

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 pterygiae 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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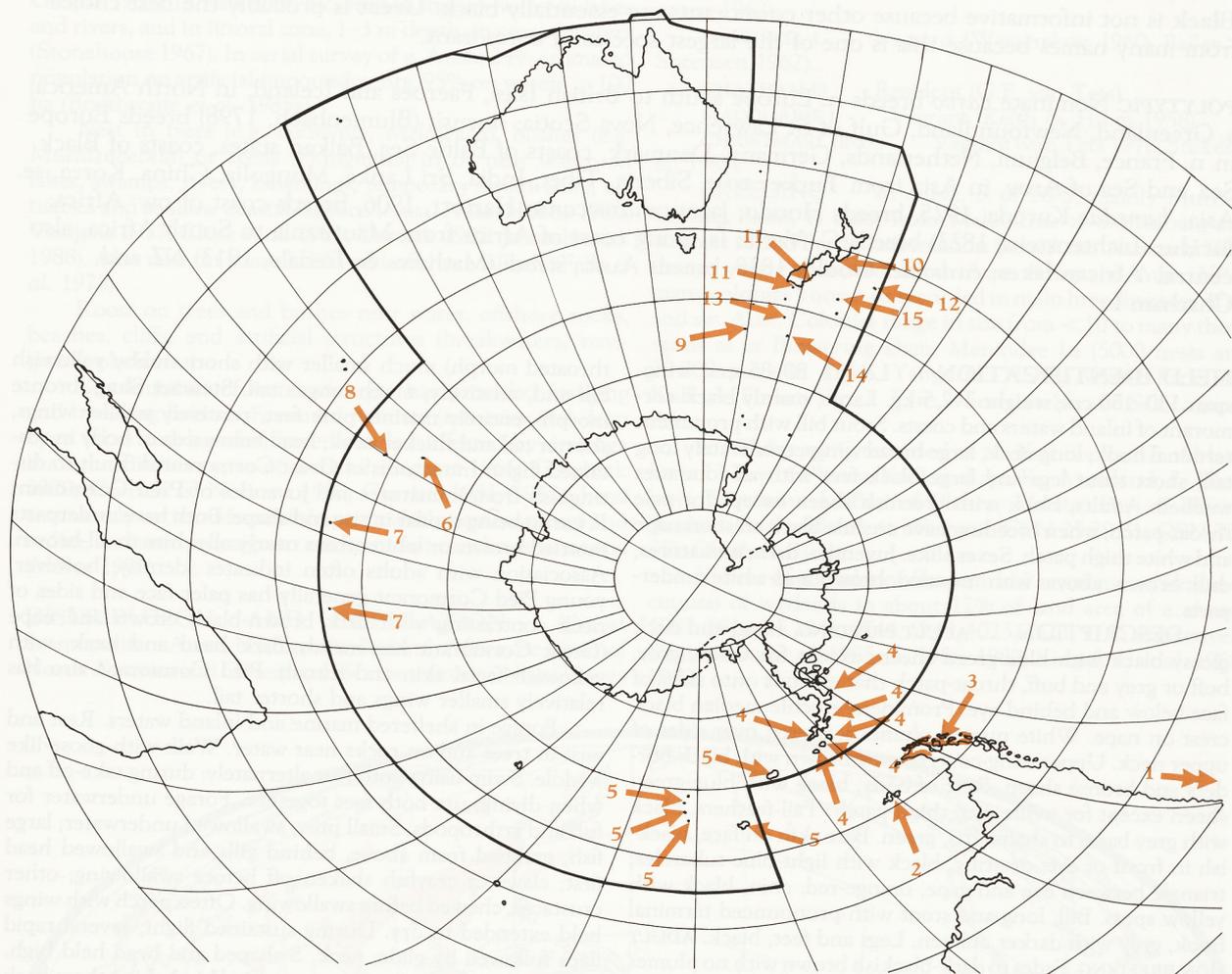


Fig. 1. Distribution of island forms of *Phalacrocorax*.

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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> | | |

Hydrocorax melanoleucos Vieillot, 1817, *Nouv. Dict. Hist. nat., nouv. éd.*, 8: 88 — Australasia = New South Wales, *apud* Mathews, 1912, *Novit. zool.* 18: 241.

Specifically named 'black-and-white' (μελάς, -άνος + λευκός) for its plumage.

OTHER ENGLISH NAMES White-throated Shag, Little Black-and-white Cormorant or Shag, Little Cormorant or Shag, Frilled or Little River Shag.

POLYTYPIC Nominate *melanoleucos* Aust., Indonesia, New Guinea, Palau, Solomon Is (except Rennell I.), Santa Cruz Is and New Caledonia and Campbell I.; *brevirostris* Gould, 1837, NZ including Stewart I.; *brevicauda* Mayr, 1931, Rennell I., Solomon Is.

FIELD IDENTIFICATION Length 55–65 cm; wing-span 85–90 cm; weight 410–880 g. Small squat black-and-white cormorant with long tail, of inland and coastal waters throughout Aust. and NZ. Similar in size to Little Black Cormorant *P. sulcirostris* but bill shorter and stubbier. In Aust., monomorphic. In NZ, polymorphic where most adults have white confined to face and throat but many have varying white underparts, some more extensive than in Aust. birds; many intermediate forms. Sexes alike. No seasonal plumages. Juveniles of white-throated morph totally dark.

DESCRIPTION ADULT BREEDING. *P.m. melanoleucos.* Crown, nape and hindneck, black with small black crest on forehead; erect white frills on sides of crown. Conspicuous white face; white starts over base of upper mandible, extending above eye to sides of nape and neck, restricting black of crown to narrow cap that expands on hind neck. Black of hindneck merges with black mantle, back and tail. Upper wing-coverts, dark grey with greeny-bronze sheen and broad black borders; remiges, black. Underparts and sides of thighs, white (in Aust. often reddish brown or orange by iron-staining); under tail-coverts, black. Underwing, black. Iris, dark brown. Bill, yellow or yellow-orange with brownish culmen, greenish towards base of lower mandible. Mouth-lining, bright pale-blue. Facial skin, dark grey in front of eye; gular pouch, orange. Legs and feet, black. **White-throated morph** *brevirostris*, dorsally, as *melanoleucos* but underparts, black with white confined to face, sides of neck and (to varying extent) throat. Crests and colour of soft parts as for *melanoleucos*. **Pied morph.** Similar to *melanoleucos* but extent of white on underparts varying. **Intermediate morph.** Dorsally as pied morph but underparts smudged black and white. **ADULT NON-BREEDING.** Like breeding but no crests or frills on head. Bill, yellow with dark culmen; facial skin, yellow. **JUVENILE.** *P.m. melanoleucos, brevirostris* (**pied morph**). Like

non-breeding adult except duller on back, and black of cap extends below eye, from base of lower mandible and covering anterior ear-coverts; mottled black and white above eye; birds have black thighs. *P.m. brevirostris* (**white-throated morph**). Totally dark brownish face and underparts. Bill, black with red base to lower bill; assumes adult colour late in first year.

