

## 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 Leucocarbininae (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, totalpalmate; 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 asynchronous. 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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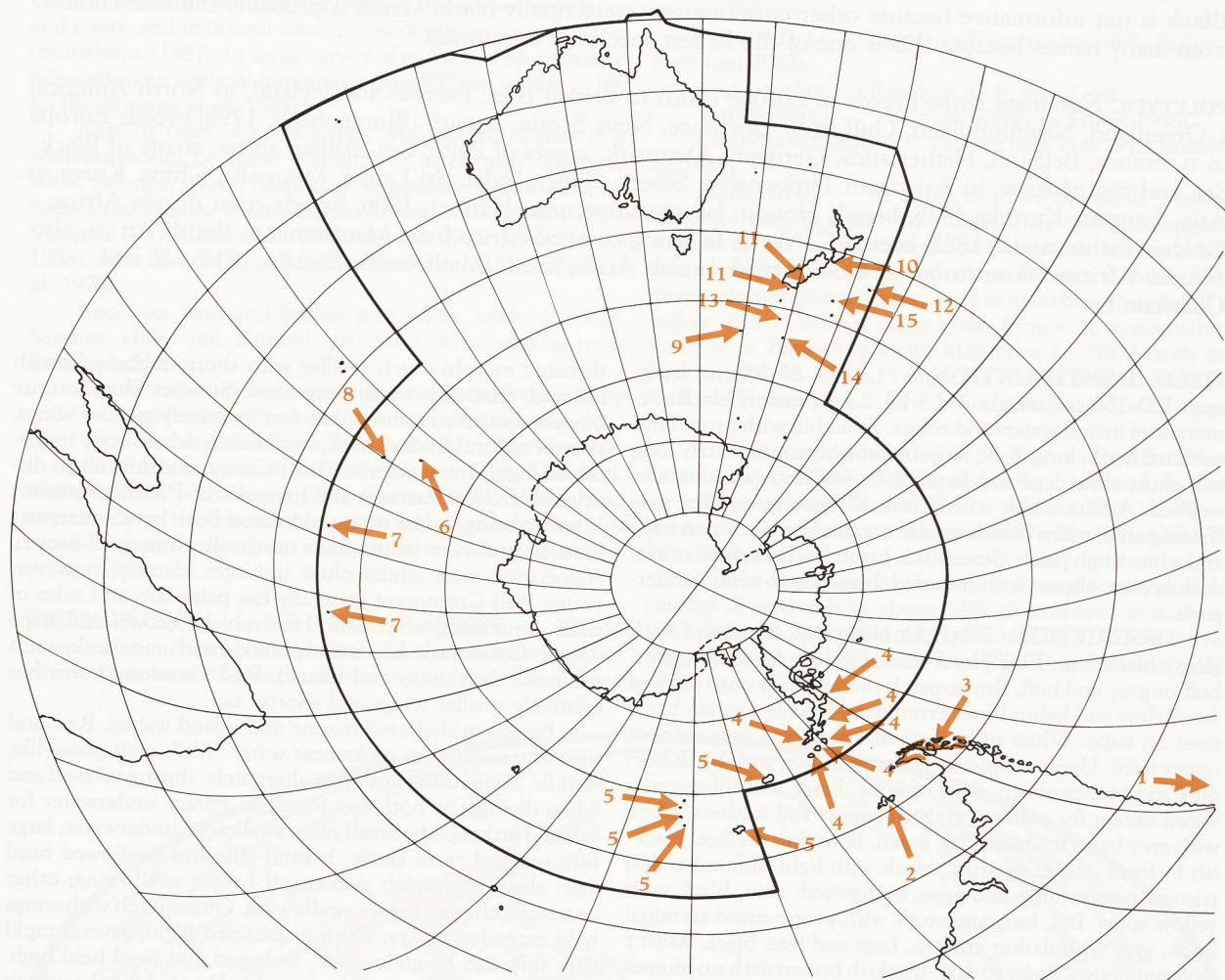


Fig. 1. Distribution of island forms of *Phalacrocorax*.

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

*Phalacrocorax carbo* Great Cormorant

*Pelecanus carbo* Linnaeus, 1758, *Syst. Nat.*, ed. 10: 133 — Europe; restricted to the 'rock-nesting form of the north Atlantic Ocean' by Hartert, 1920, *Vögel pal. Fauna*: 1387.

The generic name is compounded of the Greek φαλακρός (bald-headed) and κόραξ (a raven): *carbo* is Latin for charcoal (black).

**OTHER ENGLISH NAMES** Black, Big or Large Black Cormorant or Shag.

**Black** is not informative because other cormorants are essentially black. **Great** is probably the best choice from many names because this is one of the largest species of cormorant.

**POLYTYPIC** Nominate *carbo* breeds n. Europe south to British Isles, Faeroes and Iceland, in North America, s. Greenland, Newfoundland, Gulf of St Lawrence, Nova Scotia; *sinensis* (Blumenbach, 1798) breeds Europe in n. France, Belgium, Netherlands, Germany, Denmark, coasts of Baltic Sea, Balkan states, coasts of Black Sea and Sea of Azov, in Asia from Turkey to e. Siberia, Tibet, India, Sri Lanka, Mongolia, China, Korea, se. Asia; *hanedae* Kuroda, 1925, breeds Hondo, Japan; *maroccanus* Hartert, 1906, breeds coast of nw. Africa; *lucidus* (Lichtenstein, 1823) breeds C. Verde Is, along coast of Africa from Mauritania to South Africa, also central African lakes; *carboides* Gould, 1838, breeds Aust.; *steadii* (Mathews & Iredale, 1913) NZ and Chatham Is.

**FIELD IDENTIFICATION** Length 80–85 cm; wing-span 130–150 cm; weight 2–2.5 kg. Large, mainly black cormorant of inland waters and coasts. Stout bill with prominent terminal hook; long neck, large broad wings, moderately long tail, short stout legs and large black feet with all four toes webbed. Adults, black with greenish sheen except for pale throat-patch; when breeding have erectile black crest on nape and white thigh patch. Sexes alike. Juveniles, dark; immatures, dull brown above with mottled brown-and-white underparts.

**DESCRIPTION ADULT BREEDING.** Head and neck glossy black with blue-green sheen, except for white, grey, buff or grey and buff, throat-patch that extends onto sides of face below and behind eye. Prominent erectile median black crest on nape. White nuptial plumes scattered over sides of upper neck. Upper wing-coverts, grey-brown with black borders and bronze sheen. Rest of body, black with blue-green sheen except for white oval thigh-patch. Tail-feathers, black with grey bases to shafts. Iris, green. Bare skin on face, blackish in front of eye; eye-ring, black with light-blue tubercles; triangle between eye and gape, orange-red; chin, black with yellow spots. Bill, long and stout with pronounced terminal hook, grey with darker culmen. Legs and feet, black. **ADULT NON-BREEDING.** Fades to dark-blackish brown with no plumes or crests. Upper wing-coverts with sandy edges. No white thigh patch. Facial skin below eye and on chin, prominent bright-yellow. **JUVENILE.** At first, black, as in adult breeding plumage, but with silky texture and without median crest, nuptial plumes or white thigh-patch. Soon fades to sandy brown (G.F. van Tets). Iris, grey-brown. Facial and throat skin, yellow. **IMMATURE.** Mottled dark and light brown with varying amounts of white on foreneck, breast and abdomen. Iris, green.

**SIMILAR SPECIES** Can be confused with Little Black Cormorant *P. sulcirostris*, white-throated morph of Little Pied Cormorant *P. melanoleucos* and bronze morph of Stewart Shag *P. chalconotus*. **Little Black Cormorant**, smaller, more slender with very thin bill, relatively longer tail and without yellow facial skin. **Little Pied Cormorant** (white-

throated morph) much smaller with short stubby yellowish bill and, relatively, much longer tail. **Stewart Shag** (bronze morph), entirely marine; pink feet, relatively smaller wings, shorter tail and thicker neck; head below axis of body in sustained flight. Immatures of Great Cormorant difficult to distinguish from immatures and juveniles of **Pied Cormorant** *P. varius* being similar in size and shape. Both have underparts mottled brown or white, from nearly all-white to all-brown. Association with adults often indicates identity; however, young Pied Cormorant generally has paler face and sides of neck contrasting with dark brown-black crown and nape (Great Cormorant has mainly dark head and neck, with yellowish facial skin and throat). Pied Cormorant also has relatively smaller wings and shorter tail.

