

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.

REFERENCES

- Brisson 1760. *Orn.* 1: 60, 6: 511.
Cottam, 1957. *Bull. Br. Mus. nat. Hist. Zool.* 5: 49-72.
Linnaeus, C. 1758. *Systema Naturae Ed.* 10, Vol. 1.
Olson, S.L. 1985. *Av. Biol.* 8: 79-238.
Schmidt-Nielson, K. 1959. *Sci. Am.* 200: 109-16.
Siegel-Causey, D. 1990. *Auk* 107: 110-18.
van Tets, G.F. 1965. *AOU orn. Monogr.* 2.

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.

REFERENCES

Siegel-Causey, D. 1988. *Condor* 90: 885–905.

van Tets, G.F. 1965. *AOU orn. Monogr.* 2.

van Tets, G.F. 1968. *Emu* 67: 224.

van Tets, G.F. 1976. *Emu* 76: 151–2.

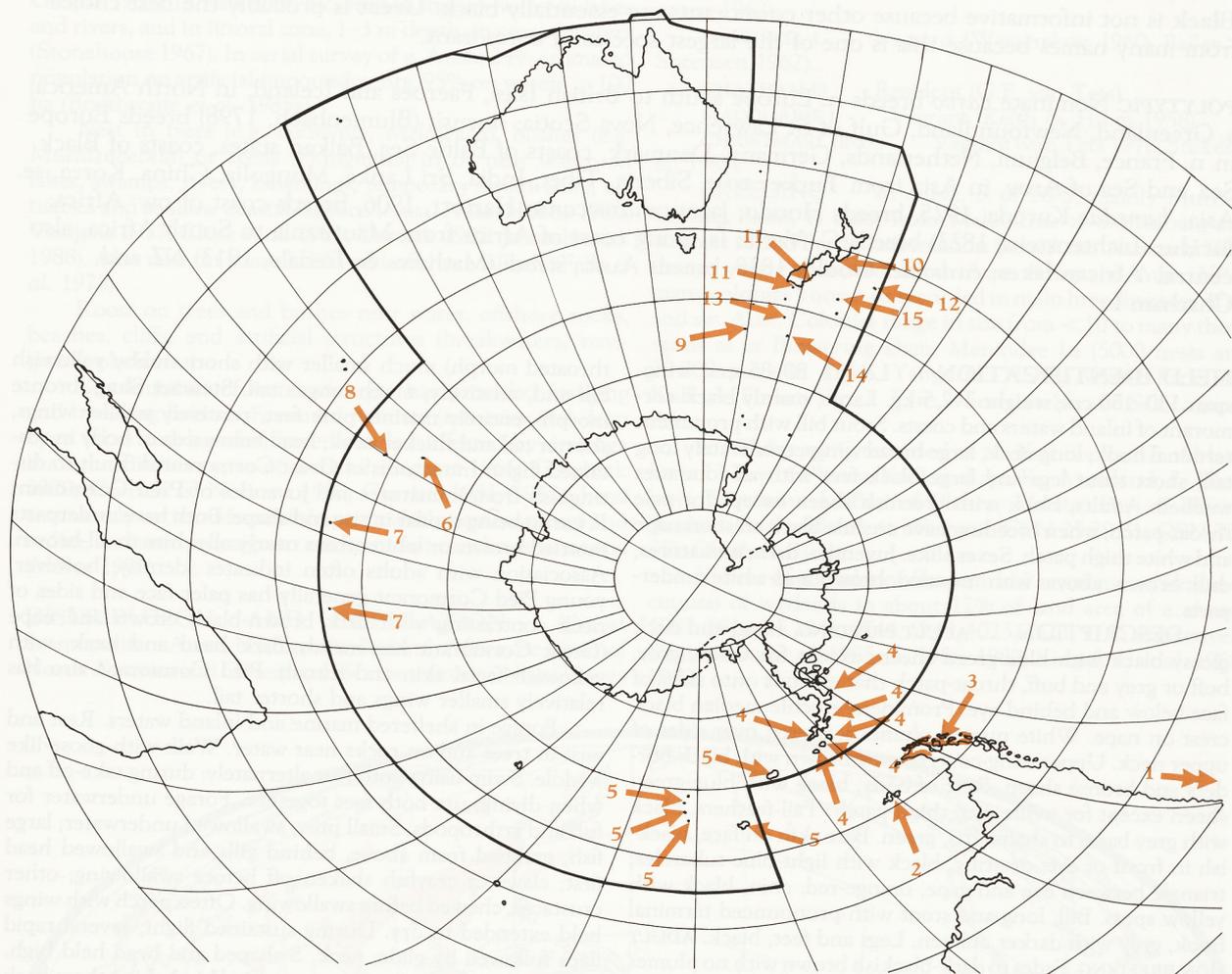


Fig. 1. Distribution of island forms of *Phalacrocorax*.

- | | | | |
|----|-------------------------------|----|------------------|
| 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 sulcirostris Little Black Cormorant

COLOUR PLATE FACING PAGE 829

Carbo sulcirostris Brandt, 1837, *Bull. scient. Acad. imp. Sci., St Pétersb.* 3: col. 56 — 'Terres australes' = New South Wales *vide* Mathews, 1912, *Novit. zool* 18: 240.

The specific name is compounded of the Latin *sulcus* (furrow or groove) and *rostrum* (beak) referring to the grooved bill.

OTHER ENGLISH NAME Little Black Shag.

MONOTYPIC

FIELD IDENTIFICATION Length 55–65 cm, of which body about half; wingspan 95–105 cm; weight 520–1210 g. Small slender all-dark cormorant with very thin bill, dark facial skin and long tail. Plumage dull brown-black when worn. Sexes alike. Breeding and non-breeding plumages similar but nuptial plumes lost during incubation; colour of lores also changes seasonally. Juveniles resemble adults but plumage, browner. No immature plumage. Highly gregarious on inland waters and estuaries throughout Aust. and n. NZ.

DESCRIPTION **ADULT BREEDING.** Upperparts and

underparts completely dull black sometimes with glossy sheen giving strongly patterned appearance; thin buff, grey or white line along throat. White nuptial plumes in line over eye, in patches on side of head and dispersed sparsely on head and hindneck. Tail, black. Upperwing, black; upper wing-coverts, grey-black with glossy purple sheen and broad grey-black borders; under wing-coverts, brown-grey, duller than upperwing. Nuptial plumes lost during incubation and plumage wears and becomes duller black-brown. Iris, bright green. Ring of blue-green tubercles round eye. Bill, long and slender, dark grey-brown with darker (sometimes black) culmen; base

of lower mandible, blue. Skin on throat, violet, appearing black in field. Legs and feet, black. **ADULT NON-BREEDING.** Nuptial plumes lost and skin on throat fades to grey-blue. With wear, plumage gradually fades to dark brown and upper wing-coverts show sandy edges. **JUVENILE.** Silky dark-brown, which fades before assuming adult coloration late in first year. Iris, brown.