Similar species. Small size, short stubby yellowish bill and long wedge-shaped tail separate Little Pied Cormorant from all other A'asian cormorants and shags. Most resembles **Pied Cormorant** *P. varius* and **Black-faced Shag** *P. fuscescens*, which are much larger with much longer bills. **Pied Cormorant** has yellow skin in front of eye, obvious black flank-patch and more extensive white, appearing brighter than on Little Pied. **Black-faced Shag** lacks white above eye and has black facial skin. Adult white-throated morph distinctive and should not be confused. Juveniles of white-throated morph closely resemble **Little Black Cormorant** in small size and all-dark plumage, but Little Black Cormorant more slender, with longer more slender dark bill.

Short stubby yellowish bill and long wedge-shaped tail give silhouettes in flight and when perched unlike those of other A'asian shags and cormorants. Forage in marine and inland waters, often in small ponds and streams. Roost and nest in trees and bushes near water; also rest on fences, navigation beacons, rigging and railings of boats, and on telephone and electric lines. Walk with slow waddle. Swim on surface using both feet alternately; during take-off and when diving, uses both feet. When stalking prey underwater, feet held out to side of body like oars, as in grebes. Feed mainly on arthropods and some fish. Claws of crayfish shaken off before remainder swallowed. Fish too large to be swallowed also dropped ashore. Flight strong and high. Able to take-off at angle of about 45°, which is about twice as steep as other

species of Asian cormorants. Usually forage and fly alone, but gather in small flocks to rest and nest. Both sexes utter cooing and croaking calls at nest-site.

HABITAT Terrestrial wetlands and sheltered coastal waters. Inland, use various natural and artificial wetlands; lakes, reservoirs, swamps, small and large waterways, billabongs, pools, channels, dams, ornamental ponds. Feed in open water, but able to use smaller wetlands and smaller areas of open water in vegetated wetlands than other species of cormorant; do not feed co-operatively. On large lakes feed in shallow margins where native crustaceans most abundant (Vestjens 1977; Miller 1979; Morton *et al.* 1989). Favoured habitats: open freshwater lakes; permanent, semi-permanent and seasonal swamps; rivers, billabongs and pools with wooded edges (Corrick & Norman 1980; Gosper 1981; Fjeldså 1985). Less common on freshwater meadows; swamps densely vegetated with reeds, sedges or trees (e.g. *Phragmites*, *Scirpus*, *Melaleuca*, *Casuarina*) (Gosper 1981). Gather at drying pools to capture trapped fish (Hobbs 1956). Along coast, use deep lagoons and sheltered estuaries, bays and harbours, remaining in sight of land (Storr 1964; Corrick & Norman 1980; Gosper 1981; Jaensch *et al.* 1988). Also found in salt-fields, saltpans, dune swamps dominated by sedge (*Lepidosperma*), mangrove swamps, saltmarshes and shallow coastal lagoons (Crawford 1975; Corrick & Norman 1980; Gosper 1981); penetrate considerable distances up small and intermittent creeks in wooded and forested areas (S. Marchant); uncommon on exposed coasts, but occasionally feed close to shore from rock platforms (Gosper 1983). In aerial survey of e. Aust., 93% estimated population on artificial impoundments; >99% on waters larger than 100 ha (Braithwaite *et al.* 1985a).

Breed in variety of small and large vegetated wetlands, mainly freshwater; lakes, swamps, billabongs, rivers (Corrick & Norman 1980; Miller 1980; Jaensch *et al.* 1988); on trees and bushes in or near water. In Booligal, NSW, breed in swamps with high levels organic matter, complex flora and diverse invertebrate population; in early stages of succession

after drying and refilling (Crome 1988). Occasionally nest among other species of cormorants on offshore islands (Lashmar 1987). Perch on trees, stumps, rocks, earth banks, and many artificial structures.

Have become more widespread where previously forested areas have been cleared and dams constructed, but artificial wetlands do not compensate for destruction of natural freshwater wetlands, which are more diverse and are important for breeding (Corrick 1981). In Northam, WA, decline of breeding colony coincided with increased salinity of river (Masters & Milhinch 1974). Lowering of water-levels in breeding places may lead to breeding failure (Miller 1979), but temporary drainage outside breeding season may stimulate breeding by improving food supply (Crome 1988). In inland NSW, feed extensively on introduced fish, particularly common carp and redfin, and eradication of fish could be detrimental (Miller 1979).

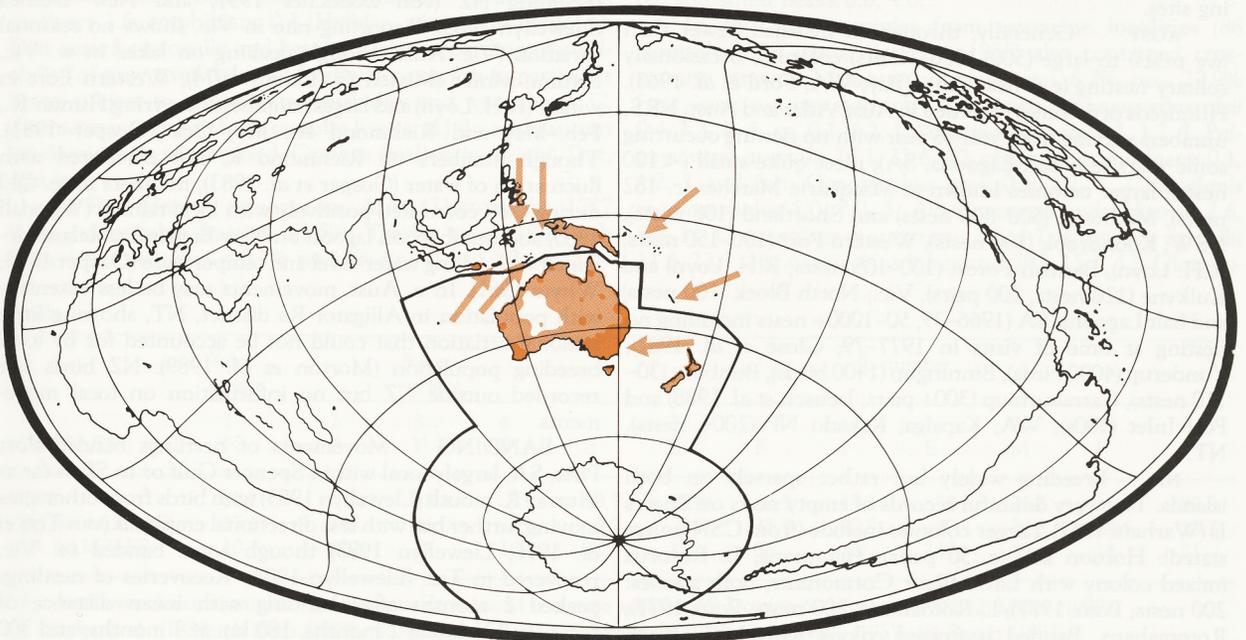
DISTRIBUTION AND POPULATION Occur in Aust., NZ. Extraliminally: New Guinea, Indonesia (e. Java, Bali, Sulawesi, Lesser Sunda Is, Moluccas, Aru Is) and sw. Pacific (Palau, Solomons, Santa Cruz, New Caledonia).