Forage in sheltered marine and inland waters. Rest and nest in trees and on rocks near water. Walk with goose-like waddle. Swim using both feet alternately; during take-off and when diving, use both feet together. Forage underwater for fish and arthropods. Small prey, swallowed underwater; large fish, grabbed from above, behind gills and swallowed head first; claws of crayfish shaken off before swallowing; other crustacea, chewed before swallowing. Often perch with wings held extended to dry. During sustained flight, several rapid flaps followed by glide; neck, S-shaped and head held high. Before take-off from water, wings dried by shaking them back and forth. Solitary or in small groups; large groups sometimes formed for flying, feeding, resting and breeding. At nest-site, calls of males loud and raucous; of females, soft and husky, becoming more like males during incubation.

**HABITAT** Widespread, in terrestrial wetlands and coastal waters. Occur inland on lakes, reservoirs, swamps, rivers, pools, billabongs. Associated with large sheets of open water (Fjeldsá 1985), favouring deep permanent lakes, major rivers (Hobbs 1961) or open water in deep marshes (Corrick & Norman 1980). Less common on small waterbodies or shallow vegetated waters: dams (Corrick 1981); edges of lakes (Vestjens 1977); seasonal and semi-permanent freshwater swamps; and freshwater meadows (Gosper 1981). Birds unaf-

ected by fluctuations in salinity and turbidity; nature of shoreline vegetation unimportant, provided trunks, branches, posts or islands in or by water for perching (Fjeldså 1985). Gather at drying pools and spillways of weirs to feed on trapped and stunned fish (Hobbs 1956; McNally 1957). Along coast, abundant in estuaries and deep coastal lagoons (Corrick & Norman 1980; Gosper 1981; Fjeldså 1985; Owen & Sell 1985; Jaensch *et al.* 1988); also occur in saltpans (Corrick & Norman 1980), mangrove swamps (Gosper 1981), saltfields (Cooper 1980), and on rock platforms, beaches and inshore waters on unindented or exposed coasts (Marchant 1977; Gosper 1983). In Kaikoura, NZ, feed in shallow water in lakes and rivers, and in littoral zone, 1–3 m depth, in coastal waters (Stonehouse 1967). In aerial survey of e. Aust., 24% estimated population on artificial impoundments; 95% on waters > 100 ha (Braithwaite *et al.* 1985a).

Nest in trees (e.g. eucalypts, *Melaleuca*), bushes (e.g. *Muehlenbeckia*) or reeds (*Phragmites*) in or near water; in lakes, swamps, rivers, billabongs, temporary floodwaters, estuaries and shallow coastal lagoons (Aust. Atlas; Hobbs 1961; Vestjens 1977; Close *et al.* 1982; Corrick 1982; Jaensch *et al.* 1988). Also nest on coastal cliffs and offshore islands (Falla *et al.* 1978).

Roost on trees and bushes near water, offshore rocks, beaches, cliffs, and artificial structures (breakwaters, navigation platforms).

Construction of water storages has provided foraging and breeding habitat. Favoured habitats (estuaries and deep open lakes and lagoons) have been less affected by drainage than most other types of wetland (Riggert 1966; Goodrick 1970; Corrick & Norman 1980; Corrick 1981, 1982). Feed extensively on introduced fish, particularly common carp and redfin, and any campaign to eradicate fish may be detrimental (Miller 1979).

**DISTRIBUTION AND POPULATION** Almost cosmopolitan: Aust., NZ, Eurasia, Iceland, Africa, ne. coast of North America and Greenland. Scarce visitor to New Guinea

(Rand & Gilliard 1967; Coates 1985), Wallacea (White & Bruce 1986).

**AUST.** Coastal and permanent inland waters, mainly E of line from Adelaide to Darwin and SW of WA, using ephemeral floodwaters elsewhere, including deserts.

**NZ** Widespread in coastal and inland waters throughout NI, SI and Stewart I. (NZ Atlas).

**LORD HOWE I.** Vagrant.

**NORFOLK I.** Vagrant: first recorded 1977 (van Tets 1978) and two in 1978 (Moore 1981).

**SNARES IS** Vagrant (Westerskov 1960; Bailey & Sorensen 1962).

**CAMPBELL I.** Vagrant (Westerskov 1960; Bailey & Sorensen 1962).

**CHATHAM IS** Resident (G.F. van Tets).

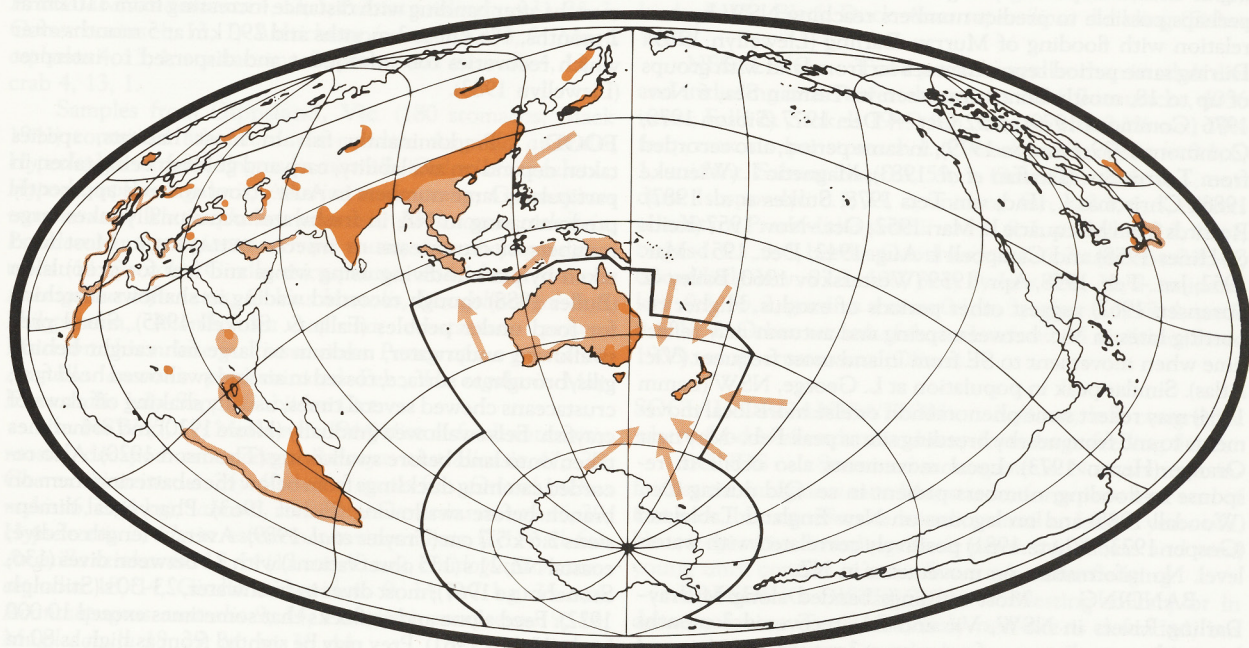
**MACQUARIE I.** Vagrant (Keith & Hines 1958).