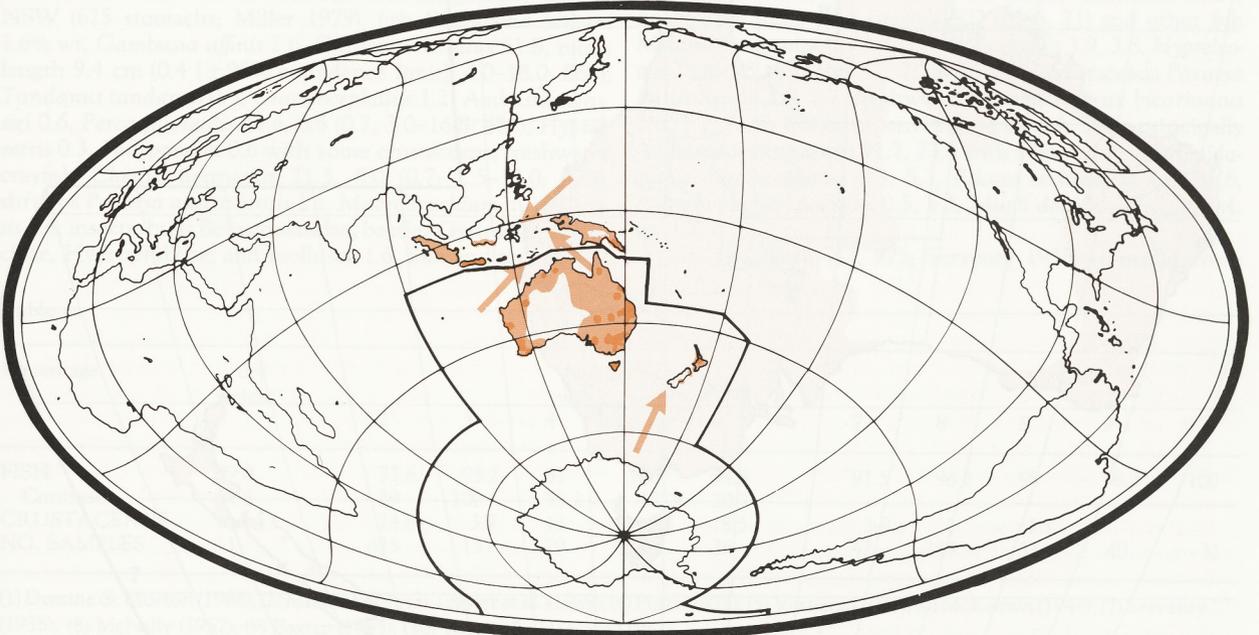
SIMILAR SPECIES In A'sian region, range overlaps with three other mainly dark cormorants or shags: Great Cormorant *P. carbo*; white-throated morph of Little Pied Cormorant *P. melanoleucos* (NZ only); and bronze morph of Stewart Shag *P. chalconotus* (se. SI and round Stewart I., NZ). **Great Cormorant** much larger and more robust with stouter bill, yellow facial skin, white feathering on lower face and throat and, in breeding plumage, white patch on flanks. **Little Pied Cormorant (white-throated morph)** distinguished from Little Black by short stubby yellowish bill; face and bill in some lights appear pale and then structure of bill most useful; rather longer wedge-shaped tail; adults have much white on face and throat, but juveniles totally dark. **Bronze morph of Stewart Shag** much larger and bulkier with distinctive pink feet and thicker neck; in flight, head held lower than axis of body.

Forage in many sorts of inland waters and marine inlets. Rest and nest in trees and bushes near water. Walk with goose-like waddle. In water, swim using feet alternately; use both feet together during take-off and when diving. Swim rapidly underwater with legs behind body. Catch prey underwater by pursuit-diving usually bringing prey to surface before swallowing. Large flocks feed co-operatively: surround schools of fish in open water and form lines across marine inlets to intercept fish leaving with out-going tides; flocks advance across surface, birds at rear flying ahead, landing and diving in front of feeding flock. Flight strong and high. During sustained flight, series of flaps of bowed wings alternate with glides; in flight, head and neck held straight (or slightly kinked) and head level with or higher than axis of body. Form large flocks for flying, feeding, resting and nesting. Also rest

and nest with other cormorants and waterbirds. At nest-site, males have many calls such as ticks, whistles and croaks; females probably silent. Ticking and croaking sounds given by birds in flocks gathering before departure.

HABITAT Widespread in wetlands and sheltered coastal waters. On Aust. mainland, most common on inland waters; in Tas., on estuaries and brackish waters (Aust. Atlas). Inland, feed mainly in open water >1 m deep (Miller 1979; Dostine & Morton 1988) and large enough to allow co-operative feeding (Miller 1979); especially in large lakes with abundant carp and redfin sheltering in deep submerged beds of ribbonweed *Vallisneria*; in rivers, billabongs and pools with flooded or fringing trees; in deep dams and channels; and in permanent and semi-permanent swamps with open water (Miller 1979; Corrick & Norman 1980; Gosper 1981; Fjeldsa 1985; Dostine & Morton 1988). Less often on shallow or vegetated waters: pools and shallow water round edges of lakes; seasonal freshwater swamps with little emergent vegetation; and swamps vegetated with sedges, reeds or trees (e.g. *Eleocharis*, *Phragmites*, *Scirpus*, *Melaleuca*) (Vestjens 1977; Corrick & Norman 1980; Gosper 1981). Along coast, most abundant in estuaries and deep coastal lagoons; also on salt-fields, shallow coastal lagoons, saltpans and mangrove swamps (Cooper 1980; Corrick & Norman 1980; Gosper 1981; Jaensch *et al.* 1988); uncommon in exposed inshore waters (Storr 1964), but occasionally feed from rock platforms or fly along coastline (Gosper 1983). In aerial surveys of e. Aust., 45% population on artificial impoundments; 90% on wetlands >100 ha (Braithwaite *et al.* 1985a).

Breed in vegetated swamps and lakes, mainly freshwater (Sibson 1956; Corrick & Norman 1980; Miller 1980; Jaensch *et al.* 1988); favour flooded trees well away from land in remote parts of large wetlands (Miller 1980). At Booligal, NSW, breed in swamps with climax vegetation of ribbonweed and abundant fish; when swamps dry then refill, breeding inhibited until climax reached (Crome 1988). Perch on trees, stumps, posts, banks of channels, and artificial structures.



Construction of reservoirs and farm dams has provided additional foraging and breeding habitat. Deep open waters and estuaries favoured by Little Black Cormorants less affected by drainage than most other types of wetland (Riggert 1966; Goodrick 1970; Corrick & Norman 1980; Corrick 1981, 1982), but some breeding swamps and lakes are threatened by increased salinity, clearing, grazing, frequent burning and groundwater extraction (Jaensch *et al.* 1988). Feed much on introduced fish, particularly common carp and redfin; campaign to eradicate these fish may be detrimental (Miller 1979).

DISTRIBUTION AND POPULATION Occur in Aust., NZ, Indonesia, New Guinea; vagrant to New Caledonia (Delacour 1966).

AUST. Widespread coastal and inland waters, including ephemeral waters in deserts. **Qld, NSW, Vic., Tas.** Generally widespread except in areas in central w. and sw. Qld (i.e. S of Cloncurry, W of Quilpie and S of Charleville) and central W of NSW (i.e. N of Broken Hill and W of White Cliffs). **SA.** Widespread E of 133°E, except desert areas N and SW of L. Eyre. **WA.** Common on coast, and in SW and N; scattered in NW; otherwise occasionally recorded on inland waters. **NT.** Widespread in Top End; scattered on waters in desert areas except Tanami and Simpson Deserts.

NZ. **NI:** coastal and inland waters, mainly in N. **SI:** Nelson & Marlborough Sounds. **STEWART I.:** vagrant (NZ Atlas).

LORDHOWE I. Vagrant; small numbers recorded May 1975; Feb., Apr., Aug. 1978 (NSW Bird Repts 1975, 1978).