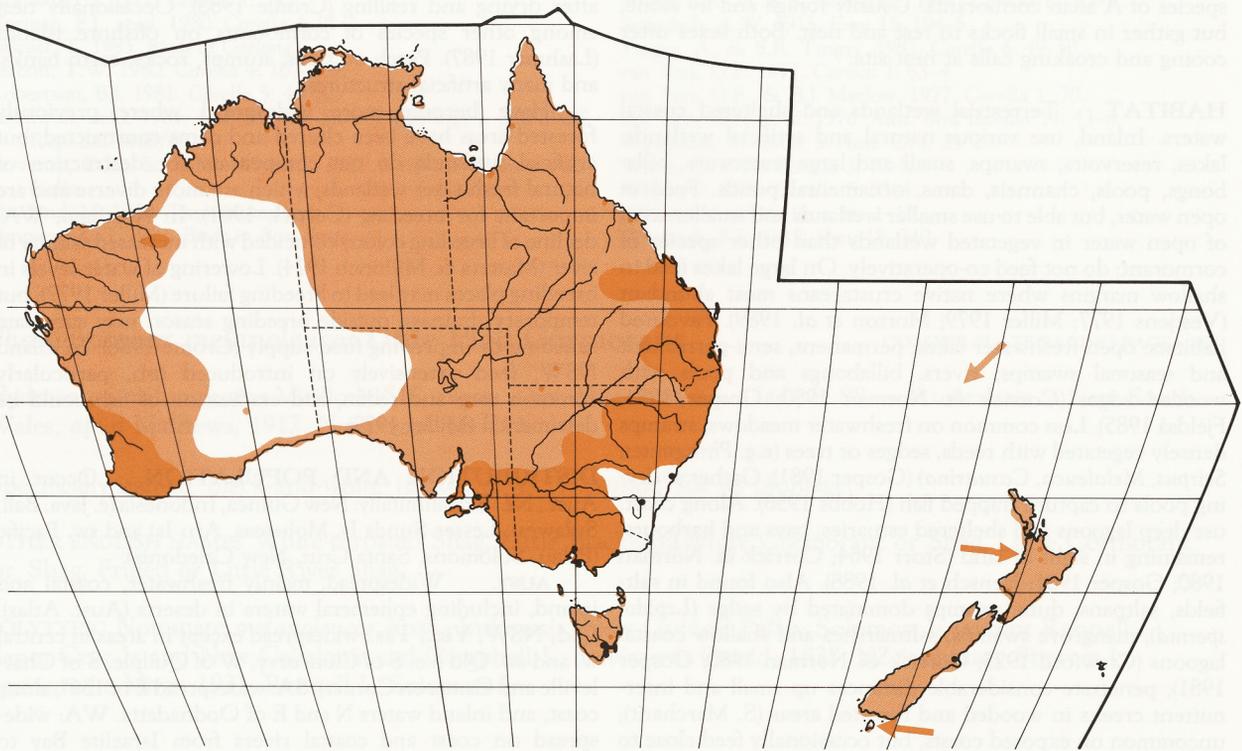
AUST. Widespread, mainly freshwater, coastal and inland, including ephemeral waters in deserts (Aust. Atlas). **Qld, NSW, Vic., Tas.:** widespread except in areas in central w. and sw. **Qld** (i.e. S of Cloncurry, W of Quilpie, S of Charleville and Cameron Corner). **SA:** widespread E of 136°, along coast, and inland waters N and E of Oodnadatta. **WA:** widespread on coast and coastal rivers from Israelite Bay to Kimberleys, generally absent from desert areas unless ephemeral waters present. **NT:** widespread in Top End; scattered on waters in desert areas except Tanami and Simpson Deserts.

NZ Widespread NI, SI and Stewart I. and fringing islands (e.g. Bay of Plenty). Coastal waters and inland rivers and lakes (Oliver; NZ Atlas).

LORD HOWE I. Recorded in small numbers (up to 22) through 1978, 1975 and Aug. 1985 (NSW Bird Reps 1975, 1978, 1985).

NORFOLK I. Vagrant; first recorded, singles, Dec.





1978 (Schodde *et al.* 1983); one, 3 Nov. 1979 (Moore 1981).

CAMPBELL I. Small breeding colony of nominate *melanoleucos* (Bailey & Sorensen 1962; Kinsky 1969).

BREEDING Aust.: probably widespread SE of line roughly from Townsville, Qld, to Adelaide, SA (Murray-Darling Basin; inland lakes in se. Qld, e. NSW, Vic., se. SA) and sw. WA (SW of line from N of Perth to Hopetoun). Few scattered records elsewhere in NT, Qld, SA and WA. There is much scope for further observations and recording of breeding sites.

AUST. Generally, throughout in small (fewer than five nests) to large (500–1000+ nests) colonies; occasionally solitary nesting (e.g. near Julien Bay, WA; Ford *et al.* 1963). Hundreds of colonies recorded in Aust. Atlas and Aust. NRS, numbers varying from year to year with no nesting occurring some years (e.g. Salt Lagoons, SA); most quite small (<100 nests); larger colonies known at Macquarie Marshes (c. 182 nests), Mathoura (500–800 nests) and Shortland (108 nests), NSW; Koondrook (100 nests), Western Port (100–150 nests), R.H. Loyn, Barmah Forest (100–105 nests; R.H. Loyn) and Kulkynne (120 nests, 200 pairs), Vic.; North Block (100 nests) and Salt Lagoons, SA (1966–79, 50–1000+ nests including no nesting at time of visits in 1977–79; Close *et al.* 1982); Yunderup (4000 birds), Binningup (1400 birds), Bunbury (30–710 nests), Carraburmup (300+ pairs; Jaensch *et al.* 1988) and Peel Inlet (100s), WA; Kapalga, Kakadu NP (200+ nests), NT.

NZ Breeding widely but rather sparsely on both islands. Two very doubtful records of empty nests on Snares Is (Warham 1967). Larger colonies include (from CSN unless stated): Hobson Bay (c. 50 pairs); Hamurana, L. Rotorua (mixed colony with Little Black Cormorants, both species: 200 nests; Potts 1977); L. Rotoehu (c. 200 nests; Potts 1977); Rotomahana, Banded Is (mixed colony with Little Black

Cormorants, both species: 600 nests; Potts 1977); Waitarere (80 pairs).

POPULATION Indices of abundance from aerial surveys (transect counts) of wetlands in about 12% of land area of e. Aust., 1983–88, were: 1594; 2228; 1201; 1835; 1206; 196 respectively (Braithwaite 1985a,b, 1986, 1987; Kingsford 1988, 1989). Population in NZ, estimated as 10 000–50 000 (Robertson & Bell 1984).

MOVEMENTS Dispersive with some moving overseas, including NZ (von Boeticher 1937) and New Guinea (Llewellyn 1983). Reporting rate in Vic. shows no seasonal variation (Vic. Atlas) though peaking on lakes in w. Vic. autumn-winter (Missen & Timms 1974), Western Port in winter (R.H. Loyn) and largest numbers occurring Hunter R., Feb.–May and Richmond R., May–Oct. (Gosper 1981). Though numbers on Richmond R. not correlated with fluctuation of water (Gosper *et al.* 1983), numbers in se. Qld during Oct. correlated positively with local rainfall (Woodall 1985) and numbers on lagoon on New England tableland declined with falling water-level and temperature (Gosper 1973; Whyte 1981). In n. Aust. movements may be less extensive with population in Alligator Rs district, NT, showing little seasonal variation that could not be accounted for by local breeding population (Morton *et al.* 1989). NZ birds not recorded outside NZ but no information on local movements.