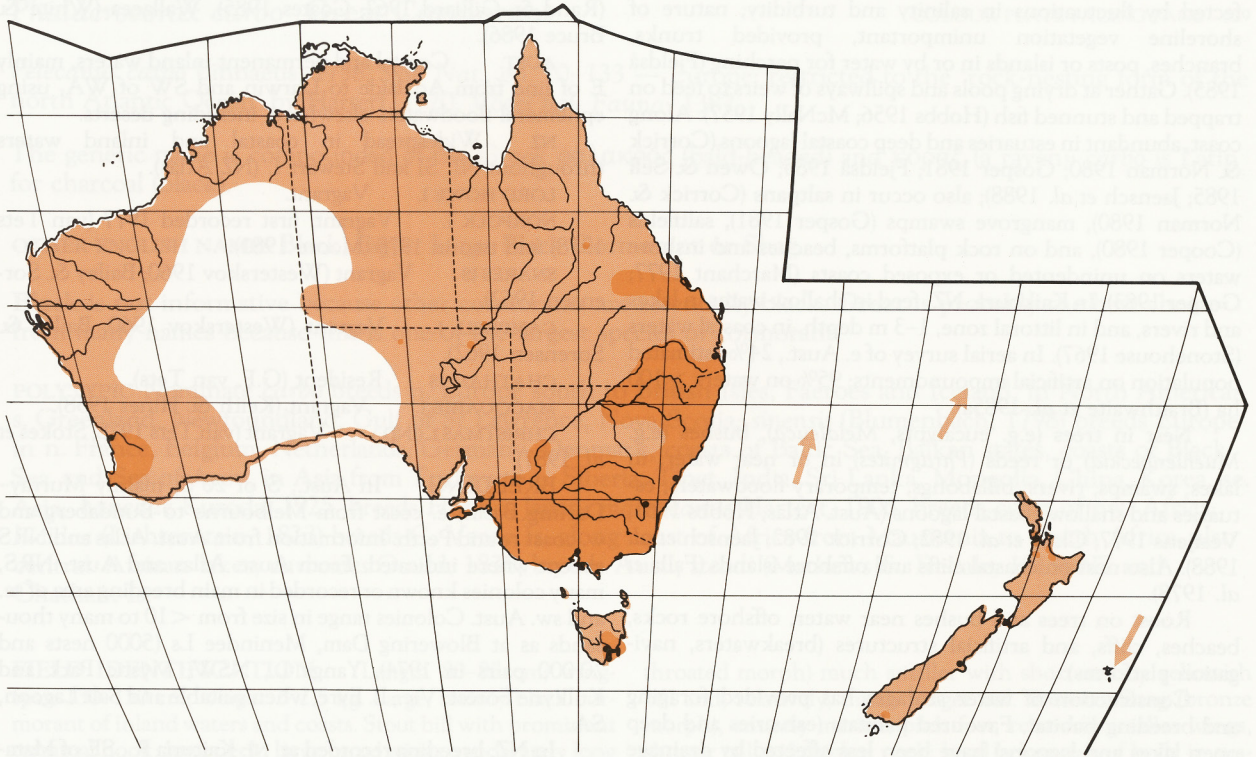
**CHRISTMAS I. (IND.)** Vagrant (van Tets 1978; Stokes *et al.* 1987).

**BREEDING** In Aust., S of 20°S, mainly Murray-Darling Basin, e. coast from Melbourne to Bundaberg and w. coast round Perth. Information from Aust. Atlas and NRS except where indicated. From Aust. Atlas and Aust. NRS, many colonies known or recorded in main breeding area of se. and sw. Aust. Colonies range in size from < 10 to many thousands as at Blowering Dam, Menindee Ls (5000 nests and 20 000 pairs in 1974), Yanga L., NSW; Mystic Park and Kulkyn Forest, Vic.; L. Eyre, when suitable and Salt Lagoon, SA.

In NZ, breeding recorded at: NI: Kaituna R., SE of Matakana I., Bay of Plenty, Kaukapakapa R., Auckland, L. Karapiro, Matakana I., Bay of Plenty, Matata, Bay of Plenty, Tuakau, S. Auckland; SI: Waituna (CSN 25,29,31, CSN 33-35); Chatham Is.

Indices of abundance from annual aerial survey (transect counts) of wetlands in about 12% of land area of e. Aust., 1983–88, were 2841; 5744; 6949; 4023; 2623; 1745 respectively (Braithwaite *et al.* 1985a,b, 1986, 1987; Kingsford *et al.* 1988, 1989).





**MOVEMENTS** Nomadic with wide dispersal following successful inland breeding. Large-scale breeding usually follows floods in se. Aust. river systems or of L. Eyre, in turn followed by rapid dispersal of juveniles and adults as lakes dry up. Movement outside Aust. occurs after exceptional conditions inland (van Tets *et al.* 1976; van Tets 1978). After L. Eyre filled in 1974, 2 years of successful breeding followed, then birds dispersed to SE and found floods on Murray-Darling in 1978, exceptionally large numbers reaching se. NSW; perhaps possible to predict numbers reaching NSW by correlation with flooding of Murray-Darling (Llewellyn 1983). During same period reported at sea far from land with groups of up to 18, mostly immatures, seen in Tasman Sea, 6 Nov. 1976 (Commons 1979) and 2 Oct.-4 Dec. 1977 (Sibson 1978; Commons 1979; Stanton 1979); in same period, also recorded from Torres Str. (Druffan *et al.* 1983), Magnetic I. (Wieneke 1988), Christmas I., (Ind; van Tets 1978; Stokes *et al.* 1987). Records from Macquarie I., Mar. 1952, Oct.-Nov. 1957 (Keith & Hines 1958) and Campbell I. Aug. 1942, Dec. 1951-Mar. 1952, Jan.-Feb. 1958, Apr. 1959 (Westerskov 1960; Bailey & Sorensen 1962) suggest other periods of exodus. Higher reporting rates in Vic. between spring and autumn may reflect time when movement to SE from inland most frequent (Vic. Atlas). Similar peak in population at L. George, NSW (Lamm 1964) may reflect same phenomenon or else more local movements to and from nearby breeding site as peak Feb.-May near Orange (Heron 1973). Local movements also occur in response to flooding; numbers present in se. Qld during Oct. (Woodall 1985) and on lagoons on New England Tableland (Gosper 1973; Whyte 1981) positively correlated with water-level. No information on movements in NZ.

**BANDING** Most nestlings banded along Murray-Darling Rivers in NSW, Vic and SA, recovered 3 months later with mean distance of recovery at 2 months, 250 km; at 4

months, 440 km; later recoveries show no pattern (Llewellyn 1983). Most movement along river systems or to wetlands adjacent to coast. Birds from SA in particular move E (van Tets *et al.* 1976). Regular recoveries from Tas. of birds banded SA thought to be accounted for by absence there of Pied Cormorant (van Tets *et al.* 1976). Most nestlings banded in SA recovered to NW in Gulf St Vincent or from coastal wetlands to the SE with a few travelling NE up Murray-Darling (van Tets *et al.* 1976). Number of returns of nestlings peaked 2 months after banding with distance increasing from 110 km at 2 months, 175 km at 3 months and 290 km at 5 months after which recoveries too infrequent and dispersed to interpret (Llewellyn 1983).

**FOOD** Predominantly fish in most habitats, species taken depend on availability; carp and goldfish being taken in particularly large numbers in Aust., trout and eels apparently predominating in NZ; in freshwater occasionally takes large numbers of crustaceans or insects. **BEHAVIOUR.** Most food taken by pursuit-diving using wings and feet for propulsion (Buller 1888) though recorded wading in shallows searching for food under pebbles (Falla & Stokell 1945). Small prey swallowed underwater, medium to large fish caught behind gills, brought to surface, tossed in air and swallowed head first; crustaceans chewed several times, usually shaking off claws of crayfish. Eels swallowed gradually (Hosie 1920) and sometimes taken onto land before swallowing (Thomson 1920). Also recorded catching ducklings from below then battering them on branch before swallowing (Fisher 1963). Pharyngeal dimensions 2.6 x 5.7 cm (Trayler *et al.* 1989). Average length of dive, coastal NZ, 21 s (135 observations) with 7 s between dives (136; Stonehouse 1967); most dives in freshwater, 23-30 s (Stidolph 1922). Feed alone and in flocks that sometimes exceed 10 000 birds (Hobbs 1961). Prey may be sighted from as high as 80 m

in the air, bird then spiralling down to land either on (NZRD) or beside water-body. Fish sometimes captured in turbid water with Secchi disc transparency depths <10 cm (Barlow & Bock 1984). Usually feed during day (NZRD).