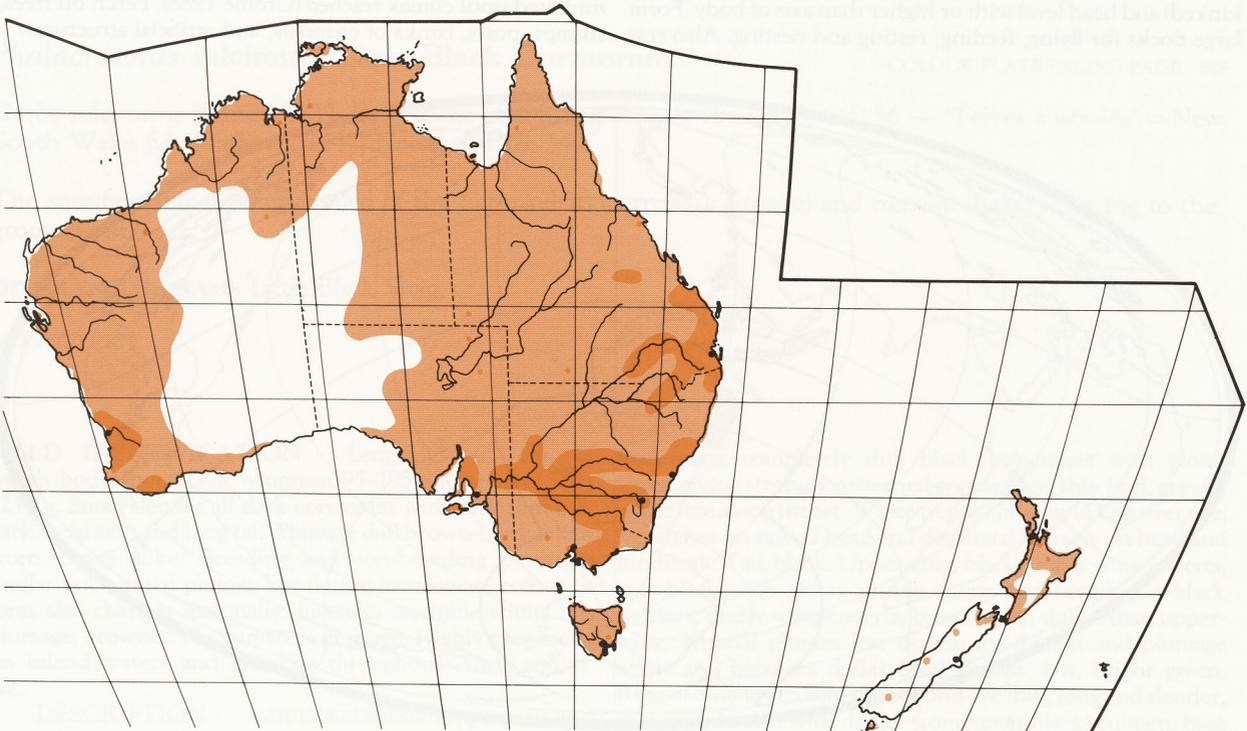
NORFOLK I. Vagrant or occasional visitor; first recorded 1892 (de Ravin 1975; Schodde *et al.* 1983; Hermes 1985).

BREEDING Widespread in suitable wetlands throughout range; solitarily in colonies of other waterbirds or

in small (up to five nests) to large (1000 nests) colonies. In Aust., primarily Murray-Darling Basin, e. coast from Melbourne to Townsville, and sw. WA; larger colonies recorded (from Aust. NRS, Aust. Atlas unless stated), include L. Muncoonie, Qld (1974, 1000 nests), L. Brewster, NSW (1973–74, 1400 nests with eggs; Miller 1980), Salt Lagoon Is, SA (1962–76, between 50 and c. 1000+ though no nesting 1977, 1979 at time of visits; Close *et al.* 1982), Yunderup, WA (1980, 1000 birds). In Tas., breeding reported recently only at Bridgewater (one nest, 1976, 1977). In NZ (from CSN), larger colonies Sulphur Bay, L. Rotorua (1982, 641 nests), L. Whangape (1979, 350 pairs), Rotomahana, Banded Is (1971, 600 pairs, including Little Pied Cormorants; Potts 1977).

Indices of abundance from annual aerial surveys of wetlands in about 12% of land area of e. Aust. 1983–88, were: 5983; 24 062; 8426; 8192; 4133; 1653 respectively (Braithwaite *et al.* 1985a,b, 1986, 1987; Kingsford *et al.* 1988, 1989).

MOVEMENTS Dispersive in Aust., possibly migratory in NZ. In Aust., movement of large numbers occurs after drought follows wet period inland. Dispersal to coast sometimes followed by movements overseas; dispersal in 1978 was followed by sudden rise in population in NZ and Torres Str. (Draffan *et al.* 1983). In Vic., leave coastal habitats when water plentiful inland (R.H. Loyn). Fluctuations in reporting rates suggest seasonal movement into Vic. during spring and summer (Vic. Atlas), with numbers on some lakes in w. Vic. peaking winter-spring (Missen & Timms 1974). Farther N, numbers at L. George, NSW, highest Oct.–Dec. (Lamm 1964); round Orange, e. NSW, Feb.–May (Heron 1973); on Hunter R., ne. NSW, Oct.–Mar. (Gosper 1981). Numbers on Richmond R., ne. NSW, were significantly lower than usual throughout 1974–76 when inland wet (Gosper *et al.* 1983) but Oct. counts, se. Qld, showed no correlation with local or inland water-levels (Woodall 1985). In n. Aust. movements



may be less extensive with population in district of Alligator Rs showing little seasonal variation that could not be accounted for by local breeding population (Morton *et al.* 1989). In NZ, appears to be movement N in early winter to coastal waters of Bay of Plenty, Hauraki Gulf, Manukau and Northland (Falla *et al.* 1966).

BANDING Most nestlings banded in SA recovered to NW in Gulf St Vincent or from coastal wetlands to 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 be interpreted (Llewellyn 1983).

FOOD Mostly fish, particularly smelt, carp and perch, with smaller numbers of freshwater crayfish and other crustaceans. **BEHAVIOUR.** Most prey caught by pursuit-diving using feet for propulsion. In sw. Aust.: in water 1–2 m deep, mean length of dive 13.4 s (13.8; 43), rests 4.3 s (4.59; 43); in water >2 m deep, 19.3 s (6.87; 39), rests 7.5 s (7.35; 32); 27% dives >20 s (Trayler *et al.* 1989). Fish usually impaled behind gills with hook of maxilla, brought to surface then turned for swallowing head first (McNally 1957). When feeding in flock, may also catch fish jumping from water (North). When chasing fish and enough birds present, usually feed in co-operative rafts of 16–1150 birds (Miller 1979) that move slowly across surface, birds at rear continually flying ahead of flock and diving immediately so that flock as whole appears to roll across water. When shoal of fish encountered by flock, leading birds seen to circle shoal before all settle to begin feeding (Serventy 1939). To take freshwater crayfish, birds feed individually, which allows more stealthy approach (McNally 1957). Birds may sight fish from air before landing beside waterbody, then often enter water from bank rather than alighting directly on water. Fish sometimes captured in turbid water with Secchi disk transparency of <10 cm (Barlow & Bock 1984). All fishing occurs during day (McNally 1957).

