head moved forward. No head-rotation. RECOGNITION consists of **Gaping** (Fig. 2): wide-open bill directed forward and sometimes slightly upward, neck vertical, body horizontal, wings drooped beside body and tail varies from pressed down to almost vertical; males utter loud slow repeated barking, which changes later in breeding sequence; females hiss. Nest-worrying and Head-lowering, not observed. OTHER DISPLAYS AT SITE. **Pre-take-off Posture** (Fig. 3): neck stretched and head raised and held slightly forward; bill held slightly open with upper mandible almost horizontal, pointing in direction of flight. Breast at base of neck pulsates and males make ticking sound; females silent. After take-off, males sometimes utter loud call. On returning to nest-site birds give **Kink-throating** (Fig. 4) display with bill held closed; males call repeatedly; females silent. **Post-landing Posture** (Fig. 5): on landing, head and upper neck lowered till horizontal, level with breast and held straight in front of body; tail pressed down; bill is closed and throat bulges; males give monosyllabic call; females hiss. **Penguin-walking** (Fig. 6): bird walks with upper neck arched and closed bill held against base of neck; ridge of feathers along nape line; wings folded tightly and tail below horizontal. **Pre-hop Posture** (Fig. 7) similar to Pre-take-off Posture but neck arched and open bill directed down. Males tick during Pre-hop and warble during **Post-hop Posture**. Females **Hop** silently.

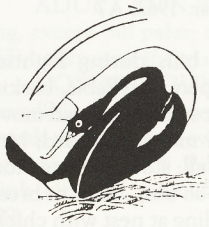


Fig. 1 Gargling

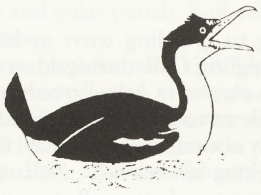


Fig. 2 Gaping

Fig. 3
Pre-take-off Posture

Fig. 4
Kink-throating

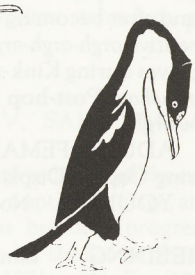


Fig. 6 Penguin-walking

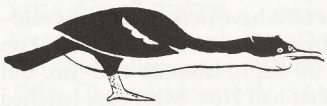


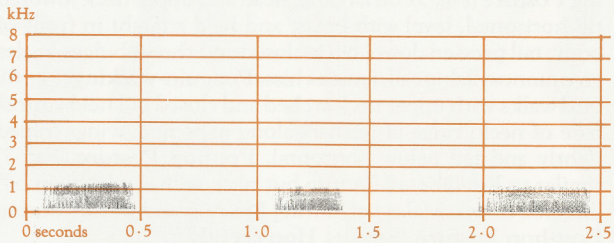
Fig. 5 Post-landing Posture

Fig. 7 Pre-hop Posture

RELATIONS WITHIN FAMILY GROUP Information from Brothers (1985). Both sexes build nest and keep it repaired. Incubation shared equally; change-overs usually in morning, early afternoon and late evening. Both parents feed young. Newly hatched chicks guarded by both parents, up to four shifts per day. Older chicks, about one month before fledging, sometimes move temporarily to adjacent nests, usually being savagely attacked by adult on the nest; however, if not driven away within about 30 s, it may be accepted and fed by 'foster' parents; these chicks always return to own nest. Usually independent of parents soon after fledging.

VOICE Little known; limited information supplied by G.F. van Tets. Most calling at colonies, which can be noisy; call when approaching nest-site and at site. Apparently mostly silent at sea; ticking calls heard from birds foraging in raft (W.J.M. Vestjens). Distinct sexual differences: males have variety of loud raucous barking calls or honks (Brothers 1985) and females hiss; associated with particular displays but description of calls and variety of calls not adequately recorded. No information on individual differences.

ADULT MALE **Threat Call**: birds threaten with raucous barking *harrr* (three examples in sonagram A) changing to growling *wirrr* as birds lock bills during Fighting. **Gargling Call**: during advertising display, disyllabic, barking *eeh-oh*, *oh-arr*, *heh-who* or *heh-hah*; first syllable as head moved back to touch rump, second as head moved forward; birds may not call during display. **Gaping Call**: slow, repeated loud barking *heh-heh-heh. . .*; changes to *oh-oh-oh. . .* later in breeding season. Latter call given when landing at nest with chicks. **Pre-flight** and **Pre-hop Call**: sometimes, birds make ticking *t-t-t-t. . .* as part of action; sometimes also give a loud *owh* sound after becoming airborne. **Kink-throating Call**: a loud, repetitive *orgh-orgh-orgh. . .*, *ooh-ooh-ooh. . .* or *oo-ah-oo-ah-oo-ah*; gives during Kink-throating Display. **Post-landing Call**: a loud *whoo*. **Post-hop Call**: gargling or warbling *ah-grrrg* or *ah-worgh*.