**ADULT** Four studies in Aust. In inland Vic. waters (613 stomachs, 1660+ identifiable items; McNally 1957) diet largely fish, mostly *Carassius auratus* 5.8% no., 11.4% freq., mean length 15 cm (4.5–31, n=41, max. per bird 19) and *Perca fluviatilis* 47.2, 61.3, 15 cm (4.5–32, 357, 30+) with some *Anguilla australis* 26.6 cm (22.9–30, 4, 4), *Nematolosa erebi* 1.5% freq., 18.3 cm (8–27, 9, 8), *Salmo* 2.4, 21.6 cm (15–36, 11, 6), *Tinca tinca* 1.6, 37.5 cm (26–43, 4, 1), *Macquaria ambigua* 0.3, 17.8 cm (7–34, 4, 4), *Nannoperca australis*, unident. 0.8 with some crustaceans, largely *Cherax destructor* 6.8, 7.5 with a few shrimps 0.3% freq., and amphibians 0.8. In same study samples from estuarine waters (437, 1220+) fish *Anguilla australis* 3.4% freq., *Hyperlophus vittatus* 3.7, 8.9 cm (1, 25+), *Engraulis australis* 5.3, Atherinidae 19.8, 11.9, *Gymnapistes marmoratus* 2.1, 12 cm (11–13, 3, 7), *Pomatomus saltatrix* 2.7, 18.8 cm (13.5–28, 13, 6), *Caranx* 1.4, 1 fish 16 cm, *Arripis trutta*, *Acanthopagrus butcheri* 21.4% no., 38.4% freq., 20.3 cm (4.5–30, 152, 4), *Aldrichetta forsteri* 18.8, 29.1, 18.8 cm (8.9–35, 39, 6), Gobiidae 37.2, 38.8, unident. 5.7 with a few crustaceans 8.9, including crabs and shrimps and from marine environments (13, 33+) Atherinidae 63.6% no., 15.4% freq., *G. marmoratus* 21.2, 23.1, *Lepidotrigla papilio* 12.1, 15.4 and crustaceans 3.0, 15.4. Also recorded were *Platycephalus* 25.5 cm (24–27, 2, 2) and *Neodax balteatus* 1 fish, 10.5 cm.

Further samples from inland Vic. (55, 547; Baxter 1985) mostly fish 80.4% no., 96.4% freq. incl. *Salmo trutta* 1.3, 5.5, Galaxiidae 19.4, 23.6, *Carassius auratus* 8.4, 27.3, *Rutilus rutilus* 0.4, 3.6, *Nannoperca australis* 1.6, 1.8, *Perca fluviatilis* 47.7, 65.5, 11.2 cm length to caudal fork (3.1, 8–23, 48), fish eggs -, 3.6, unident. 1.6, 12.7; tadpoles 13.5, 3.6; crustaceans 5.7, 21.8: Atyidae 0.2, 1.8, Parastacidae 5.0, 20.0; insects 0.5, 12.5: mayflies 0.2, 1.8, beetles 0.2, 1.8; plants -, 1.8.

In sw. Aust. (8, 26; Serventy 1938) fish: *Nematolosa come* 4% no., 13% freq., max. no. per stomach 1, *Cnidoglanis macrocephalus* 25, 38, 4, *Atherinomorus endrachtensis* 4, 13, 1, *Amniataba caudavittata* 4, 13, 1, *Pelates octolineatus* 31, 25, 7, *Gerres ovatus* 4, 13, 1, *Aldrichetta forsteri* 15, 38, 2, *Mugil cephalus* 4, 13, 1; crustaceans: *Palaemonetes australis* 4, 13, 1, crab 4, 13, 1.

Samples from Gippsland, Vic. (180 stomachs; Mack 1941) contained fish *Mordacia mordax*, *Anguilla australis*, *Hyperlophus vittatus*, *Engraulis australis*, *Galaxias maculatus*, *Hyporhamphus regularis*, *Atherina microstoma*, *Gymnapistes marmoratus*, *Platycephalus bassensis*, *Pomatomus saltatrix*, *Pseudocaranx georgianus*, *Arripis trutta*, *Acanthopagrus australis* (14.6% vol.), *Girella tricuspidata*, *Aldrichetta forsteri*, *Arenigobius bifrenatus*, *Gobius lateralis*, *Lizagobius galwayi*, *Philypnodon*, *Rhombosolea tapirina*; crustaceans prawns *Macrobrachium intermedium* crabs *Paragrapsus gaimardii*. *Anguilla australis* predominated Feb., *H. regularis* May, *E. australis* July–Sept., Gobiidae Oct.

In NSW (5, 17; McKeown 1944) diet at freshwater sites mostly decapod crustaceans *Paratya australiensis* 47, 20, *Cherax bicarinatus* 24, 40 with some fish *Oncorhynchus mykiss* 6, 20 (1 kg), *Salmo* 6, 20 (22 cm) *Carassius auratus* 6, 20, *Hypseleotris* 2, 12; in estuarine environments (7,11) all fish *Anguilla reinhardtii* 18, 14 (13 cm, 40 cm), *Cnidoglanis macrocephalus* 18, 14, *Girella tricuspidata* 9, 14 (0.7 kg, 35 cm), *Acanthopagrus australis* 9, 14, *Pempheris compressus* 9, 14, *Mugil dobula* 18, 29, *M. sp.* 18, 14.

Four studies in NZ; (27, 629; Dickinson 1951) fish 63% freq. incl. *Salmo* 0.3% no., 4% freq., *Retropinna* 22.7, 4, 3.5 cm, *Carassius* 0.8, 7, 6–14 cm, *Gobiomorphus* 3.2, 19, 3–13 cm; gastropod molluscs (probably from fish stomachs) *Lymnaea* 0.2, 4, 1.9 cm, *Potamopyrgus* 48.7, 33, 0.1–0.6 cm; freshwater crayfish *Paraneohpops* 1.6, 26, 7.5–10.5 cm; caddisflies *Olinga* 4.1, 4, 0.5–0.6 cm; (36, 936; Falla & Stokell 1945) fish *Anguilla australis* 0.4% no., 6% freq., max. per stomach 3, *A. sp.* 27, 39, 3, *Salmo trutta* 0.1, 3, 1, unident. Salmonidae 1.5, 19, 3, *Galaxias* 0.1, 3, 1, *Carassius* 0.1, 3, 1, *Rhombosolea* 0.1, 3, 1, *Gobiomorphus basalis* 0.7, 6, 6, *Philipnodon breviceps* 0.1, 3, 1, unident. Eleotridae 2.6, 11, 10, unident. Isospondyli 0.2, 6, 1, unident. fish 0.4, 11, 1; molluscs bivalves *Pisidium* 0.5, 3, 5, gastropods *Isidorella* 0.2, 3, 2, *Potamopyrgus* 1.4, 8, 8; insects bugs ad. 0.2, 6, 1, beetles 0.1, 3, 1, caddisfly larv. 85.4, 19, 500; plants seeds 0.7, 3, 8, *Elodea canadensis* fragments 3% freq., unident. 3; (19; Stead 1908) fish *Anguilla* 89% no., *Salmo* 5 (17 cm) freshwater crayfish *Paraneohpops* 5.

**Other records:** fish: *Anguilla reinhardtii* (Edwards 1920), *Anguilla* (Aust.: North; 45 cm, White 1919; 45 cm, Hosie 1920; 45 cm, Thomson 1920; NZ: 55 cm, 70 cm, Buller 1888; Stidolph 1939; 75cm, Oliver), *Muraenichthys breviceps* (Close et al. 1982), *Nematolosa erebi* (Close et al. 1982), *Engraulis* (North), *Salmo trutta* (36 cm, 600 g; Buller 1888), Cyprinidae (Hobbs 1961), *Carassius auratus* (North; Bright 1935; Vestjens 1977; Close et al. 1982), *Tinca tinca* ( $\leq 1$  kg; Close et al. 1982), Plotosidae (Cleland 1911; Cleland et al. 1918), Hemiramphidae (North; Campbell & Barnard 1917), *Gambusia affinis* (Vestjens 1977), *Maccullochella* (North; 30 cm, Anon. 1929), *Macquaria colonorum* (400 gm; White 1919), *Leiopotherapon unicolor* (Lavery & Haysom 1963), *Perca fluviatilis* (North; Vestjens 1977), *Sillago* (Rose 1973), *Caranx*, *Acanthopagrus* (North), Mugilidae (North; 40 cm, 1.5 kg; Forster 1918), *Arripis georgianus*, *Pseudaphritis urvilli* (Close et al. 1982); crustaceans: freshwater crayfish (North; Bright 1935); spiders; insects: bugs *Diplonychus rusticus* (Vestjens 1977; Barker & Vestjens 1989), beetles *Eretes* (Brooker et al. 1979); frogs (North): *Neobatrachus* tadpoles (Brooker et al. 1979); reptiles: turtle *Chelodina longicollis* (Edwards 1920); birds: Pacific Black Duck *Anas superciliosa* duckling (Fisher 1963).