ADULT Summarized Table 1. **ANALYSES BY WEIGHT. IN AUST.:** At Ls Brewster and Cargelligo, central NSW (625 stomachs; Miller 1979), fish *Retropinna semoni* 1.6% wt, *Gambusia affinis* 2.6, *Carassius auratus* 51.8, mean length 9.4 cm (0.4 [\pm 95% confidence limit]; 4.0–18.0; 864), *Tandanus tandanus* 0.3, *Craterocephalus* 1.2, *Ambassis agassizi* 0.6, *Perca fluviatilis* 14.6, 6.5 (0.7; 3.0–16.8; 481), *Hypseleotris* 0.3, *Philypnodon* 0.6 with some crustaceans, freshwater crayfish *Cherax destructor* 21.3, 8.0 (0.7; 2.5–18.0; 139), shrimps *Paratya australiensis* 1.1, *Macrobrachium australiensis* 2.4; insects: bugs Belostomatidae, beetles Gyrinidae, Dytiscidae, Hydrophilidae; and molluscs 1.6. Size and quantity of

C. auratus and *P. fluviatilis* varied regularly with season. From Dec. to May size of *C. auratus* progressively increased as fry grew until most were too big for Cormorants to swallow; only a few large specimens were caught rest of year. Similarly many small *P. fluviatilis* were caught Nov.–Apr., a few large ones May–Oct. From June to Oct. fish mostly replaced by *C. destructor*.

In Peel Inlet-Harvey Estuary, sw. Aust. (13 stomachs, 891 items, identifiable fraction 81.5%; Trayler *et al.* 1989) fish were *Hyperlophus vittatus* 1.1% wt., 3% no., 0.5 g, 4.0 cm (3.8–4.5), Atherinidae 92% no., 0.7 g, 4.5 cm (2.7–6.0) incl. *Atherinosoma elongata* 34.0% wt. *A. presbyteroides* 0.6, *A. spp.* 8.0, *Allanetta mugiloides* 9.6, *Gymnapistes marmoratus* <0.6% wt., *Pelates sexlineatus* 0.6, 7.6 g, 9.9 cm (9.5–10.2), *Apogon ruppellii* 4.4% wt., 3.2 g, 5.6 cm (5.2–5.9), *Argyrosomus hololepidotus* 6.3, Gobiidae 1.8 g, 6.5 cm (4.2–7.0) incl. *Callogobius mucosa* 21.3% wt., *Favonigobius lateralis* 1.0, *Pseudogobius olorum* 0.5, unident. Gobiidae 8.5; crustaceans shrimps *Palaeomonetes australis* 3.9, 1% no., 0.1 g, 1.9 cm (1.5–2.4); other food 1.0.

On tropical Magela floodplain, NT (11, 377; Dostine & Morton 1988) fish 99.5% no.: *Neosilurus rendahli* 37.7% wt., 5.6% no., *N. hyrtlui* 5.6, 0.3, unident. Plotosidae 14.0, 2.4, *Melanotaenia splendida* 14.9, 27.9, *Pseudomugil tenellus* 1.2, 6.1, *Ambassis agrammus* 13.9, 43.0, *Denariusa bandata* 0.2, 0.5, *Morgunda* 6.4, 4.2, *Oxyeleotris nullipora* 3.1, 8.0, unident. fish 2.1, 1.6 with remainder gastropod molluscs *Glyptophysa* 0.7, 0.3; crustaceans: freshwater crayfish *Cherax quadricarinatus* trace; insects: dragonflies Anisoptera larv. 1.0, 0.3; sponges Spongilidae trace; plants (0.2, –); 84.7% of prey was 1.5–3.5 cm.

At L. Cowal, NSW (11; Vestjens 1977) only fish taken (*Retropinna semoni*, *Carassius auratus*, *Perca fluviatilis*, *Philypnodon*). In regurgitations (n=187) only *C. auratus*.

In NZ: at Ls Rotorua and Rotoehu (79; Potts 1977) *Carassius auratus* 39% wt., 31% no., 28% freq., bully 23, 32, 35, *Retropinnidae* 25, 31, 23, Galaxiidae <1, <1, 1, freshwater crayfish 13, 6, 13.

ANALYSES BY NUMBER: at freshwater sites, NSW (26, 77 identifiable items; McKeown 1944) mostly *Carassius* 53.2% no., 80.8% freq., 10.2 cm (42, 502–1506, 21) and other fish *Melanotaenia nigrans* 3.9, 3.8, *P. fluviatilis* 3.9, 3.8, *Hypseleotris* 28.6, 3.8, unident. 5.2, 7.7 with some crustaceans *Paratya australiensis* 2.6, 7.7, freshwater crayfish *Cherax bicarinatus* 2.6, 7.7; from estuarine environments (19, 302), principally *Ambassis jacksoniensis* 91.7, 73.8 with a few other fish *Cnidoglanis macrocephalus* 0.3, 5.3, *Pelates sexlineatus* 4.6, 31.6, *Acanthopagrus australis* 0.3, 5.3, *Mugil dobula* 1.3, 10.5, *M. sp.* 1.7, 5.3.

In sw. Aust. (42, 975; Serventy 1938) stomachs from

Table 1.

Percentage	dry weight		wet weight				number				
	1	2	3	4	5	6	7	8	8	9	10
FISH	99.0	73.6	95.2	87	100	94.8	91.5	96.2	99	98.2	100
<i>Carassius</i>	51.8	39	100	53.2	10.0	20.3					
CRUSTACEANS	tr.	24.8	3.9	13	5.2	8.5	3.8	1	1.1		
NO. SAMPLES	11	625	13	79	187	26	42	259	31	40	32

(1) Dostine & Morton (1988); (2) Miller (1979); (3) Trayler *et al.* (1989); (4) Potts (1977); (5) Vestjens (1977); (6) McKeown (1944); (7) Serventy (1938); (8) McNally (1957); (9) Baxter (1985); (10) Lavery & Haysom (1963).

estuarine localities contained the fish *Spratelloides robustus* ad. 0.7% no., 2.4% freq., max. number per stomach 7, juv. 1.0, 4.8, 5, unident. Clupeidae 0.4, 4.8, 2, *Cnidoglanis macrocephalus* 0.5, 7.1, 3, *Atherinomorus endrachtensis* 49.1, 50.0, 49, *Gymnapistes marmoratus* 0.2, 2.4, 2, *Platycephalus bassensis* 0.1, 2.4, 1, *Pelates ocolineatus* 0.8, 4.8, 6, *Apogon ruppellii* 10.7, 21.4, 40, *Sillago maculata* 0.2, 4.8, 1, *Gerres ovatus* 0.4, 9.5, 1, *Aldrichetta forsteri* ad. 0.4, 2.4, 4, juv. 0.1, 2.4, 1, *Mugil cephalus* 0.1, 2.4, 1, *Arenigobius bifrenatus* 0.9, 9.5, 6, *Glossogobius suppositus* 25.4, 38.1, 53, *Odax* 0.1, 2.4, 1; and crustaceans: prawns *Metapenaeus monoceros* 0.6, 7.1, 2, shrimps *Palaemonetes australis* 7.9, 23.8, 23; 1 from freshwater contained 3 freshwater crayfish *Cherax tenuimanus*.

On inland waters of Vic. (259, 1255 identifiable items; McNally 1957) also largely fish: *Nematolosa erebi* 1.5% freq., mean length 13.5 cm (9–18, n=2, max. per bird 9), *R. semoni* 36.4% no., 38% freq., *Galaxius* 6.2% freq., *Carassius* 10.0, 26, 8.7 cm (2–22, 28, 14), *P. fluviatilis* 50.7, 76, 9.8 cm (4.5–21, 49, 60), *Macquaria ambigua* 1.2% freq., 11.8 cm (7–16, 3, 1), *Nannoperca australis* 4.6% freq., *Philypnodon* 4.6, 5.3 cm (4–6, 7, 3), with some crustaceans shrimps *Paratya australiensis* 1.8% no., 10.0% freq., *Palaemonetes australis*, freshwater crayfish *Cherax destructor* 1.2, 9.3 and molluscs 0.8% freq. In same study samples (31, 100) from estuarine waters contained fish: *Acanthopagrus butcheri* 2, 2, 1 fish 12 cm, *Aldrichetta forsteri* 11, 2, 1 fish 3.8 cm, Gobiidae 70, 7 and crustaceans 1, 3 and from marine waters (1, 6), 1 *Mugil* and 5 shrimps. *Salmo* 14 cm (7.6–20.5, 3, 5) was also recorded in diet.