BANDING Movements of nestlings banded Port Pirie, SA, largely local within Spencer Gulf or to SE as far as Murray R. mouth (Llewellyn 1983) with birds from other sites moving further but with less directional emphasis (van Tets *et al.* 1976; Llewellyn 1983) though some banded se. Vic. recovered in Tas. (Llewellyn 1983). Recoveries of nestlings peaked 2 months after banding with mean distance of recovery 125 km at 2 months, 180 km at 3 months, and 300

km at 6 months. Few recoveries made near banding site during first 10 months but some appear to return to natal colony after that time (Llewellyn 1983).

FOOD Mostly freshwater crayfish and other crustaceans with smaller numbers of fish, particularly carp and perch. **BEHAVIOUR.** Prey caught during succession of brief dives, often in circular or zigzag path (Miller 1979). Average length of dive in coastal NZ: 16 s (13 s in water 1–2 m deep; 22 s in water 3–4 m deep; 726 observations) with 7 s between dives (4–11; 736; Stonehouse 1967); in sw. Aust. in water <1 m deep: 6.8 s (6.0; 30) rests 2.6 s (2.5; 38); in water 1–2 m: 12.5 s (13.4; 279), rests 4.7 s (4.9; 263), rarely diving more than 20 s (Trayler *et al.* 1989). Large prey brought to surface, sometimes tossed in air before swallowing (Batey 1907). Claws of crayfish shaken off before remainder swallowed; fish too large to be swallowed may be dropped ashore (W.J.M. Vestjens). Sometimes swim on surface with only head submerged apparently looking for prey. Usually feed alone, though has been seen feeding cooperatively (Wheeler 1946) in groups of up to 200 (Gosper 1981) that sometimes include Little Black Cormorants (Vic. Atlas) or else small numbers feeding in association with flocks of Little Black Cormorant (Serventy 1939; Carruthers 1968); also sometimes follow feeding egrets *Ardea* (Bolger 1959). Fish may be sighted from air before landing beside water body; then take to water from bank rather than landing on it directly (Barlow & Bock 1984). Fish sometimes captured in turbid water with Secchi disc transparency depths <10cm (Barlow & Bock 1984).

ADULT Summarized Table 1. **AUST.: Ls Brewster and Cargelligo, central NSW** (527 stomachs; analysis by weight; Miller 1979) diet over 40 months mostly crustaceans, freshwater crayfish *Cherax destructor* 43.3% wt, mean length 8.3 cm (0.4 [95%CL]; 2.3–16.0; 242), shrimps *Macrobrachium australiense* 11.6, *Paratya australiensis* 5.1; fish *Gambusia affinis* 1.8, *Retropinna semoni* 0.1, *Carassius auratus* 23.8, 10.9 (0.6; 6.0–15.8; 172), *Tandanus tandanus* 0.3, *Craterocephalus* 0.2, *Ambassis agassizi* 0.1, *Perca fluviatilis* 9.3, 9.5 (1.0; 4.0–14.5; 113), *Hypseleotris* 0.1, *Philypnodon* 2.6; insects: beetles: Belostomatidae, Dytiscidae, Gyridae, Hydrophilidae; molluscs 1.6; amphibians 0.1 (Hylidae, adults and tadpoles). Diet varied seasonally and between lakes according to availability of prey, availability of freshwater crayfish in particular being subject to temperature, turbidity and water-level. *C. destructor* was absent from samples June and July, and shrimps predominantly winter food. Catches smallest in weight, Dec. and Jan.

In Peel-Harvey estuary, sw. Aust. (71 stomachs, 1727 items, identifiable fraction 73.5%; Trayler *et al.* 1989) fish *Hyperlophus vittatus* <0.1% wt., 3% no., 0.4 g, 4.0 cm (3.4–

5.0), *Cnidoglanis macrocephalus* <1.2% wt., 0.2 g, 4.0 cm, Atherinidae 3% no., 0.6 g, 4.4 cm (2.7–7.0) incl. *Atherinosoma elongata* <0.5% wt., *A. spp* 5.2, *Gymnapistes marmoratus* <0.5% wt., *Apogon ruppellii* 10.9% wt., 20% no., 0.6 g, 2.5 cm (1.3–7.0), Gobiidae 0.5 g, 3.6 cm (2.8–6.0) incl. *Arenigobius bifrenatus* 4.5% wt., *Callogobius mucosa* 13.7, 47% no., *Favonigobius lateralis* 8.2, *Glossogobius suppositus* <0.5, *Pseudogobius olorum* 4.5, unident. Gobiidae 3.1; crustaceans shrimps *Palaemonetes australis* 35.2, 24% no., 0.1 g, 2.2 cm (1.5–3.0), *Penaes latisulcatus* 7.6, *Metapenaes dalli* 0.7, other crustaceans 2.6; other food 1.9.

On tropical **Magela floodplain, NT** (ten stomachs, 169 items; Dostine & Morton 1988) fish: 45.6% no., *Neosilurus rendahli* 11.7, 2.4, *N. hyrtlilii* 5.2, 0.6, unident. Plotosidae 4.9, 0.6, *Melanotaenia splendida* 17.3, 7.7, *Pseudomugil tenellus* 0.2, 1.8, *Ambassis agrammus* 8.4, 26.6, *Denariusa bandata* 0.5, 0.6, *Morgunda* 5.0, 2.4, *Oxyleotris nullipora* 1.0, 2.4, unident. fish 0.1, 0.6; but also substantial proportions of frogs: Hylidae *Litoria dahlii* 10.2, 1.8, unident. tadpoles 0.8, 0.6; crustaceans *Cherax quadricarinatus* 15.6, 3.0; sponges Spongilidae 0.7, –; insects 18.3, 49.1: odonotans: Aeschnidae larv. 3.0, 6.0, Anisoptera larv. 0.5, 3.0; bugs Belostomatidae *Diplonychus* 8.6, 39.1; beetles Dytiscidae *Cybister* 3.2, 3.0, ad beetles <0.1, 1.2; plants 0.2, –; 70.5% of prey was 1.5–3.5 cm.

At freshwater sites in NSW (22 stomachs, 160 items; McKeown 1944) diet mostly crustaceans shrimps *Paratya australiensis* 51.9% no., 63.6% freq., *Palaemonetes australis* 9.4, 4.5, *Cherax bicarinatus* 5.6, 36.4 with some fish *Carassius auratus* 6.3, 22.7, 17.6 cm (4.3, 126–201, 3), *Hypseleotris* 21.9, 13.6, unident. 0.6, 4.5 and a few insects; beetles Caraboidea 3.1, 4.5, caddisfly larvae 1.3, 4.5. **From estuarine environments** (25, 164), principally fish *Ambassis jacksoniensis* 49.4, 28.0 with few other fish Sygnathidae 0.6, 4.0, *Centropogon australis* 0.6, 4.0, *Pelates sexlineatus* 9.1, 20.0, *Girella tricuspidata* 1.8, 8.0, *Enoplosus armatus* 0.6, 4.0, Mugilidae 6.1, 4.0, *Neodax* 0.6, 4.0, *Favonigobius obliquus* 11.0, 8.0, *Ostreogobius mophthalmus* 1.8, 4.0, Aluteridae 0.6, 4.0, unident. 0.6, 4.0 with some crustaceans prawns Penaeidae –, 16.0, *Panaeopsis* –, 8.0, shrimps *Macrobrachium intermedium* 9.8, 24.0, unident. –, 8.0 and squid beaks 0.6, 4.0.