**NESTLING** Food possibly smaller than in adult diet and including more invertebrates. In NZ (17 stomachs, 4056 items; Falla & Stokell 1945) fish *Salmo trutta* 0.1% no., 24% freq., max. no. per stomach 1., *Oncorhynchus mykiss* <0.1, 6, 1, unident. Salmonidae 0.3, 59, 1, *Galaxias* <0.1, 6, 1, unident. Isospondyli 0.1, 24, 2, unident. fish <0.1, 6, 1, insects odonatan *Procordulia smithii* <0.1, 6, 1, stoneflies 0.1, 18, 1, bugs ad. 0.1, 6, 3, beetles *Odontria* <0.1, 6, 2, unident. 0.4, 41, 6, caddisfly larv. 97.7, 100, 824, fly larv. 0.2, 35, 2, unident. larv. 0.2, 35, 2; gordius worms 0.1, 6, 3; other 0.6, 59, 4; seeds 0.1, 12, 2. Other records: fish, incl. eels when available (Stead 1908), small crustaceans (Oliver).

**SOCIAL ORGANIZATION** Solitary, but congregate where food is abundant and may form large feeding flocks.

**BONDS** Sustained monogamous. No systematic information on divorce rate. May start to form pairs near end of first year, but no effective breeding until at least 2 years old. No co-operative breeding. Both parents incubate and tend young until contact is lost a few weeks after fledging.

**BREEDING DISPERSION** Nesting solitary or in dense colonies. Territorial; only nest-site is defended, but sometimes an adjacent perch also.

**ROOSTING** Solitary or communal roosts in trees and bushes, and on cliffs, rocks, partly submerged fence posts and navigation platforms. May have separate diurnal and nocturnal roosts, depending on locations of food and shelter. No systematic information on times of arrival and departure from roosts.

**SOCIAL BEHAVIOUR** Based mainly on van Tets (1965); information supplied by G.F. van Tets. Displays generally easily seen, but care needed not to disturb displaying birds. Individual distance just out of pecking distance of other birds. Flocks integrated only when flying in V-formation on migration or when commuting between feeding areas, breeding colonies and roosting sites. Birds possess median, erectile crest on nape and upper neck; used in various circumstances, agonistic and sexual. Crest raised when bird beside nest; lowered when on nest; when alarmed, plumage sleeked and crest lowered.

**AGONISTIC BEHAVIOUR** Defend nest-sites against intruders using Threat and Nest-worrying. **THREAT:** with body horizontal, wings partly spread to side and downwards, tail fanned and raised almost vertically, birds display wide-open bill and bulging throat and move head back and forth and sideways with irregular sinusoidal neck movements; males utter raucous barking; females soft hoarse puffing. **Nest-worrying** (=Stick-grabbing) (Fig. 4): bird grabs nearby twig or piece of nest material with bill and shakes it vigorously as threat; males sometimes call, females silent.

**SEXUAL BEHAVIOUR** Males advertise by **Wing-waving** (Fig. 1): partly-folded wings raised and lowered by humeral rotation, with wing-tips moving up and outwards, 1–2 times/s; exposes and covers patches of white nuptial plumes on rump which act as flashing semaphore. Sometimes, when raised, wings rapidly vibrated, displaying grey underwing (primaries) against background of black secondaries. At high intensity, bill closed, and head, neck and fanned tail pointed vertically upwards, body held horizontal with breast pressed down and rump raised. Birds silent. During and after pair-formation, greeting and recognition by **Gargling** (= Gaping in van Tets 1965) and **Pointing**. **Gargling** (Fig. 2). Differs for males and females; head swung back through vertical arc; body held horizontal with tail cocked in males, drooped down in females; as head moves back and forth, males call loudly; females utter soft purr. In females, head moves only partly back; in males head moved back until nape touches rump, where head rotated sideways round axis, bill closed, and uttering gargling sound. **Pointing** (Fig. 3). Similar in both sexes; neck, head and closed bill stretched forward c. 30° above horizontal; tail raised c. 30° above horizontal. No sounds made. **OTHER BEHAVIOUR AT SITE.** Includes Nest-worrying (see above), Kink-throating and Pre-take-off and Post-landing Postures. **Pre-take-off Posture** (Fig. 5). Adopted just before flight: neck almost vertical and closed bill tilted slightly above horizontal; front of throat straight and hyoid bones spread sideways. Sometimes base of throat pulsates and purring sound made, which is similar in both sexes. **Kink-throating** (Fig. 6). Before arrival, bill wide open, except when nest material carried. Males make various loud raucous repetitive barking sounds; females make soft hoarse repetitive puffing sounds. Sometimes Kink-throating inserted 'mid-Hop' between Pre- and Post-hop; may Kink-throat when Circle-flying (see below). **Post-landing Posture** (Fig. 7). After alighting, head and throat formed into laterally flattened disk, with crest raised, bill closed and pointing slightly down; male often

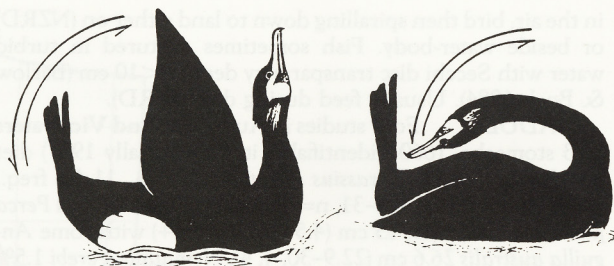


Fig. 1 Wing-waving

Fig. 2 Gargling



Fig. 3 Pointing

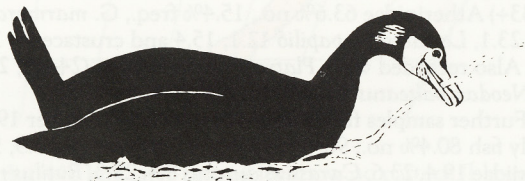


Fig. 4 Nest-worrying

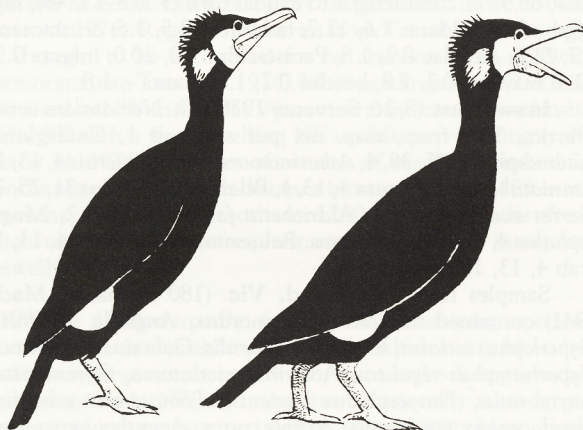


Fig. 5 Pre-take-off Posture

Fig. 6 Kink-throating

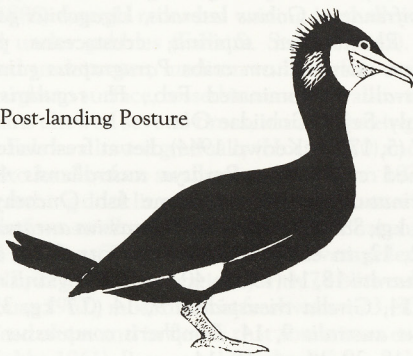


Fig. 7 Post-landing Posture

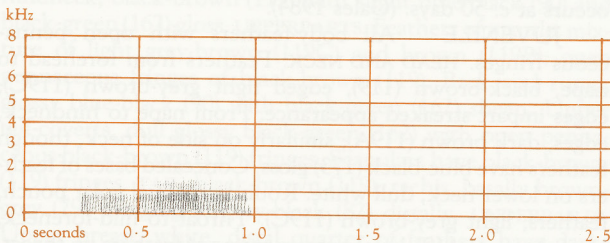


makes loud roaring call and female emits soft puffing sounds. Also perform on and near nest-site the **Hop**, abbreviated symbolic flight that starts with Pre-take-off Posture and ends with Post-landing Posture. Hopping grades between the following: (1) flying from one part of colony to another; (2) **Circle-flying** away and back to nest-site or nearby perch; (3) **Hopping** from one perch to another; (4) **Hop** only a few centimetres or in place; (5) alternating Pre-take-off and Post-landing Postures without feet leaving ground (van Tets 1965). Hop starts in both sexes with purring; ends in males with loud roaring, and in females with soft puffing.