A W.J.M. Vestjens; Macquarie I., Mar. 1962; A7

ADULT FEMALE **Hiss**: only call given is *hiss* during Gaping Display, Threat and Post-landing Posture.

YOUNG No information.

BREEDING Limited details. One study by Brothers (1985) over three breeding seasons. Breed colonially in small (three) to large (300) colonies on bare rocky shores and stacks.

SEASON Adults in nuptial plumage in June (Falla 1937). Nest-building starts in July; by early Aug. only 10% of nests well formed and further 60% have nest material; by mid-Sept., 50% well formed and by end Sept. birds began to sit on empty nests. Earliest laying 30 Sept., latest in mid-Jan. but mostly in last half Oct. and first half Nov. Most eggs hatched by late Dec. Fledging from late Jan. to mid-Feb.

SITE On bare rocks washed clean by water from year to year. Not far above high-tide mark and in spray zone. Birds placed new nests on exact site used previously.

NEST, MATERIALS Truncated cone, 20–30 cm high; cemented to rock by mixture of vegetation, guano and mud, collected nearby. Plant material added to base and collected from up to 300 m away. Material mostly *Poa foliosa* with some *Cotula plumosa*, *Festuca erecta*, *Colobanthus muscoides* and *Stilbocarpa polaris*. Seaweed not used except fortuitously. Nest soon becomes well cemented with guano. Both sexes build and repair nest well into nestling period when chicks tend to destroy them. Building begins in late July.

EGGS Elliptical ovate; rough-textured, mat; pale blue with white chalky coating.

MEASUREMENTS: 64 (58–69; 130) x 40 (38–42) (Falla 1937); 63.6 (0.46; 58.6–67.5; 30) x 39.5 (0.2; 37.0–41.4) (Brothers 1985)

CLUTCH-SIZE C/1 x 1, C/2 x 13, C/3 x 44 in three seasons for average 2.74 (2.5–2.93) (Brothers 1985). Single brooded. Replacement laying if eggs lost; no replacement if young lost.

LAYING No information on interval between laying of each egg or on time of day of laying.

INCUBATION Shared equally between sexes. Change-overs in morning, early afternoon and late evening, mostly by mutual agreement but occasionally incubating bird kept on nest by reluctance of mate to take over. Overnight shifts averaged 14.9 h (10.5–16.4); daytime shifts 8.4 h (2.4–8.5). Off-duty birds spent up to 2.5 h beside nest during day, av. 53 min (2–105). Incubation period not determined. Two incomplete observations suggested 32–33 days.

NESTLING Altricial, nidicolous. Hatched naked, black with pink throat; develop sooty-brown down; face pink or white. Brooded (guarded), at least while small, and fed by both parents by incomplete regurgitation. Up to four guard shifts in one day at one nest. Av. absence of adult from nest 4.98 h (2–7; 23). Chicks begin to move from their own nests in late Jan., when some may fledge. No proper estimate of nestling period.

FLEDGING TO MATURITY Most chicks are independent of parents by mid-Feb. Full adult plumage acquired in second year. Individuals may breed in second year but others not till third or fourth year (Brothers 1985; ABBBS). First-year and unpaired birds congregate on seaward side of colonies. Those that had paired and taken up nest-sites, found throughout colony but often in less favourable places near sea. Some established themselves close to birthplace.

SUCCESS During three seasons, of 159 eggs laid, 119 (75%) hatched: of these 119 chicks, 97 (82%) survived till 10 Jan. and 86 (72%) survived till 29 Jan., giving possible total success of *c.* 57–61%. Mean fledging rate in these three seasons varied from 1.0 to 1.9 per nest. Predation by skuas *Catharacta* and starvation were chief causes of death by chicks. Skuas even dislodged large chicks from nests when only partly covered by parent. Storm-waves sometimes damaged or destroyed nests. Cats may take chicks.

PLUMAGES Minimum age at first breeding, 2 years, but most breed *c.* 4 years, or later (Brothers 1985; ABBBS).