In sw. Aust. samples from estuarine localities (86 stomachs, 998 items; Serventy 1938) also contained crustaceans: prawns *Metapenaes monoceros* 6.7% no., 27.9% freq., max. no. per stomach 14, shrimps *Alpheus edwardsii* 0.4, 2.3, 2, *A. sp.* 0.1, 1.2, 1, *Palaemon serenus* 0.1, 1.2, 1, *Palaemonetes australis* 26.1, 32.6, 60, crabs *Amarinus laevis* 0.1, 1.2, 1 and fish: *Gonorynchus greyi* 0.4, 1.2, 1, *Cnidoglanis macrocephalus* 1.0, 7.0, 3, *Atherinomorus endrachtensis* 2.6, 5.8, 11, *Gymnapistes marmoratus* 2.2, 4.7, 9, *Apogon ruppellii* 11.6, 23.3, 16, *Arenigobius bifrenatus* 707, 15.1, 12, *Glossogo-*

Table 1.

HABITAT*	%dry weight		%wet weight			% number						
	1	2	3	4	5	5	6	6	7	7	7	8
	F	E	F	F	E	E	F	F	E	M	F	
FISH	54.2	38.3	48.4	55	29.7	89.6	66.5	19.2	50	75.2	35.4	87.8
CRUSTACEANS	15.6	61.1	46.0	45	65.9	9.8	33.5	80.8	49	24.8	64.6	8.7
NO. SAMPLES	10	527	71	169	22	25	86	15	247	49	14	21

* F = freshwater/inland samples; E = estuarine samples; M = marine samples. (1) Dostine & Morton (1988); (2) Miller (1979); (3) Trayler *et al.* (1989); (4) Potts (1977); (5) McKeown (1944); (6) Serventy (1938); (7) McNally (1957); (8) Baxter (1985).

bius suppositus 30.9, 43.0, 52, *Gobius* 10.0, 5.8, 9, *Scobinichthys granulatus* 0.4, 1.2, 4. Those from **marine environments** (3, 13) contained only fish: *Foetorepus caulauropomus* 7.7, 33.3, 1, *G. marmoratus* 7.7, 33.3, 1, *Apogon* 23.1, 33.3, 3, *Pentapodus milii* 7.7, 33.3, 1, *Odax* 23.1, 33.3, 3, *Gobius* 7.7, 66.7, 2, *S. granulatus* 7.7, 66.7, 2. Those from **freshwater** (15, 47) contained crustaceans: *Cherax quinquecarinatus* 44.7, 46.7, 10, *C. tenuimanus* 34.0, 40.0, 6, *Palaemonetes australis* 2.1, 6.7, 1; with some fish: *T. tandanus* 6.4, 13.3, 2, *P. fluviatilis* 12.8, 20.0, 4.

On **inland waters of Vic.** (247 stomachs, 312+ items; McNally 1957) also largely crustaceans, particularly *Cherax destructor* 40.7+ % no., 52.6% freq. and *Paratya australis* 8.3, 10.5 with smaller nos. of fish: *Retropinna semoni* 1.6% freq., *Galaxias* 2.0, 9 cm mean length (max. per bird 30+), *Carassius* 6.1% no., 5.3% freq., 8.4 cm (5–12, n=7, max. per bird 6), *Perca fluviatilis* 21.2, 8.1, 8.2 cm (5–14, 39, 14), amphibians (ad. frogs and tadpoles) 13.1 no., 5.3 freq. and aquatic insects 0.2 freq. In same study, samples from **estuarine waters** (49, 105+) crustaceans 24.8 no., 38.8 freq. and fish: *Gymnapistes marmoratus* 5.7, 8.2, 10 cm (1, 2), Atherinidae 13.3, 6.1, Gobiidae 45.7, 30.6. Those from **marine environments** (14, 48+ items) crustaceans 64.6, 57.1, fish Clupeidae 4.2, 14.3, Gobiidae 18.8, 42.9. Also recorded were *Salmo* 18.5 cm (14–23, 2, 1), *Tandanus tandanus* 15.5 cm (15–16, 2, 2), *Macquaria ambigua* (1 fish 4 cm), *Acanthopagrus butcheri* 5.6 cm (4–7.5, 5, 10).

Further samples from **inland Vic.** (21 stomachs, 229 items; Baxter 1985) contained mostly fish 87.8% no., 66.7% freq. (Galaxiidae 48.5, 42.9, *Cyprinus auratus* 27.1, 4.8, *Nannoperca australis* 1.3, 4.8, *Perca fluviatilis* 13.5, 47.6, Gobiidae 0.9, 4.8, fish eggs -, 4.8) with the remainder crustaceans 8.7, 57.1 (Parastacidae).

At **Tinaroo Dam, n. Qld** (29 stomachs; Lavery & Haysom 1963), birds contained mostly fish (30 identified). *Leioptherapon bicolor* 6.7% no., *Glossamia aprion* 56.7, *Oxyeleotris lineolatus* 36.7; and crustaceans: Palaemonidae incl. *Macrobrachium*; also gastropod molluscs and insects, grasshoppers Acrididae; 82.8% of birds contained bark or sticks.

In **coastal SA** (five stomachs, 13 items; Morgan 1917; White 1917) fish *Neodax baltaetus* 23% no., 40% freq., unident. fish 15, 40, small brown crabs 62, 20. At **L. Cowal, NSW** (23; Vestjens 1977) fish 30.4% freq. (*Gambusia affinis*, *Carassius auratus*, *Perca fluviatilis*, *Philypnodon*), molluscs 4.3 (freshwater snails), crustaceans (shrimps 17.4, freshwater crayfish 73.9), spiders 17.4, insects (dragonfly nymphs 13.0, crickets 4.3, bugs 8.7, water bugs 17.4, ground beetles 17.4, water beetle ads. 56.5, larv. 13.0, click beetles 13.0, tenebrio beetles 13.0, weevils 8.7, ants 21.7).

NZ. At **Ls Rotorua and Rotoehu** (169; Potts 1977) fish: Retropinnidae 16% wt., 32% no., 25% freq., Galaxiidae <1, <1, <1, *Carassius auratus* 24, 21, 21, bully 15, 33, 38, crustaceans: freshwater crayfish 45, 14, 25; frogs *Litoria raniformis* <1, <1, 2.

In **NZ** (56 stomachs, 2867 items; Dickinson 1951) fish 61% freq. incl. *Gobiomorphus* 9.4% no., 41% freq., 2–9 cm, *Carassius* 0.2, 7, 3–18 cm, with frogs 0.1, 4, 5 cm, molluscs (probably from fish stomachs) bivalves *Corneocyclas* 0.3, 5, 0.3 cm, gastropods *Lymnaea* 0.1, 4, 0.6–0.8 cm, *Potamopyrgus* 40.6, 45, 0.1–0.6 cm, crustaceans freshwater crayfish *Paranephrops* 5.9, 64, 3–10 cm, insects odonatan 0.1, 4, 2 cm, flies Chironomidae larv. <0.1, 2, 1 cm. At another site (10; Falla 1932) fish 50% freq., crustaceans 50 (ten freshwater crayfish

one stomach).