Further 40 samples from inland Vic. (40, 1366; Baxter 1985) had fish 98.2% no., 100% freq.: *Retropinna* 6.4, 12.5, Galaxiidae 15.6, 20.0, *Cyprinus carpio* 4.9, 10.0, *Carassius auratus* 20.3, 22.5, *Gambusia affinis* 1.0, 2.5, *Nannoperca australis* 8.6, 10.0, *Perca fluviatilis* 8.7, 32.5, Gobiidae 1.0, 2.5, fish eggs -, 7.5, unident. 31.8, 35.0; tadpoles 0.1, 2.5; crustaceans 1.1, 12.5: Atyidae 0.1, 2.5, Parastacidae 1.0, 10.0; insects 0.5, 12.5: mayflies 0.1, 2.5, odonatanas 0.1, 2.5, beetles 0.1, 2.5, flies 0.1, 2.5, unident. 0.1, 2.5; gastropod molluscs 0.2, 5.0; plants -, 2.5.

At Tinaroo Dam, n. Qld. (32 stomachs, 44 ident. items; Lavery & Haysom 1963) fish: *Leiopotherapon unicolor* 50% no., *Glossamia aprion* 46, *Oxyeleotris lineolatus* 5, bark or sticks 28% freq.

Other records: six small fish (one stomach; Lea & Gray 1935), small catfish (Mathews 1910), flathead 30 cm (North), eels, carp, mullet (Oliver).

NESTLING Generally similar to adult (10–20 chicks sampled/month for two seasons; Miller 1979), with most prey of similar size. Higher percentage of fish recorded in some nestling samples probably reflects more rapid digestion of crustaceans in adult's stomach. Food found beneath nests se. SA (Close *et al.* 1982): fish *Nematolosa erebi*, *Sardinops neopilchardus*, *Galaxius maculatus*, *Carassius auratus*, *Atherinason*, *Platycephalus*, *Lizagobius galwayi* and shrimp-like crustacean.

INTAKE Mean weight stomach contents sw. Aust. 64.3 g (13; Trayler *et al.* 1989).

SOCIAL ORGANIZATION Little studied, based mainly on information supplied by G.F. van Tets. Solitary or gregarious; normally social, flying singly or in flocks; often congregate for feeding, roosting or breeding, often in association with Little Pied Cormorant (Miller 1979). Mostly dispersive after breeding; females may wander more than males from breeding colony (Serventy 1939); can form large

flocks as in July–Aug. 1976 when 'thousands' seen (Aust. Atlas). Congregate where food copious; form co-operative feeding flocks, often with Great Cormorants, groups of birds herding shoals of fish (Miller 1979). If flock too small, shoals can escape; report of flock of 30 birds being unable to hold shoal, but when numbers increased to over 100, fishing more effective (Wheeler 1946). If not enough birds present usually do not attempt co-operative fishing and feed singly (Miller 1979). Size of feeding flocks varies: singly or in small numbers (Serventy 1939), between 16 and 1150 (Miller 1979), up to 120 (Gosper 1981).

BONDS Possibly sustained monogamous; may form pairs and breed at any time of year (see Breeding); no information from banded birds. Both parents incubate and tend young until contact lost a few weeks after fledging. Parents incubate eggs and warm small chicks with webbed feet.

BREEDING DISPERSION Occasionally nest singly (Vestjens 1977; Fletcher 1915; Aust. Atlas), but more often colonially in trees near freshwater; frequently within colonies of Little Pied Cormorant and tree-nesting waterbirds such as other species of cormorant, herons, ibises and spoonbills (Sibson 1956; Potts 1977; Vestjens 1977; Miller 1980; Aust. NRS). Colonies usually fewer than 100 nests (Aust. Atlas), regularly 100+ nests (Close *et al.* 1982) or between five and 450 birds (Miller 1980); as well as thousands (see Distribution). No information on densities within colonies. Laying in colonies synchronized to within few days (Close *et al.* 1982). May be partly philopatric and form social grouping ('subunit') during breeding; discrete flocks of up to 30 birds arrive at colony; members of these flocks may make up subunits of three to 12 nests within colony, nesting close together and synchronically; group stimulation within subunit could synchronize date of laying (Miller 1980). Territorial; defend nest-site only.

ROOSTING Solitary or communal roosts, often with Little Pied Cormorant and other species (Sibson 1956; Potts 1977), in trees and bushes, and on wires, rocks and stumps near water. May have separate diurnal and nocturnal roosts. Daytime roosts usually more varied and characterized by fewer birds; often rest at several such sites during day's feeding; after feeding fly to roost and stand for up to 1.5 h, before feeding again (Potts 1977). After communal feeding often roost communally (Serventy 1939). Flocks return to roost at regular time each evening (Campbell), in late afternoon or at dusk after feeding, and leave at dawn or just after (Potts 1977). No systematic information on times of arrival and departure.

SOCIAL BEHAVIOUR Based mainly on Hoogerwerf (1953) and information supplied by G.F. van Tets. Displays observed easily, provided no obstructing vegetation; care needed not to disturb displaying birds. Flocks integrated when foraging (Serventy 1939; Wheeler 1946; Miller 1979) and, when in groups, fly in V-formation. After feeding bathe vigorously and beat wings; this behaviour may stimulate whole flock to preen and dry wings. At or beside nest-site, feathers of neck of both sexes never raised unless stated for specific displays.

AGONISTIC BEHAVIOUR Individual distance just out of pecking reach of each other. When THREATENING, stretch neck towards intruder with bill closed, hyoid bones spread and feathers of upper-neck raised below nape and hyoid lines. Head then moved back and forth in darting motion with bill partly open and wings partly spread. Male

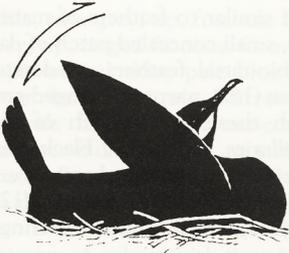


Fig. 1 Wing-waving



Fig. 2 Gargling



Fig. 3 Pointing



Fig. 4 Pre-take-off Posture



Fig. 5 Kink-throating

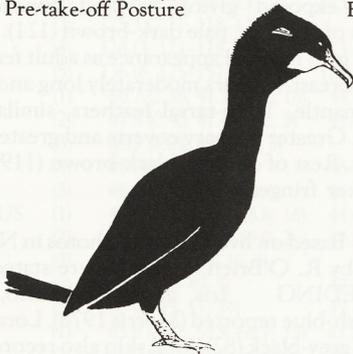


Fig. 6 Post-landing Posture

calls harshly; female probably silent. At nest-site, **Nest-worrying** also serves as threat display: lateral movements of head observed in male or female while holding nesting material.