ADULT BREEDING HEAD AND NECK. Crown to nape and sides of head (from gape to below ear), glossy blue-black (90) with strong pale black-green (162) sheen; concealed bases, light grey-brown (119C). In pre-nuptial plumage, small erectile crest, 45–50 mm long, on forecrown, glossy pale

black-green (162), narrowly fringed black-green (162). Lores, mostly bare with deep, thick, arch-shaped caruncles, *c.* 15–22 mm long at front. Above, and immediately behind eye, long narrow white nuptial plumes lie horizontally. When birds on eggs, nuptial plumes and crest-feathers lost. Gular pouch, mostly naked. Hindneck, glossy blue-black (90). Foreneck, white; feathers on throat extend on to basal quarter of gular pouch, in sharp inverted V; demarcation between black of crown and sides of head and white of face extends in shallow arch below eye and ear-coverts and down sides of neck; demarcation sharp apart from slight intrusion of white feathers at rear of malar region. Cheek pattern typical *albiventer*-type (e.g. Devillers & Terschuren 1978; Rassmussen 1986). Feathers on head and neck have silky texture. UPPERPARTS. Mantle, glossy pale black-green (162); feathers, fringed black-green (162), fringes become progressively broader towards lower and outer margins of mantle; feathers in centre of mantle, glossy blue-black (90). Back and rump, glossy blue-black (90); concealed bases of feathers, dark brown (119A). Some feathers on sides of rump, entirely white. Upper tail-coverts, glossy pale black-green (162). Scapulars similar to mantle-feathers but fringes on subscapulars narrow. TAIL. Rectrices, rigid at base, with thick rachis; feathers, black-brown (119) with glossy pale black-green (162) shade on outer webs; rachis, black (89). UPPERWING. Most lesser coverts, except near humerus and carpal joint, white, forming alar bar, though not on all adults (G.F. van Tets). Rest of coverts, except greater primary coverts and alula, glossy pale black-green (162) narrowly fringed black-green (162); concealed bases, dark brown (219). Greater primary coverts and alula, black-brown (119) with slight glossy pale black-green (162) sheen on outer web. Remiges, black-brown (119); rachis, dark red-brown (221A). UNDERPARTS, almost all white. Long lateral breast feathers, 40–53 mm long; concealed beneath these, small patch of dark brown (119A) semiplumes. Thighs, glossy blue-black (90); tibio-tarsal feathers similar to feathers of mantle, *c.* 45–57 mm long; at base of tibia, small concealed patch of dark-brown (119A) semiplumes. Under tail-coverts, white (*contra* Lindsey 1986). Axillaries, glossy pale black-green (162). UNDERWING. Greater primary coverts, and greater coverts, glossy brown-grey (79). Rest of coverts, dark brown (121) and fringed slightly darker; faint gloss of pale black-green (162) present on webs.

ADULT NON-BREEDING Similar to adult breeding, but without nuptial crest and narrow white nuptial plumes; size of caruncles reduced.

DOWNY YOUNG Naked at hatching. Protoptile, sparse and black-brown (119). Mesoptile, pale dark-brown (119A), with scattered white plumules on crown, chin, upper breast, flanks, abdomen and thighs. Down, thick and woolly on head and neck, loose and longer on back. Face and small area of forehead, bare.

JUVENILE, IMMATURE HEAD AND NECK. Crown, including ear-coverts, to hindneck, dark brown (119A). Caruncles, absent; small papillae only. Foreneck, white. Cheek-pattern similar to adult but demarcation with dark hindneck and light foreneck not so sharp; for further details see Rasmussen (1986). UPPERPARTS. Mantle, dark brown (121) and broadly fringed black-brown (119); in some lights, some feathers may show slight glossy pale black-green (162) shade. Fringes on mantle, progressively broader from uppermost to lowermost. Rest of upperparts, dark brown (121); scapulars, black-brown (119); feathers have pointed tips; tips, brown (119B); some shorter feathers, narrowly fringed dull white. TAIL, dark brown (121); rachis, basally white, merging to grey (84). UPPERWING. Remiges, dark brown (121), with pointed tips. Marginal and lesser coverts, dark brown (119A), broadly fringed dull white; marginals near humerus, narrowly fringed light grey-brown (119C). Greater coverts, dark brown (121), narrowly fringed dull white. Greater primary coverts and alula, similar, but fringes slight. Alar patch, when present, indistinct and pale brown (G.F. van Tets). UNDERPARTS, almost all white. Long lateral breast feathers, *c.* 37 mm long and varyingly streaked dark brown (119A) on webs, entirely white, or with bi-coloured webs. Thighs, black-brown (119); upper margins, dark brown (119A), with scattered white filoplumes. Tibio-tarsal feathers, dark brown (221) and narrowly fringed slightly darker. Axillaries, similar to adult. UNDERWING, similar to adult. Juveniles lack alar bar and caruncles (Watson 1975).