Other records: fish *Anguilla* (Buller 1888; Stidolph 1939), *Nematolosa* (Carruthers 1968), *Carassius* (North), *Odax*, Gobiidae; crustaceans: prawns (North); insects: beetles Dytiscidae (Gray 1938). Further information on diet available in Barker & Vestjens (1989).

NESTLING Generally similar to adult (10–20 chicks sampled/month for two seasons; Miller 1979), with most prey of similar size. However generally fewer and, in one month, significantly smaller, freshwater crayfish and, in one year, higher proportion of shrimp in nestling diet.

INTAKE Mean weight stomach contents, sw. Aust., 24.3 g (n=71 stomachs; Trayler *et al.* 1989).

SOCIAL ORGANIZATION Little known; based mainly on information supplied by G.F. Van Tets. Solitary (Hobbs 1961), but congregate for nesting and sometimes in small flocks for roosting and feeding. Dispersive, few birds remain near natal colony during first 10 months of independence, some appear to return after that; dispersal from inland breeding areas considerable, dispersal much less in coastal breeding areas (Llewellyn 1983). Can form flocks of hundreds of birds (Aust. Atlas), but in sw. NSW seldom form flocks of more than dozen birds (Hobbs 1961). Often in company of Little Black Cormorants (Miller 1979; Vic. Atlas); sometimes small numbers feeding in association with them. Often feed alone (Campbell; Miller 1979; Aust. Atlas) and rarely form feeding flocks, but may congregate where food plentiful in flocks of hundreds, e.g. 190 at Kooragang I., Mar. 1971 (Gosper 1981). In NZ, solitary or semi-gregarious feeders (Potts 1977).

BONDS Probably sustained monogamous, but no systematic information from banded birds. In Aust., courtship and pair-formation recorded Sept. (Harley 1946). In NZ, most birds find mate and begin nesting soon after joining colony and leave colony when young have fledged; pairs established and start nest-building about Aug., but others can join colony and begin nesting in Dec. or Jan.; no immatures and few unattached birds observed within colony (Taylor 1987). Both parents incubate and tend young (Taylor 1987), until contact lost a few weeks after fledging.

BREEDING DISPERSION Colonial, rarely nest singly. Colonies often mixed with Little Black Cormorants and tree-nesting waterbirds such as other cormorants, herons, darters, spoonbills and ibises (Campbell; Vestjens 1977; G.F. van Tets). Pied Cormorants nesting in same tree may cause decline in number of Little Pied Cormorants trying to nest (Taylor 1987). Usually breed in freshwater swamps, lakes and along rivers (Campbell; Vestjens 1977). Solitary nesting recorded near Julien Bay, WA (Ford *et al.* 1963). Colonies usually small. At L. Cowal, NSW, colonies of 4–135 nests (Vestjens 1977), but at least 300 pairs reported in colony at Carraburmp, WA (Jaensch *et al.* 1988) and more than 1000 nests at Salt Lagoons, SA (Close *et al.* 1982; see Distribution). Asynchrony of laying between colonies; Miller (1980) found synchronic subunits within colonies similar to that described for Little Black Cormorant. No quantified data on density of colonies: 7–8 pairs in *Melaleuca* tree; 15–20 nests in group of trees with 3–4 nests/tree; c. 100 nests in one small eucalyptus tree (Campbell); hundreds of nests reported in one tree (HASB); 11 nests in one tree (Harley 1946). In NZ, 14 nests in one tree (Goodwin 1956); nests sometimes no more than 1 m apart, but neighbours tolerate one another; may reuse nest (Taylor 1987). Territorial, only nest site defended.

ROOSTING Solitary or communal roosts, often with Little Black Cormorant, in trees and bushes, and on wires, rocks and stumps near water. During breeding also roost on nests (Gosper 1981). In NZ, recorded roosting with Great, Little Black and Pied Cormorants (Goodwin 1956; Potts 1977); roost at Clevedon averaged 100 birds during Apr. (Moisley 1960); roost in hundreds in trees overhanging water at L. Rotorua (Potts 1977). Daytime roosts usually characterized by fewer birds and more varied sites; will often rest at several such sites during course of day's feeding; after feeding bout, fly to roost and stand for up to 1.5 h before returning to feed (Potts 1977). After feeding, birds arrive at night-time roosts in late afternoon or at dusk and leave at dawn or just after (Potts 1977). No systematic information on times of arrival and departure at roosts.

SOCIAL BEHAVIOUR In Aust. based mainly on Harley (1946) and information supplied by G.F. van Tets; in NZ, Matthews & Fordham (1986) and Taylor (1987). Displays easy to observe except in densely vegetated sites, though care needed not to disturb displaying birds. Early in season birds take flight, later do not leave nest (Taylor 1987). Flocks integrated only during group-flights. Adults in colony usually silent (Matthews & Fordham 1986). In NZ, forehead crest erect when bird sitting, and sleeked when standing beside nest; also droop wings exposing back, whereas bird beside nest folds wings well up.

AGONISTIC BEHAVIOUR Individual distance just out of pecking reach of other birds. **THREAT** display varies in intensity: during **Low-intensity Threat** bill pointed at opponent; in **Medium-intensity**, head pointed towards opponent and head moved back and forwards in median plane; at **High Intensity**, crest raised fully, tail lifted and wings may be partially raised; bill thrust repeatedly at intruder, widely open at forward limit of each thrust. **FIGHTING**. Birds spread wings, peck at opponent's bill and attempt to grab hold of each others wings. Very rarely seen. In **APPEASEMENT DISPLAYS**, bill directed away from aggressor. Appear to be less aggressive than Little Black and Great Cormorants. **Alarm**. In Aust., threatening includes croaking sounds, also used as alarm calls; in NZ, alarm calls made by adult in response to aerial predator such as Marsh Harrier *Circus approximans* or Kelp Gull *Larus dominicanus*. First adult to see predator utters loud *coo*; calling spreads through whole colony within 1 or 2 s; only given when chicks present. Goodwin (1956) describes alarm call as low croak. No other overt anti-predator behaviour. Adults in colony generally fly off silently (Matthews & Fordham 1986).

SEXUAL BEHAVIOUR **ADVERTISING** by male consists of Wing-crouching (=Squat-thrust of Matthews & Fordham [1986]) and Bowing (=Bow-gape of Matthews & Fordham [1986]). Taylor (1987) recorded Wing-crouching less often than Bowing. **Wing-crouching** (*melanoleucos*; Fig. 1a,b): bird starts by standing with body upright and raising closed wings out from, and slightly above, body, by humeral rotation; bird then squats in horizontal sitting position for one second, then stands, returning to upright position and lowering wings. In sitting (squatting) position, head and bill held horizontally. During display, bill closed, forehead crest raised, and body-feathers ruffled and moved up and down; tail raised 30–45° above horizontal. Display performed repeatedly and no sound made. In NZ (*brevirostris*; Fig. 4a,b), starts with body erect and folded wings held slightly away from body. Body then lowered to near sitting position and head held vertically

Fig. 1
Wing-crouching,
Aust.