SEXUAL BEHAVIOUR **ADVERTISING** by male consists of **Wing-waving** (Fig. 1): partly folded wings, raised and lowered, with tips moving up and outwards, by humeral rotation, 1–2 times/s. Head rests on back and almost-closed bill tilted up and forward c. 45° above horizontal. Only

ornamentation is bulged iridescent violet throat-pouch; no white areas for wing movement to emphasize. No associated call. **RECOGNITION** consists of Gargling and Pointing. **Gargling** (Fig. 2): head, with bill open, swung back through vertical arc and rotated above rump with bill closed. Male emits single call as head moved back and double call as head rotated. Female greets mate by performing at least initial open-bill phase and sometimes entire Gargling display, but silent. In male, sometimes fused onto end of Wing-waving display. **Pointing** (Fig. 3): with body horizontal (sitting position), neck and head stretched, with bill closed, and tail raised c. 30° above horizontal. Similar in both sexes. No sounds made. **OTHER DISPLAYS AT SITE**. Include Pre-take-off and Post-landing Postures, Kink-throating and Hopping. In **Pre-take-off Posture** (Fig. 4), bird's neck and body in line c. 45° above horizontal, closed bill slopes down and tail almost horizontal; feathers of head flattened in mask-like fashion while feathers of neck, below nape-line, raised to form broad ruff. Throat pulsates with ticking sound made by male and, possibly, female. When arrive at site, **Kink-throating** (Fig. 5) performed with bill closed; male makes whistling call during pair-formation, changing to croak later in breeding; female probably silent. In **Post-landing Posture** (Fig. 6), head and throat form laterally flattened disk with crest raised, and bill closed and pointing down; both sexes silent. **Hopping** similar to Great Cormorant. **Pre-hop**: breast-feathers sometimes raised, and moved up and down slowly; ticking sound made by male. When **Hopping**, male screeches loudly; female silent.

RELATIONS WITHIN FAMILY GROUP Parental care same as in Great Cormorant. In hot weather, adult bird shades young and pours water into their open bills.

VOICE Very poorly known; no detailed studies. Information supplied by G.F. van Tets from studies at Port Pirie, SA, and L. Cowal, NSW. Apparently silent away from breeding colonies; at site, males make various hoarse barking croaks, whistles and ticking calls; females probably silent (though may call during Gargling and Pre-take-off Posture but undescribed). Calling mostly during breeding season. No information on individual differences or geographical variation.

ADULT MALE **Gargling Call**: hoarse barking *hack* as head moved back to rump, followed by repeated double note *ak-he* as head rotated on rump. **Threat Call**: hoarse croaking *ake-ake-ake*. . . similar to second part of Gargling Call. **Pre-take-off** and **Pre-hop Calls**: repeated ticking *t-t-t*. . . **Kink-throating Call**: whistling *tu-tu-tu* during pair-formation but changes later in breeding season to hoarse *hack-hack-hack*. . . or croaking *krah-krah-krah*. . . **Hop Call**: loud monosyllabic barking *kar* or *krah*.

YOUNG No information.

BREEDING No detailed studies; poorly known. Information supplied by G.F. van Tets and from Aust. NRS. Nest colonially, usually with other cormorants, herons, spoonbills, ibises and darters; occasionally singly (Vestjens 1977; Fletcher 1915); only on freshwaters except at one locality on Gulf St Vincent, SA (Campbell) and in mangroves at Port Pirie, SA (G.F. van Tets).

SEASON Not clearly known. Summer to autumn in n. Aust. and spring to summer in s. Aust. but also continuous or at any time of year in favourable conditions of water, food and shelter as generally claimed. Campbell gave records in SA for Mar. and May but usually Aug.–Dec. At L. Cowal, NSW;

Sept. to June (Vestjens 1977). In n. Aust. (N of 23°S) eggs Apr.–May, Aug., young May, Aug., Oct.; in s. Aust. (S of 34°S) eggs May and Nov., young May and Dec. (Aust. NRS).

SITE In stems or forks of trees over water (Campbell); near tops of trees up to 30 m above water in deeper parts of swamps; generally high in trees growing in water (Vestjens 1977).

NEST, MATERIALS Platform of sticks, leaves, dry reeds, lignum, water weed; lined with paperbark, leaves, cormorant quill feathers (Aust. NRS); even entirely of paperbark (Campbell). No systematic measurements; one nest measured 30 cm across and 30–60 cm deep (Aust. NRS). No details of building or roles of sexes.

EGGS Elongate oval; mat, rough texture; bluish or greenish white with white chalky outer layer.

MEASUREMENTS:

49 (44–51; 12) x 32 (31–33) (North);

54 (50–56; 6) x 35 (33–36) (Campbell);

48 (47–49; 9) x 32 (31–33) (HASB);

47 (45–53; 40) x 33 (32–42) (Vestjens 1977).

CLUTCH-SIZE No quantified data. At L. Cowal, four (n=28; Vestjens 1977). Otherwise claimed: usually three (Campbell); usually five, occasionally six (North); usually four but five or six occasionally (HASB).

INCUBATION No information.

YOUNG Altricial, nidicolous; naked when hatched with dark skin. Later covered with black down; naked crown, purplish grey; iris, brown. Young may regurgitate or jump into water when threatened (Aust. NRS). No further information on care of young, role of parents, growth of young, fledging to maturity or success. **PREDATION.** Eggs taken by 'crows' *Corvus* spp and Whistling Kites *Haliastur sphenurus* (Aust. NRS).

PLUMAGES

ADULT BREEDING Age at first breeding unknown. Assumes adult plumage late in first year. **HEAD AND NECK.** Feathers, dull glossy black-green (162). Profuse short white filoplumes above eye, on outer margins of crown, and scattered on hindneck. Lores, largely bare; covered in minute black-brown (119) papillae. At ear-coverts, 4–8 long, narrow white nuptial plumes lie horizontally, moulted when birds on eggs. Gular pouch, bare; feathers on throat extend on to basal quarter of gular pouch in inverted V-shape. Feathers of head and neck have silky texture. **UPPERPARTS.** Mantle, dull glossy black-green (162), with brown-grey (79) shade, narrowly fringed grey-black (82); when worn, fringes become dark brown (119A) and rest of feather approaches brown-grey (79). Fringes narrower on upper mantle; concealed bases of feathers, dark brown (121). Fringes of feathers of mantle become progressively broader towards lower and outer margins. Rest of upperparts, dull glossy black-green (162); subscapulars, narrowly fringed grey-black (82). **TAIL,** black-brown (119) with dull black-green (162) gloss on webs; shaft, rigid; rachis, grey-black (82). **UPPERWING.** Marginal coverts, black-brown (119), almost grey-black (82). Most other coverts, including alula, combination of dull glossy black-green (162) and brown-grey (79), fringed grey-black (82); fringes become progressively broader from marginal coverts towards greater coverts. Greater primary coverts, edged grey-black (82) on outer web. Remiges, black-brown (119); basal inner webs, dark brown (121). Tertiaries, humerals and secondaries, edged grey-black (82) on outer web. **UNDERPARTS,** dull glossy black-green (162); concealed bases of feathers, dark brown (121). Lateral breast-

feathers, moderately long and similar to feathers of mantle; beneath these on outer flanks, small concealed patch of dark brown (121) semiplumes. Tibio-tarsal feathers, moderately long and dull glossy black-green (162), narrowly fringed grey-black (82); concealed beneath these, small patch of dark brown (121) semiplumes. Axillaries, dull glossy black-green (162). **UNDERWING.** Greater primary coverts, and greater coverts, glossy brown-grey (79). Rest of coverts, dark brown (121), with dull gloss of black-green (162); feathers narrowly fringed grey-black (82).