BARE PARTS Based on photos in Lindsey (1986), and information from E.J. Woehler, G. Copson and I. Skira. Further details of bare parts in Falla (1937), for all ages.

ADULT BREEDING Intensity of bare parts, likely to be brighter during courtship (Falla 1937). Iris, dark brown (219). Eye-ring, dark blue (170A); fleshy skin, scale-like. Bill, dark brown (119A); darker on culmen; nail, brown (119B); skin covering base of upper mandible covered in orange-buff (153) nodules. Caruncles, orange-buff (153); posterior end of caruncles points towards centre of eye. Loral skin, grey-black (82) with purple (172B) shade, covered in minute orange-buff (153) papillae. Gular pouch, grey-black (82) with profuse orange-buff (153) nodules. Legs and feet, dull red (10); hind-tarsus, joints, tops of toes and webs, similar, but with strong dark brown (119A) shade.

ADULT NON-BREEDING Similar to adult breeding, except bill paler; caruncles and gular pouch, buff-yellow (53); unknown if caruncles regress.

DOWNY YOUNG Iris, black-brown (119). Upper mandible, tip of lower, small spot on lower near gape and streak mid-way on lower, black (89). Rest of lower mandible, light violet (170D). Bill, dark at fledging. Gular pouch, dirty pink (4); dull pink (5) distally. Legs and feet, brown-grey (79).

JUVENILE, IMMATURE Iris, brown (119B). Bill, dark grey (83); grey-black (82) on culmen. Legs and feet, grey (84) with slight dirty pink (4) shade. Oliver states feet, grey, tinged with yellow.

MOULTS Based on skins (MV, SAM, QM, AM, TMAG, QVM).

ADULT Primaries moult outwards in staffelmauser; timing and duration unknown. In pre-nuptial plumage, attain crest about June (Falla 1937); lost as breeding progresses, about Jan. Pattern of moult likely to be similar to that described in Bernstein & Maxson (1981) and Rasmussen (1988a,b).

POST-JUVENILE Undescribed.

MEASUREMENTS (1) Adults, combined data from literature sources and skins (Derenne *et al.* 1971). (2) Adults, end of breeding season; WING = minimum chord (Brothers 1985). (3) Adult skins (MV, SAM, QM, AM, TMAG, QVM). (4) Adult skins (Falla 1937).

		MALES	FEMALES	
WING	(1)	317.0 (1.0; 315–318; 3)	293.0 (4.0; 278–300; 5)	
	(2)	313.0 (5.37; 301–322; 16)	293.0 (5.01; 285–304; 18)	*
	(3)	305.0 (9.52; 290–319; 6)	291.2 (7.22; 279–300; 7)	*
	(4)	316.6 (1.24; 315–318; 3)	293.2 (8.44; 278–300; 5)	
BILL	(1)	62.3 (O.7; 61–63; 3)	56.6 (0.9; 54–59; 5)	
	(2)	59.3 (1.21; 57.2–61.5; 16)	54.8 (1.67; 52.1–57; 18)	*
	(3)	58.4 (1.42; 56–60; 7)	54.8 (1.92; 53.4–59; 8)	*
	(4)	62.3 (0.94; 61–63; 3)	56.6 (1.84; 54–59; 5)	
TARSUS	(1)	63.7 (0.7; 63–65; 3)	60.3 (0.3; 60–62; 6)	
	(2)	66.8 (1.31; 64–69; 16)	62.0 (1.63; 59.1–64.5; 18)	*
	(3)	65.5 (0.84; 64.4–67; 7)	61.9 (1.57; 59.2–64; 7)	*
	(4)	63.6 (0.94; 63–65; 3)	60.0 (0; 5)	
TAIL	(2)	121.4 (8.48; 100–134; 16)	112.7 (4.41; 104–120; 18)	*
	(3)	132.8 (5.63; 125–138; 5)	129.8 (14.50; 116–161; 6)	
	(4)	130.6 (4.10; 126–136; 3)	126.4 (4.75; 117–130; 5)	
TOE	(2)	111.6 (1.78; 109.8–115.2; 16)	103.4 (4.26; 91.6–107.4; 18)	
	(3)	85.0 (2.87; 79.2–88; 7)	78.7 (1.61; 76.8–81.9; 6)	*
	(4)	105.6 (0.47; 105–106; 3)	99.4 (2.33; 95–102; 5)	