**RELATIONS WITHIN FAMILY GROUP** Parents place webbed feet underneath eggs during incubation and underneath small chicks. During hot sunny weather, small chicks and eggs depend on parental shade for survival. When begging for food, young chicks reach up with neck stretched, bill closed and throat kinked by forward protrusion of hyoid bones. In older chicks, wings spread and flapped back and forth, and bill prods at throat of parent. All chicks squeak repeatedly while begging. In response to very small chicks, parent lowers upright head beside chick and points open mouth backwards; chick fed regurgitated fluid from trough formed by lower bill and throat pouch. Older chicks take partly digested food from throat and gullet of parents. Small chicks fed more frequently than older ones. In begging for water, chick directs open bill silently upwards. In response, parent flies down to water, fills its throat and, on return to the nest, pours water into bills of chicks.

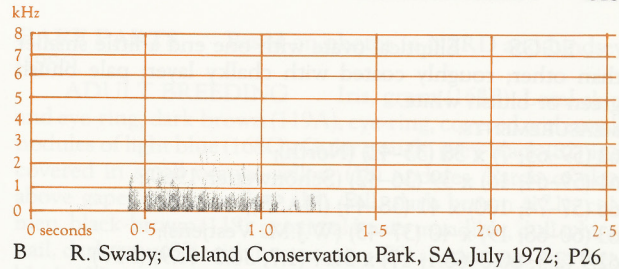
**VOICE** No detailed studies in Aust.; information supplied by G.F. van Tets. No differences detected in calls of birds from Canada, England, Holland, South Africa, Aust., Chatham Is or elsewhere in NZ (G.F. van Tets). Vocalizations described for European populations (BWP; Kortlandt 1938). Generally quiet away from nest; at site, complex variety of calls and marked sexual differences; males have range of loud, raucous sounds; calls of females, soft and husky early in breeding period but become more like calls of males during incubation (Kortlandt 1938). Much individual variation (BWP). Apparently no geographical variation (see above) but detailed analysis of calls needed and could be of particular value in A'asia. Non-vocal sounds: none described.

**ADULT MALE** **Gargling.** Loud *ah*, *arr* (sonagram A), *kroh* or *eh-eh-eh* as head moved backwards over body,



A R. Swaby; Cleland Conservation Park, SA, July 1972; P26

followed by gargling, rattling *rooo*, *r-r-r-r*... or *rooooo* (sonagram B) as head rotated as it rests on rump. Used during Gargling Display in greeting and recognition of mate. **Threat Call:** raucous, barking *tock-gock-gock*...*cock*; directed at intruders to territory. **Kink-throating Call:** repeated and varying, loud raucous barking, described as *kro-kro-kro*... , *gorr-gorr-gorr*... , *arre-arre-arre*... , *roh-roh-roh*... , *rahr-rahr-rahr*... or *reh-reh-reh*... Used during Kink-throat-



B R. Swaby; Cleland Conservation Park, SA, July 1972; P26

ing Display, before arrival at nest. **Pre-take-off Call:** purring *r-r-r-r-r*...; **Pre-hop Call** like Pre-take-off Call or utter single *ah*; no other discernible differences between calls used in these displays (G.F. van Tets). **Post-landing, Post-hop Calls:** loud, roaring *roooo*. **Nest-worrying Call:** sometimes utter *ah-roo-roo*... during this display.

**ADULT FEMALE** **Gargling:** utter repeated, soft *fff*... , *sh-hi-hi*... , *fhi-fhi-fhi*... or *heh-heh-heh*... **Threat Call:** soft hoarse puffing *fhi-fhi-hi-hi*... **Kink-throating Call:** repeated soft hoarse puffing *ghi-ghi-ghi*... , *fee-hi-hi*... or *for-for-for*... (as for male). **Pre-take-off Call:** purring *r-r-r-r*... , similar to male's call; **Pre-hop Call:** like Pre-take-off Call or utter single *ah*. **Post-landing, Post-hop Calls:** described as soft *fhi* or *fheee*.

**YOUNG** Beg with repeated squeaky wheedling *thue-tjue-tjue*... Beg for water silently.

**BREEDING** Not well known in Aust., no detailed studies; only generalized accounts of most aspects of nesting, which is probably similar to that of other subspecies in n. hemisphere (see BWP; Palmer 1962). Information supplied by G.F. van Tets. Cormorant nester, usually associated with other species of cormorants, herons, spoonbills, ibises; occasionally solitary (North). Probably likely to use colonial sites erratically and irregularly.

**SEASON** In e. Aust., usually July to end Oct.; in Tas., Sept. to end Dec. (North). Nesting said to be continuous from early summer to autumn and start again in early spring and continue to mid-summer (HASB). From Aust. NRS: Qld: Apr.-Aug.; NSW: Sept.-Jan. and Mar.-Aug.; Tas.: Apr.-June and Dec.-Feb.; SA: eggs and young in Apr., young in May. Probably occurs at any time of year depending on conditions of water, food and shelter (G.F. van Tets). No quantified data.

**SITE** In trees, bushes, reeds and on ground near water; on rocks in rivers and lakes, ledges on cliffs, man-made structures (navigational platforms); 'in most secure positions afforded by trees' about 1-3 m above water (North) but up to 7 m (Aust. NRS); average height of nests in trees 2.3 (1.4; 0.6-6.1; 19) (Aust. NRS); average height at L. Cantala, Vic., 4.2 (1.9; 0.6-10; 76) (Aust. NRS). Probably limited only by height of trees.

**NEST, MATERIALS** Open, nearly flat platform, about 45 cm across outside, 20 cm across inside and about 10-90 cm in thickness according to age (North); often used for several seasons. Made of dead sticks, twigs, plant material and debris. Diameter of two nests: 0.7 and 0.8 m (Aust. NRS). Male selects and claims site; female builds with material brought by male. Soft material needed first to form a holdfast on rocks or branches of trees; dry sticks are then added with quivering motions of bill. Building occurs whenever both adults at nest and continues during incubation and nestling periods (G.F. van Tets). Normally only one nest built before laying.

**EGGS** Elliptical-ovate with one end a little smaller than other; roughly coated with chalky layer; pale bluish green or bluish white.

**MEASUREMENTS:**

62 (59-63; 7) x 38 (33-42) (North);  
61 (59-64; 16) x 39 (36-42) (Schönwetter 1960);  
66 (57-74; 100) x 41 (38-44) (HASB);  
63 (60-68; 19) x 40 (37-43) (W.J.M. Vestjens);  
62.9 (2.3; 60.0-68.1; 17) x 39.4 (1.7; 36.0-41.9) (MV)  
63.1 (1.2; 61.9-65.0; 5) x 38.2 (2.5; 35.8-41.0) (Aust. NRS).  
**WEIGHTS:** 75 g (n=1; W.J.M. Vestjens).

**CLUTCH-SIZE** Generally said to be 3-5, even six. Aust. NRS gives average 4.1 (3-6; 30).

**LAYING** At intervals of 48 h. No information on replacement laying; may have two broods a year (Aust. NRS).

**INCUBATION** By both adults, starting with first egg; reliefs at least three times a day. **INCUBATION PERIOD:** 27-31 days (W.J.M. Vestjens). No further information.

**NESTLING** Altricial, nidicolous; hatched naked. Skin, dark slaty-blue but top of head, throat and bill, pale pinkish-yellow. Later covered with sooty grey-brown down; throat becomes yellow and legs and feet, black (Archey & Lindsay 1924). Brooded, guarded and fed by both parents, by incomplete regurgitation. Guard stage lasts until young can ward off other adults and predators (G.F. van Tets). Chicks tend to leave nest at about 4 weeks old and fledge at about 7 weeks. Fed by both parents until contact lost about 4 weeks after fledging. No other information on growth of young, fledging to maturity, except that some birds may breed at end of their second year, many not until several years older.