ADULT NON-BREEDING Lacks long white nuptial plumes and differs largely in bare parts; plumage duller, browner, like adult breeding during latter stages of breeding season.

DOWNY YOUNG Naked at hatching. Protoptile, sparse. Mesoptile, thicker, woolly and entirely dark brown (121); no down on forecrown.

JUVENILE HEAD AND NECK. Feathers of crown, dark brown (121) narrowly tipped light grey-brown (119D), giving finely scalloped appearance; foreneck, similarly scalloped, but tips light grey-brown (119C) and narrower round throat. Hindneck, dark brown (121). **UPPERPARTS.** Feathers of mantle, light grey-brown (119C) fringed dark brown (119A) to black-brown (119); concealed bases of feathers, pale dark-brown (121). In some lights, fringes may have dull gloss of black-green (162). Fringes on feathers of mantle become progressively broader from upper to lower and outer margins. Back, rump and upper tail-coverts, pale dark-brown (121), narrowly tipped glossy black-green (162); pale dark-brown (121) on feathers often exposed, giving slight mottled appearance. Subscapulars, dull glossy black-green (162), fringed grey-black (82). **TAIL,** black-brown (119), tipped dark brown (119A); rachis, grey-black (82). **UPPERWING.** Remiges, black-brown (119), with pointed dark-brown (119A) tips. All coverts, including alula, light grey-brown (119C), fringed dark brown (119A); fringes on marginal coverts, almost black-brown (119). **UNDERPARTS,** mostly dark brown (119A); three-quarters of length of feathers, light grey-brown (119D), narrowly tipped dark brown (119A). Light grey-brown (119D) on feathers often exposed giving mottled appearance. Towards vent, bases of feathers, pale dark-brown (121). With age, underparts may gain mottled appearance as adult feathers appear. Long lateral breast-feathers moderately long and similar to feathers of mantle, Tibio-tarsal feathers, similar but duller. **UNDERWING.** Greater primary coverts and greater coverts, similar to adult. Rest of coverts, black-brown (119) with narrow slightly darker fringes.

BARE PARTS Based on live birds and photos in NZRD, Lindsey (1986) and by R. O'Brien, except where stated.

ADULT BREEDING Iris, green (163); also, light green to light greenish-blue reported (Morris 1978). Loral skin and part of eye-ring, grey-black (82); loral skin also recorded as purple-grey (HASB); appears black in field. On eye-ring, small light-violet (170C) nodules. Gular pouch, grey-black (82) with pimple-like, light-violet (170C) patches. Bill, dark brown (119A); culminicorn, black-brown (119). No sexual difference apparent during breeding. Legs and feet, grey-black (82).

ADULT NON-BREEDING Colours less intense than in adult breeding. Differs in eye-ring and gular pouch, grey-black (82); latericorns approach light grey-brown (119C).

NAKED YOUNG Label data from skins at SAM, recorded 5 min after death: iris, pale dull-brown. Upper man-

dible, pale grey; tip, fuscous. Lower mandible, whitish blue-grey; tip, tinged fuscous. Crown, whitish buff, with face and supra-orbital skin, pale blue-grey. Palate, pale violet-pink; cream-buff anteriorly. Narrow black-brown (119) eye-stripe extends from bill to ear-coverts; behind eye, eye-stripe definite. Gular pouch, mottled pale pink and pale yellow-cream. Egg tooth, white. Legs and feet, blackish; webs, buffy blackish.

DOWNY YOUNG Similar to naked young; changes of colour with time insufficiently recorded.

JUVENILE Iris, brown (Morris 1978; NZRD). Bill, pale grey. Facial skin and gular pouch, light grey. Legs and feet, greyish black (Morris 1978).

MOULTS In Aust., no definite moult-period can be ascribed, as breeding protracted. Based on skins (MV, SAM).

ADULT Complete; primaries moult outwards in staffelmauser. Duration of moult-wave undescribed. Pre-nuptial plumage involves development of white nuptial plumes; when feeding chicks, white nuptial plumes lost. Tail moults irregularly at same time as wing.

POST-JUVENILE, SUBSEQUENT MOULTS Undescribed.

MEASUREMENTS (1) SE. Aust., adults, skins (MV, SAM, ANWC, QM, QVM). (2) Adults, skins; label data (NMNZ). (3) NZ, adults, skins; methods unknown (Falla 1932). (4) NZ, skins (AWMM, AM, CM, NMNZ; G.F. van Tets). (5) NSW, live (G.F. van Tets & W.J.M. Vestjens).

	MALES	FEMALES
WING	(1) 253.3 (7.38; 236-263; 16)	240.1 (8.63; 225-257; 16) *
	(2) 257.5 (9.50; 248-267; 2)	246.3 (4.92; 240-252; 3)
	(3) 252.0 (9.27; 239-260; 3)	
	(4) 251 (16; 229-264; 4)	243 (9; 230-259; 9)
	(5) 262 (7; 250-280; 39)	245 (8; 240-270; 31)
TAIL	(1) 133.4 (8.86; 113-150; 15)	128.3 (5.83; 116-136; 14)
	(2) 132.5 (2.50; 130-135; 2)	123.6 (3.09; 121-128; 3) *
	(3) 125.3 (7.71; 118-136; 3)	
	(4) 126 (3; 121-128; 5)	123 (10; 108-141; 8)
	(5) 136 (6; 125-157; 34)	128 (8; 113-148; 25)
BILL	(1) 46.7 (2.36; 41.7-50.5; 16)	44.1 (1.89; 40-49.5; 16) *
	(2) 47.8 (0.40; 47.4-48.2; 2)	41.8 (0.65; 41.1-42.7; 3) *
	(3) 48.5 (1.08; 47-49.5; 3)	
	(4) 48 (4; 41-53; 5)	46 (4; 41-52; 9)
	(5) 48 (2; 42-52; 38)	44 (2; 41-52; 28)
TARSUS	(1) 46.8 (1.29; 44.2-48.6; 16)	44.6 (1.91; 41.5-48; 14) *
	(2) 50.2 (4.75; 45.5-55.0; 2)	47.8 (0.35; 47.3-48.1; 3)
	(3) 44.6 (0.47; 44-45; 3)	
	(4) 47 (2; 43-49; 5)	47 (3; 43-51; 9)
	(5) 50 (2; 45-53; 34)	47 (2; 45-51; 15)
TOE	(1) 63.8 (2.72; 58.9-66.7; 15)	61.2 (2.29; 56.8-65.5; 16) *
	(2) 63.7 (2.55; 61.2-66.3; 2)	59.2 (1.72; 57.6-61.6; 3)

Additional measurements in HASB.

WEIGHTS Few data from NZ. In se. Aust., label data from adult skins (MV, SAM, ANWC, QM, QVM): males 920.0 (131.87; 660-1015; 5), females 716.6 (141.55; 575-910; 3). In NSW, live birds (G.F. van Tets & W.J.M. Vestjens): males 1100 (100; 800-1300; 42), females 900 (100; 700-1300; 34). In NZ, label data from adult skins at NMNZ: males 913.0 (291.44; 517-1210; 3), females 704.6 (120.08; 576-865; 3).

Morris (1978) gives range 573-925 g. Additional weights and details of seasonal changes in Serventy (1939).