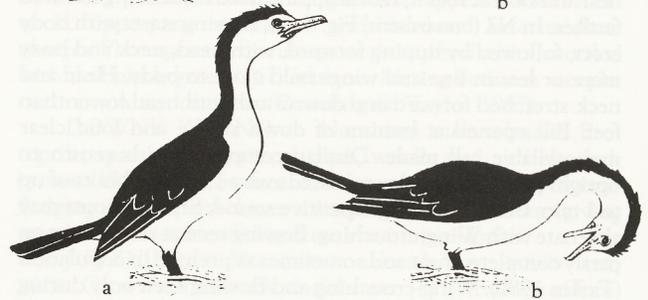
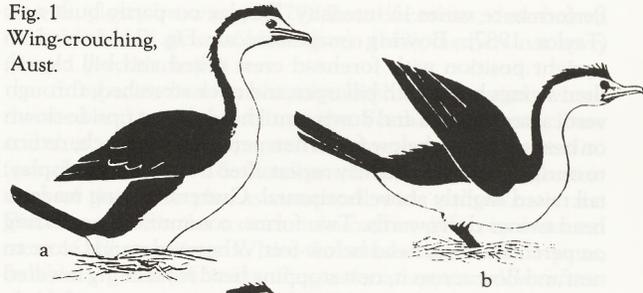


Fig. 2 Bowing, Aust.

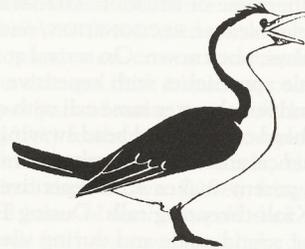


Fig. 3

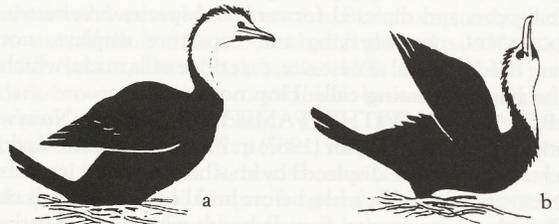


Fig. 4 Wing-crouching, NZ

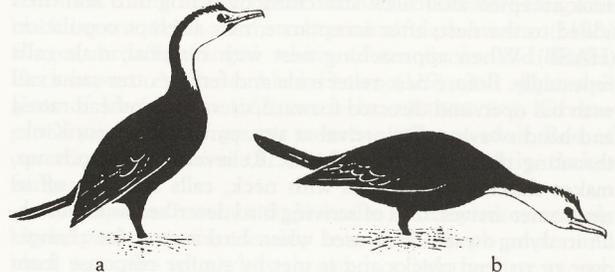


Fig. 5 Bowing, NZ

with bill pointing upwards. On upward movement, bird thrusts up, wings extend farther from body, forehead crest raised and feathers, ruffled, particularly at side of head; chest expanded and a bisyllabic call uttered. Display completed by return to upright position. Wings raised only once per display (Matthews & Fordham 1986). Performs once or twice, at irregular intervals or for some minutes, at rate of 2–3/min.

Performance varies in intensity. Display on partly built nest (Taylor 1987). **Bowing** (*melanoleucos*; Fig. 2a,b): bird in upright position with forehead crest raised and bill closed; then swings head, with bill open and neck stretched, through vertical arc forward and down, until head almost upside-down on nest surface or below feet when perched on branch; return to upright position and may repeat after 2–3 s. During display, tail raised slightly above horizontal. Guttural cooing made as head swings downwards. Two forms: commonest is standing on perch and Bow head below feet; otherwise stands close to nest and Bow across it, nest stopping head from being lowered farther. In NZ (*brevirostris*; Fig. 5a,b), Bowing starts with body erect, followed by tipping forward, with head, neck and body more or less in line and wings held close to body. Head and neck stretched forward and downward until head lower than feet. Bill opened at bottom of down stroke and loud clear monosyllabic call made. Display completed with return to upright position. Display repeated every 1.5–2 s in bouts of up to 1 min, thus producing repetitive sound. Shorter bouts may alternate with Wing-crouching. Bowing seen at nest-site or on partly completed nest and sometimes as prelude to copulation (Taylor 1987). Wing-crouching and Bowing seen only during earliest stages of courtship; distinctive call accompanying Bowing heard at no other time or situation. OTHER DISPLAYS AT SITE. Subspecies *melanoleucos*: RECOGNITION, nest-worrying and departure displays, not known. On arrival at nest-site with nest material, male approaches with repetitive call. Before nest-relief, male and female utter same call with open bill directed forward, forehead crest up and head swaying (Fig. 3). Later in breeding sequence, and especially when coming in to feed chicks, arriving parent makes soft repetitive sound, which appears to be **Kink-throating** calls. During **Pre-hop**, harsh repetitive cooing sound made and during silent **Post-hop** posture, head held up and slightly forward, throat bulged and bill open and directed forward. Subspecies *brevirostris*: RECOGNITION, nest-worrying and departure displays, not known. Before arrival at nest-site, repetitive calls made, which may be **Kink-throating** calls. **Hop** not known.

RELATIONS WITHIN FAMILY GROUP No systematic observations. Taylor (1987) in 7% of nesting attempts, found that birds were displaced by another pair early in nesting. Nest-site selected by male; before building begins, birds sit side-by-side at chosen site. Female builds with material gathered by male; once eggs laid, both parents bring material. Each stick accepted after neck stretching by sitting bird and then added to the nest; after acceptance, may attempt copulation (HASB). When approaching nest with material, male calls repeatedly. Before nest-relief male and female utter same call with bill open and directed forward, crest on forehead raised and head swaying. On arrival at site, parents perform **Kink-throating** display to feed chicks. Relieved bird stands up, makes shaking movements with neck, calls and flies off as newcomer arrives. Call of arriving bird described as *uh-uh-uh-uh* in dying-away series, used when bird arrives for change-over or to feed chicks and is met by similar response from mate (Taylor 1987). No detailed study on parental care and feeding, and communications in young. Birds incubate with webbed feet. For 2–3 days after hatching, chicks feed on liquid from tip of adult's lower mandible. When older, feed on bits of pre-digested food, from parent's throat by putting their heads inside parent's bill. Fledgelings can swim, dive and hop before they can fly well (Harley 1946). Feathered and partly feathered young liable to plunge out of nests if disturbed, dive and disappear (North). If parents give alarm call, chicks fall

silent and huddle at bottom of nest (Matthews & Fordham 1986).

VOICE No detailed studies; reasonably well known from behavioural studies in NZ (Matthews & Fordham 1986; Taylor 1987) and observations in Aust. (Harley 1946; G.F. van Tets). Generally silent, even at breeding colonies (Matthews & Fordham 1986); very small range of cooing and clicking calls with slight variations. Call mostly during breeding season but also reported to utter cooing *keh-keh-keh* at evening roosts when landing and moving about in trees (Moisley 1960). Appear to be no differences in calls between sexes (G.F. van Tets). No information on individual differences.

ADULT Threaten silently. **Alarm Call**. In Aust., croaking sounds used to warn chicks. In NZ, loud repeated *coo-coo-coo* . . . given but only when chicks in nest; initiated by first bird to see threat (e.g. Marsh Harrier or Kelp Gull), spreading rapidly through colony within 1–2 s. **Wing-crouching Call**. Silent in Aust.; in NZ, two-syllable *uh-aah* or *ow-aah*, uttered repeatedly during display (Matthews & Fordham 1986; Taylor 1987). **Bowing Call**. In Aust., guttural cooing *oo-oo* or *oo-oo-oo* with two or three unevenly spaced syllables; uttered when head swings downwards. In NZ, loud clear one syllable call made with bill open at bottom of downward stroke; repeated at 1.5–2 s intervals in bouts lasting more than 1 min (Matthews & Fordham 1986). **Greeting Call**. In Aust., when arriving with nest material, male makes repetitive *uck-uck-uck* . . .; also used by both sexes at change-over (G.F. van Tets). Later in season, and especially when arriving at nest to feed young, adult makes soft repetitive *uk-uk-uk* . . . call, which appears to be **Kink-throating Call**. In NZ, series of short harsh *aark-aark-aark* (Matthews & Fordham 1986) or *uh-uh-uh-uh* . . . (Taylor 1987); may be **Kink-throating Call**. **Pre-hop Call**. In Aust., harsh repeated cooing *oo-oo-oo* . . .