**SUCCESS, PREDATORS** Of 87 eggs laid, 36 hatched, or 41% (19 clutches where clutch-size and outcome known) (Aust. NRS). Nests on logs in Derwent R., Tas., destroyed by high tides. Little Ravens *Corvus mellori* and Whistling Kites *Haliastur sphenurus* take eggs and chicks (Aust. NRS).

**PLUMAGES** Subspecies *novaehollandiae*.

**ADULT BREEDING** Age of first breeding, unknown. **HEAD AND NECK.** Crown to lower hindneck, glossy blue-black (90) with black-green (162) sheen. Prominent erectile crest along back of upper neck (see Fig. 15, van Tets [1965]); feathers, glossy blue-black (90); capable of erectile movement. Patches of white filoplumes on sides of upper-neck, sparse compared with nominate *carbo* (G.F. van Tets); lost as season progresses (soon after pair-formation in *P.c. carbo*; Stokoe [1958]). Loes, largely bare; covered in small black-brown (119) papillae. Feathers on throat, extending upwards to malar area to behind eye, dark pink-buff (121D); often scattered dark-brown (119A) feathers at upper margins of malar area; entire pink-buff (121D) area sharply demarcated from rest of neck (mixture of white, grey and buff in live birds and pink-buff could be caused by discoloration of skins; G.F. van Tets). Rest of neck, glossy blue-black (90) with black-green (162) sheen. Gular pouch, largely bare; feathers on throat extend on to basal one-quarter of gular pouch in inverted V. Feathers on head and neck have silky texture. **UPPERPARTS.** Feathers of mantle, combination of brown (119B) and yellow-brown (123C), with open pennaceous fringes of black-green (162). Concealed bases, pale dark-brown (121); fringes become progressively broader towards lower and outer margins of mantle. Narrow margin along entire mid-mantle, whole of back and rump, glossy blue-black

(90) with black-green (162) sheen. Upper tail-coverts, short, dull glossy pale black-green (162) with narrow open pennaceous fringes of black-green (162). Scapulars, similar to outer mantle-feathers; fringed black-green (162). Upper subscapulars, similar to scapulars but edged on outer web, black-green (162). Lower subscapulars, dark brown (121) with dull gloss of pale black-green (162). **TAIL,** black-brown (119) with pale black-green (162) gloss; rachis, rigid, grey (84) basally, merging to grey-black (82) distally. **UPPERWING.** Most coverts, similar to outer mantle-feathers, though fringes narrower on marginal coverts; fringes become progressively broader from marginal towards greater coverts. Greater primary coverts and alula, black-brown (119) with slight dull gloss of pale black-green (162) on webs. Primaries, black-brown (119) with dull gloss of pale black-green (162) on webs; tips of webs, rounded. Tertiaries and secondaries, similar to greater coverts in colour, but edged black-green (162) on outer web. Humeral, black-brown (119). **UNDERPARTS,** almost entirely glossy blue-black (90) with black-green (162) sheen. Long lateral breast-feathers, similar to feathers on upper mantle; beneath these, small concealed patch of dull-white semiplumes. Concealed bases of feathers from foreneck to lower abdomen, white; white bases become progressively larger towards lower margins of body, but rarely exposed. On lower flanks, patch of long, rather narrow, white nuptial feathers; lost as season progresses (in nominate *carbo*, when eggs hatch; Stokoe [1958]). Tibio-tarsal feathers, similar to feathers on outer mantle; beneath these feathers, small concealed patch of dark brown (121) semiplumes. Axillaries, glossy blue-black (90) with black-green (162) sheen. **UNDERWING.** Greater primary and greater coverts, glossy brown-grey (79). Underside of remiges, glossy. All other coverts, dark brown (121), narrowly fringed dull black-green (162).

**ADULT NON-BREEDING** Similar to adult breeding late in season, though less glossy; largely indistinguishable on plumage.

**DOWNY YOUNG** Naked at hatching with closed eyes; eyes begin to open at 4 days. Protoptile, sparse and grey-black (82); at 1 week restricted to caudal region; by 2 weeks, covers nestling except round eye, loes, crown, chin, neck and underwing area (Gales 1984). Mesoptile, grey-black (82), thicker and woolly; sparse on facial area and throat; attained at 3 weeks, leaving occipital region and loes bare; at this age, rectrices and remiges begin to emerge from sheaths. Fledging occurs at c. 50 days. (Gales 1984).

**JUVENILE** All body-feathers with open pennaceous fringes. **HEAD AND NECK.** Feathers from forehead to nape, black-brown (119), edged light grey-brown (119C); edges impart streaked appearance. From nape to hindneck, edges, dark brown (119A); similarly on side of neck, though feathers have blue-black (173) gloss. Concealed bases of feathers on lower neck, dull white. Round proximal gular pouch, feathers, light grey-brown (119C). Throat to mid-foreneck, black-brown (c119); basal outer margins of feathers on throat, light grey-brown (119C); edges impart streaked appearance on neck. Towards lower foreneck, feathers become dark brown (119A) to light grey-brown (119C), fringed dark brown (119A). Side of head, behind gape, streaked light grey-brown (119C) and dark brown (119A), merging to black-brown (119) on distal malar region. Anterior of loes, largely bare and covered in sparse small black-brown (119) papillae. **UPPERPARTS.** Mantle-feathers mixture of brown (119B) and light grey-brown (119C) with subterminal fringes of black-brown (119), and open pennaceous fringes of dark brown (119A).

Subscapulars, black-brown (119) with dull pale black-green (162) sheen, which is absent on edge of outer web; tips of webs, pointed with slight dark-brown (119A) fringes through wear; rachis, black (89). Similarly, scapulars, black-brown (119), fringed dark brown (119A). Humeral, dark brown (121); shaft, black (89). Concealed bases of feathers on back and rump, pale dark brown (121); fringes, mixture of dark brown (119A) and glossy blue-black (90). Upper tail-coverts, short and glossy, dull pale black-green (162), fringed dark brown (119A). TAIL, black-brown (119); tips, dull white through wear; rachis, basally dark grey (87), merging to light brown (223D) at tip. UPPERWING. Marginal coverts, dark brown (119A), with sub-terminal fringe of black-brown (119), fringed light grey-brown (119C). Lesser and median coverts, similar to feathers of mantle. Greater coverts, dark brown (121) with dull gloss similar to feathers of mantle; tips of innermost, dull white through wear. Primaries, black-brown (119) with pointed tips. Secondaries and tertials, similar to adult but duller; outer edges of feathers and adjacent to shaft, lack dull glossy bloom. Feather tips from s1 to tertials, brown (119B), merging to light grey-brown (119D). Greater primary coverts and alula, black-brown (119), faintly fringed dark brown (119A). UNDERPARTS. Basal edges of feathers on upper breast, dull white; rest, dark brown (119A) with subterminal fringes of black-brown (119). Feathers on mid-line of body from breast to vent, white with dark brown (119A) rosethorn streaks; streaks progressively narrower towards abdomen. White bases of feathers, conspicuous. Beneath closed wing on flanks and on thighs, open pennaceous fringes, glossy blue-black (90). Tibio-tarsal feathers, glossy dull black-green (162) with open pennaceous fringes of dark brown (119A); tips pointed and brown (119B) through wear. Under tail-coverts, dark brown (119A) narrowly fringed brown (119B). Axillaries, dark brown (121). UNDERWING. Underside of remiges, glossy. Greater primary coverts, glossy brown-grey (79). Rest of coverts, dark brown (121) narrowly fringed dark brown (119A).

**IMMATURE HEAD AND NECK.** Throat, light brown (223D); demarcation not sharp as in adult; at border of demarcation, tips of feathers, dark brown (119A); some feathers, edged light grey-brown (119C) giving slightly streaked appearance. Concealed bases of feathers, white. Feathers on crown, slightly edged dark brown (119A) and brown (119B). From nape to hindneck, feathers edged dark brown (119A). Rest of hindneck, black-brown (119) with slight blue-black (90) and black-green (162) gloss. UPPERPARTS. Feathers of mantle, mixture of light grey-brown (119C) and brown (119B); open pennaceous fringes of black-brown (119). Back and rump, glossy blue-black (90) with black-green (162) sheen. Upper tail-coverts, dull glossy black-green (162) with open pennaceous black-brown (119) fringes. Scapulars have black-brown (119) fringes. TAIL, black-brown (119); rachis, basally brown-grey (79) merging to grey-black (82) distally. UNDERPARTS. Upper breast, white, distal quarter of feathers have dark-brown (119A) shaft-streak; on lower breast, distal quarter of feathers, black-brown (119). Long lateral breast-feathers, similar to mantle-feathers; beneath these, concealed patch of dull-white semiplumes. Basal half of feathers on thighs and outer flanks, pale dark-brown (121). Rest similar to juvenile.