STRUCTURE Wing, long and broad. Eleven primaries: p8 usually longest, p10 4-6 mm shorter, p9 0-3, p7 4-10, p6 27-31, p5 39-44, p4 49-55, p3 58-67, p2 66-74, p1 73-85, p11 minute. P10-8 emarginated on inner webs; p9-7 on outer webs. Six humerals. Tips of remiges, pointed in juveniles, rounded in adults. Tail, long and wedge-shaped; 12 rectrices, t1 longest, t6 41-88 mm shorter. Bill, short; maxillary unguis hooked at tip. Upper mandible, extends to gape, where sharply ridged. At base of upper mandible, numerous fine striae extend short distance. Small groove on side of culmen. Near base of upper mandible, small secondary external nostril plate on cutting edge. Bill, flaky in juveniles, smoother in adults. Tarsus, short and rounded in cross-section. Feet, totipalmate. Outer toe c. 127% of middle, inner c. 70%, hind c. 42%.

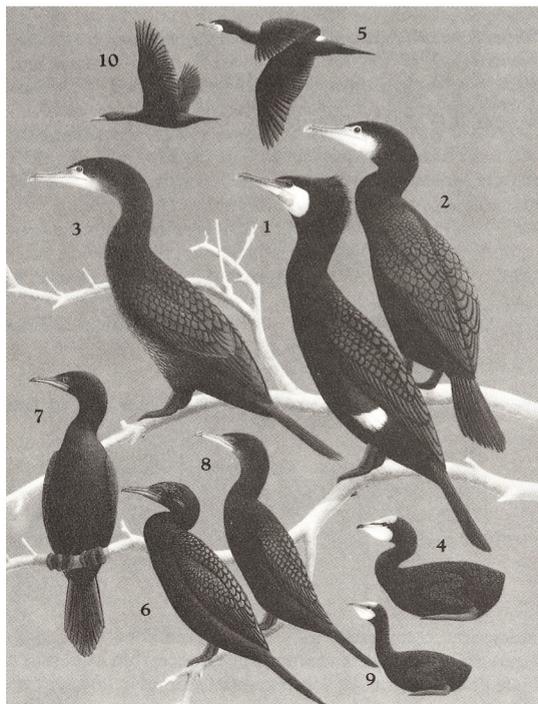
GEOGRAPHICAL VARIATION None. In NZ, a tentative subspecies *purpuragula* (Peale 1848), said to have longer wing, shorter bill and tarsus (Oliver), has been reviewed by Mees (1982), and found not to be substantiated, confirming Oliver's later statements.

RMO

REFERENCES

- Barlow, C.G., & K. Bock. 1984. *Aust. Wildl. Res.* 11: 559-66.
 Baxter, A.F. 1985. *Arthur Rylah Inst. Env. Res. Tech. Rep.* 13: 1-26.
 Braithwaite, L.W., et al. 1985a. *Tech. Memo Div. Wildl. Rglds Res. CSIRO Aust.* 21.
 Braithwaite, L.W., et al. 1985b. *Tech. Mem. Div. Wildl. Rglds Res. CSIRO Aust.* 23.
 Braithwaite, L.W., et al. 1986. *Tech. Mem. Div. Wildl. Rglds Res. CSIRO Aust.* 24.
 Braithwaite, L.W., et al. 1987. *Tech. Mem. Div. Wildl. Rglds Res. CSIRO Aust.* 27.
 Close, D.H., et al. 1982. *Corella* 6: 25-36.
 Cooper, R.P. 1980. *Birds of a Salt-field.*
 Corrick, A.H. 1981. *Proc. R. Soc. Vict.* 92: 187-200.
 Corrick, A.H. 1982. *Proc. R. Soc. Vict.* 94: 69-87.
 Corrick, A.H., & F.I. Norman. 1980. *Proc. R. Soc. Vict.* 91: 1-15.
 Crome, F.H.J. 1988. *Emu* 88: 243-8.
 Delacour, J. 1966. *Guide des Oiseaux de la Nouvelle-Calédonie.*
 de Ravin, J.A. 1975. *Aust. Bird Watcher* 6: 4-10.
 Dostine, P.L., & S.R. Morton. 1988. *Emu* 88: 263-6.
 Draffan, R.D.W., et al. 1983. *Emu* 83: 207-34.
 Falla, R.A. 1932. *Rec. Auck. Inst. Mus.* 1: 139-54.
 Falla, R.A., et al. 1966. *A Field Guide to the Birds of New Zealand.*
 Fjeldså, J. 1985. *Emu* 85: 141-9.
 Fletcher, J.A. 1915. *Emu* 15: 114-18.
 Goodrick, G.N. 1970. *CSIRO Div. Wildl. Res. Tech. Memo* 5.
 Gosper, D.G. 1981. *Corella* 5: 1-18.
 Gosper, D.G. 1983. *Corella* 7: 7-13.
 Gosper, D.G., et al. 1983. *Aust. Wildl. Res.* 10: 319-27.
 Hermes, N. 1985. *Birds of Norfolk Island.*
 Heron, S.J. 1973. *Emu* 73: 1-8.
 Hoogerwerf, A. 1953. *Limosa* 26: 71-9.
 Jaensch, R.P., et al. 1988. *RAOU Rep.* 30.
 Kingsford, R.T., et al. 1988. *Tech. Memo. Div. Wildl. Ecol. CSIRO Aust.* 30.
 Kingsford, R.T., et al. 1989. *NSW NPWS Occ. Pap.* 8.
 Lamm, D.W. 1964. *Emu* 64: 114-28.
 Lavery, H.J., & N.M. Haysom. 1963. *Qld. J. agric. Sci.* 20: 543-5.
 Lea, A.M., & J.T. Gray. 1935. *Emu* 34: 275-92.
 Lindsey, T.R. 1986. *The Seabirds of Australia.*
 Llewellyn, L.C. 1983. *Aust. Wildl. Res.* 10: 149-67.

- Mathews, G.M. 1910. *Emu* 10: 103-10.
- McKeown, K.C. 1944. *Emu* 43: 259-69.
- McNally, J. 1957. *Vic. Fish Game Dept. Fauna Contrib.* 6.
- Mees, G.F. 1982. *Zool. Verh. Leiden* 191: 1-189.
- Miller, B. 1979. *Aust. Wildl. Res.* 6: 79-95.
- Miller, B. 1980. *Aust. Wildl. Res.* 7: 85-101.
- Missen, R., & B. Timms. 1974. *Aust. Bird-Watcher* 5: 128-35.
- Morris, F.T. 1978. *Birds of the Australian Swamps.* 1.
- Morton, S.R., et al. 1989. *Dist. Abund. Waterbds Alligator Rs, NT.*
Rep. to ANPWS.
- Peale, T.R. 1848. *US Explor. Exped.* 1838-42.
- Potts, K.J. 1977. *Wildl. Rev.* 8: 34-8.
- Riggert, T.L. 1966. *Study Wetlds Swan Coastal Plain.* Dept. Fish.
Fauna, Perth.
- Schodde, R., et al. 1983. *ANPWS Spec. Publ.* 8
- Serventy, D.L. 1938. *Emu* 38: 293-316.
- Serventy, D.L. 1939. *Emu* 38: 357-71.
- Sibson, R.B. 1956. *Notornis* 7: 24.
- Storr, G.M. 1964. *Emu* 63: 297-303.
- Trayler, K.M., et al. 1989. *J. Zool., Lond.* 218: 87-98.
- van Tets, G.F., et al. 1976. *Aust. Bird-Bander* 14: 43-6.
- Vestjens, W.J.M. 1977. *Tech. Memo. Div. Wildl. Res. CSIRO Aust.*
12.
- Wheeler, R. 1946. *Emu* 46: 192-4.
- Woodall, P.F. 1985. *Aust. Wildl. Res.* 12: 495-506.



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

© [Jeff Davies](#)