		UNSEXED
WING	(1)	302.0 (5.0; 278–318; 8)
BILL	(1)	58.7 (1.0; 54–63; 8)
TARSUS	(1)	61.4 (0.7; 60–65; 8)

WEIGHTS (1) Before breeding season (Brothers 1985). (2) After breeding season (Brothers 1985). (3) Label data from adult skins (MV, SAM, QM, AM, TMAG, QVM). (4) Label data from skins (G.F. van Tets).

	MALES	FEMALES	
(1)	2860 (145; 2650–3200; 16)	2430 (152; 2180–2700; 18)	*
(2)	3320 (166; 2950–3500; 8)	2700 (120; 2550–2990; 8)	*
(3)	2970 (170; 2800–3200; 3)	2370 (161; 2240–2600; 3)	
(4)	3200 (200; 2900–3500; 11)	2600 (200; 2200–2900; 12)	

Males heavier than females ($P<0.05$). Weight decreases during breeding,; see Brothers (1985) for details.

STRUCTURE Wing, long and broad. Eleven primaries, p8 usually longest, p10 8–14 mm shorter p9 0–2, p8 0–2, p7 3–4, p6 13–20, p5 42–50, p4 45–67, p3 60–79, p2 80–91, p1 84–102, p11 minute. P10–9 emarginated on inner vane, slight on outer of p9–p7. Remiges and scapulars with rounded tips to webs in adults; pointed in juveniles; 14 secondaries, four of tertial form. Twelve rectrices, t1 longest, t6 26–42 mm shorter. Bill, long and slender; upper mandible with flange at gape; nail hooked at tip. Bill, rough in juveniles, largely smooth in adults. Gular pouch with profuse small nodules. Caruncles at front of lores. Tarsus, short. Feet, totipalmate. Outer toe *c.* 139% of middle, inner *c.* 62%, hind *c.* 35%.

SEXING On calls (Brothers 1985; G.F. van Tets). Brothers (1985) provides discriminant function analysis for separation of sexes; males larger than females.

RECOGNITION Similar to Crozet Shag *P. melanogenis* which differs in having posterior end of caruncles pointing over eye; loral skin bare; no nodules at base of upper mandible; no intrusion of white feathers at posterior malar.

RMO

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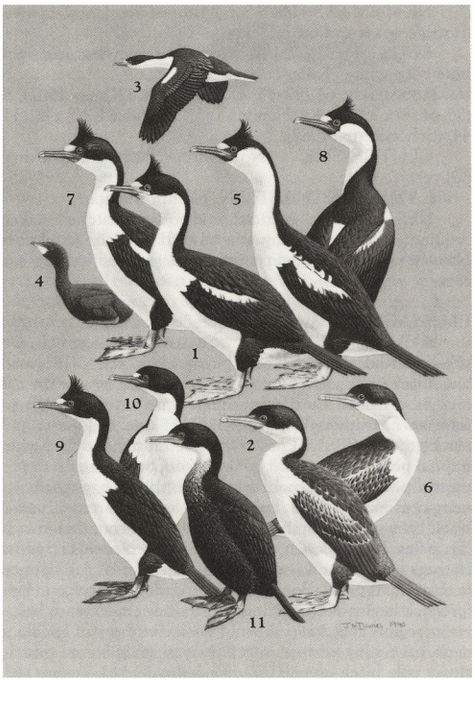

Volume 1 (Part B), Plate 63

Macquarie Shag *Phalacrocorax purpurascens*
1. Adult breeding
2. Juvenile
3. Adult non-breeding
4. Downy young

Heard Shag *Phalacrocorax nivalis*
5. Adult breeding
6. Juvenile

Crozet Shag *Phalacrocorax melanogenis*
7. Adult breeding courtship

Antarctic Shag *Phalacrocorax bransfieldensis*
8. Adult breeding

Kerguelen Shag *Phalacrocorax verrucosus*
9. Adult breeding
10. Adult non-breeding
11. Juvenile