**ABERRANT PLUMAGES** An albino has been recorded (Oliver); another bird observed with white patch on sides under wing, connecting with patches on flanks; another with similar but smaller patch (Moisley 1960).

**BARE PARTS** Based on photos in NZRD and Lindsey (1986).

**ADULT BREEDING** Iris, green (162B). Loral skin and eye-ring, dark brown (119A); eye-ring, covered with small nodules of light blue (168C). Gular pouch, grey-black (82) and covered in small orange-yellow (18) nodules. Patch of skin above gape, orange-yellow (18). Bill, dark brown (121); culmen, black-brown (119); proximal lower mandible, dull white; nail, dark grey (83) with brown-grey (79) shade. Legs and feet, black (89).

**ADULT NON-BREEDING** Similar to adult breeding, but bill, paler. Gular pouch and patch of skin above gape, yellow.

**NAKED YOUNG** Colours recorded 1 min after death, label data, skins (SAM). Crown, dull pale pink-purple. Orbital area, dull pale blue-grey. Gular pouch, pale ochre. Narrow black line extends from nares to in front of eye. Bill, pale ochre, tipped black. Skin on throat, black, tinged lilac; rest of neck, dark black-grey. Legs and feet, ochre-grey; webs grey-buff.

**DOWNY YOUNG** Full details given in Archey & Lindsay (1924).

**JUVENILE** Sequence of acquisition of colours of bare parts, given in Archey & Lindsay (1924). Iris, brown (NZRD).

**IMMATURE** Few data. Iris described as varying from yellow-brown, pale blue or greyish-green (described under juvenile; Morris 1978). Face and gular pouch, greenish-yellow (Oliver).

**MOULTS** Few data. No definite moult-period can be ascribed, because breeding season protracted.

**ADULT** Based on skins; staffelmauser. Remiges and rectrices moult outwards. Duration of moult-series unknown. Continuous body-moult; nuptial plumes lost as breeding season progresses; gained at pre-breeding.

**POST-JUVENILE** Undescribed.

**SUBSEQUENT MOULTS** Undescribed. See details given in BWP as guide.

**MEASUREMENTS** (1) Aust., adult skins (MV, QVM, SAM, ANWC, AM). (2) NZ, adults, skins; methods unknown (Falla 1932). (3) NZ, skins (AWMM, MV, CM, AM; G.F. van Tets). (4) NSW, live (W.J.M. Vestjens).

	MALES	FEMALES
WING	(1) 343.0 (5.91; 332-356; 17) (2) 349.8 (8.03; 340-357; 5) (3) 353 (19; 285-373; 22) (4) 347 (8; 320-360; 77)	333.0 (6.20; 324-345; 11) * 340.5 (0.5; 340-341; 2) 346 (15; 331-385; 13) 327 (8; 305-345; 228)
TAIL	(1) 154.8 (9.11; 145-174; 14) (2) 152.6 (2.80; 150-157; 6) (3) 152 (8; 141-174; 22) (4) 151 (7; 134-165; 67)	151.3 (8.80; 145-173; 9) 158.5 (6.50; 152-165; 2) 153 (12; 140-180; 13) 143 (8; 123-159; 209)
BILL	(1) 67.5 (2.17; 61.9-70.1; 17) (2) 63.0 (3.41; 59-68; 6) (3) 66 (4; 56-73; 22) (4) 69 (3; 61-76; 79)	63.1 (3.97; 58.6-70.6; 14) * 61.0 (0; 61, 61; 2) 60 (5; 54-70; 13) 62 (3; 54-74; 221)
TARSUS	(1) 63.1 (2.39; 57.9-67.0; 16) (2) 59.8 (2.85; 55-64; 6) (3) 66 (2; 62-70; 21) (4) 68 (2; 62-72; 78)	60.5 (1.74; 58.4-64; 13) * 53.0 (1.0; 52.54; 2) 63 (3; 58-59; 13) 64 (2; 54-69; 228)
TOE	(1) 82.7 (4.17; 77.6-91.5; 17) (2) 91.0 (1.45; 89.6-92.5; 2)	77.7 (3.74; 71-85.5; 13) * 79.9 (0.35; 79.6-80.3; 2) *

Additional measurements in Oliver, HASB and Morris (1978).

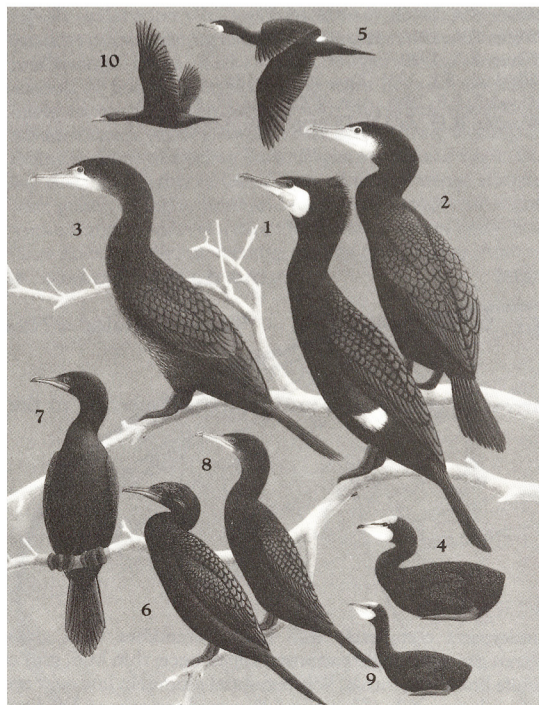
**WEIGHTS** Few data. NSW (W.J.M. Vestjens): males 2400 (300; 1600–3100; 79); females 2000 (200; 1200–3000; 228).

**STRUCTURE** Wing long and broad. Eleven primaries: p8 usually longest, p10 9–15 mm shorter, p9 0–1, p7 8–13, p6 34–46, p5 51–65, p4 67–79, p3 81–94, p2 92–109, p1 106–121, p11 minute. P10–8, emarginated on inner web; p9–8 on outer web. Five humerals. Of secondaries, 5 of tertial form. Tips of remiges, pointed in juveniles, rounded in adults. Tail, wedge-shaped; 14 rectrices, t1 longest, t7 27–67 mm shorter. Bill, long and narrow; nail, hooked at tip. Upper mandible, extends to gape, where sharply ridged. At base of upper mandible, numerous fine striae extend short distance; less prominent in juveniles. Small groove on side of culmen. Near base of upper mandible, small secondary external nostril plate on cutting edge. Bill, largely smooth in juveniles, though slightly flakey at base; no rugose plates on lower mandible as in adult. Exterior of bill in adults, rough. Tarsus, short, reticulate. Feet, totipalmate. Claws, curved; claw of middle toe, serrated and curves outwards. Outer toe longest, c. 130% of middle, inner c. 69, hind c. 44.

**GEOGRAPHICAL VARIATION** Peters recognized six subspecies world-wide, distinguished on basis of plumage and mensural characters e.g. extent of white on head, neck and breast; colour of dorsal sheen; size of bill. For discussion of subspecific characters, see BWP and Brown *et al.* (1982). One subspecies *novaehollandiae* occurs in A'asia. All subspecies best considered as forming superspecies, defined by superficial similarities in plumage and external morphology (Siegel-Causey 1988). For contrary opinion, see Marion (1983). Siegel-Causey (1988) states that *novaehollandiae* may represent species, but gives no details. Peters suggests that *P. carbo* forms superspecies with *P. capillatus*. RMO

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**Volume 1 (Part B), Plate 60**

Great Cormorant *Phalacrocorax carbo*

- 1. Adult breeding
- 2. Adult non-breeding
- 3. Juvenile
- 4. Downy young
- 5. Adult non-breeding

Little Black Cormorant *Phalacrocorax sulcirostris*

- 6. Adult breeding
- 7. Adult non-breeding
- 8. Juvenile
- 9. Downy young
- 10. Adult non-breeding

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