YOUNG No information.

BREEDING Poorly known. No detailed studies. Information supplied by G.F. van Tets. Colonial nesting often in company with other cormorants, herons, spoonbills, ibises; usually in freshwater swamps, lakes and along rivers; seldom on coast but solitary nesting recorded near Julien Bay, WA (Ford *et al.* 1963). At L. Cowal, NSW, colonies of 4–135 nests (Vestjens 1977), and c. 100 nests in one tree (Campbell).

SEASON Not properly known. Nesting more commonly reported Oct.–Nov., but records for May in SA (North), Aug. in Vic. (Aust. NRS); Aug.–Nov. usual (Campbell). At L. Cowal, Sept.–Mar. (Vestjens 1977). Claimed spring–summer breeding in s. Aust., probably continuous throughout year if conditions favourable, and late autumn–winter in n. Aust. (HASB).

SITE In forks, stems and branches of trees (*Melaleuca*, *Casuarina*, *Eucalyptus*, mangroves), on bushes, lignum, snags, in swamps, lakes and along rivers; sometimes over dry land; on mooring spike and disused jetty in Tas. (Aust. NRS). Average height above water: 2.8 m (2.97; 0.6–23.0; 79) (Aust. NRS).

NEST, MATERIALS Platform with shallow cup of sticks or bark alone (Campbell), lined with leaves; 30–40 cm across outside, c. 17 cm across inside, 6 cm in depth (North; Campbell) but no systematic measurements. Building routine probably as in other species of cormorant; no systematic observations.

EGGS Elliptical, pointed at one or both ends; mat, rough texture; pale bluish with white chalky coating.

MEASUREMENTS: *P.m. melanoleucos*

47.8 (1.9; 44.5–49.0; 6) x 30.8 (0.3; 30.5–31.0) (Aust. NRS)

48 (44–50; 23) x 32 (30–34) (North)

48 (45–52; 51) x 32 (31–34) (Schönwetter 1967)

46 (36–52; 46) x 31 (27–33) (HASB)

47 (45–51; 29) x 32 (29–33) (Vestjens 1977)

P.m. brevirostris

49 (46–55; 14) x 32 (29–34) (Schönwetter 1967)

WEIGHTS: 23 (20–27; 14) (W.J.M. Vestjens);

36.3 (36–37; 3) (Aust. NRS).

CLUTCH-SIZE Vestjens (1977) gives four (n=208); Aust. NRS gives four (1–6; 24). Variously said to be 3–5 (Campbell; North) with 6–7 occasional (North) but few quantified data. No information on replacement laying, second clutches.

LAYING No information.

INCUBATION No information.

NESTLING Altricial, nidicolous; hatched naked; skin, black; throat-patch, red; becomes covered in black down. Fed by incomplete regurgitation. Feathered and partly feathered young liable to plunge out of nests if disturbed, dive and disappear (North). No information on growth, parental care, fledging to maturity.

SUCCESS From Aust. NRS, where clutch-size and outcome known: from 24 eggs, 14 hatched; from two nests in a colony, eight eggs laid, seven young hatched and six fledged. PREDATION. 'Crows' *Corvus* spp and Whistling Kites *Haliaeetus spheurnus* reported to take eggs (Aust. NRS).

PLUMAGES

ADULT *P.m. melanoleucos*. Age at first breeding unknown. Adult plumage attained late in first year (G.F. van Tets & W.J.M. Vestjens, observations on captive birds). HEAD AND NECK. Narrow anterior margin of forehead, and from crown to base of hindneck, dull glossy black-green (162). Short white filoplumes on crown and hindneck. Lores, mostly bare; covered in minute white papillae. Throat and side of head to lower foreneck, white; narrow strip of white feathers above eye tapers to base of bill as narrow supercilium. Gular pouch, bare; feathers on throat extend on to basal quarter of gular pouch in inverted V. Demarcation of white foreneck and dark hindneck above ear-coverts. 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); fringes narrower on upper mantle; concealed bases of feathers, pale dark-brown (121). Fringes 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); basal inner web, dark brown (121); rachis, grey-black (82). UPPERWING. Marginal coverts, black-brown (119). Most other coverts, including alula, dark grey (83), fringed grey-black (82); greater primary coverts, edged grey-black (82) on outer web. Remiges, black-brown (119); basal inner webs, dark brown (121). Tertials, faintly edged grey-black (82) on outer web; grey-black (82) edge on outer web of humerals more obvious. UNDERPARTS, mostly white. Long lateral breast-feathers, moderately long; beneath these on outer flanks, small concealed patch of dark brown (121) semiplumes. Outer flanks, concealed beneath wing, dull glossy black-green (162). Tibio-tarsal feathers, moderately long and white; 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).

Subspecies *brevirostris* polymorphic, with pied, white-throated and intermediate morphs. Feathers, elongate, loose and thin on crown, nape and ear-coverts; can be erected to form frill (Matthews & Fordham 1986). Plumage characteristics of these morphs, as compared with *melanoleucos* are: **Pied morph**. Similar to *melanoleucos* but differs in measurement of bill and wings. **White-throated morph**. Underparts, dull black-green (162) extending as far as upper or lower foreneck; upperparts similar to *melanoleucos*. **Intermediate morph**. Plumage varies; underparts most often white, mottled with dull black-green (162) feathers. Mating between morphs occurs non-assortatively (Dowding & Taylor 1987).

DOWNY YOUNG Nominate *melanoleucos*. Protoptile, sparse. Mesoptile, thicker, woolly and entirely dark brown (121); down on face and throat, sparse. As birds near fledging, underparts have scattered white feathers, giving mottled appearance. Subspecies *brevirostris* similar.

JUVENILE Nominate *melanoleucos*. HEAD AND NECK. Crown to hindneck, dark brown (121); feathers of forehead, narrowly tipped dull white; tips merge to black-brown (119) at hindcrown. No white supercilium. Ear-coverts, dark brown (119A) with scattered white feathers. Numerous short white filoplumes on crown and hindneck. Demarcation of light foreneck and dark hindneck occurs below eye, in line with upper part of malar region. At base of foreneck, dark-brown (119A) feathers form incomplete collar; rest of foreneck, white. UPPERPARTS. Mantle, black-brown (119) with subterminal dark-brown (119A) fringe, fringed dull-white; concealed bases of feathers, pale dark-brown (121). In some lights, some feathers may show slight dull gloss of black-green (162). Fringes on mantle become progressively broader from upper to lower and outer margins. Back, rump and upper tail-coverts, black-brown (119) with dull gloss of pale black-green (162). Subscapulars, black-brown (119); feathers have pointed dark-brown (119A) tips. TAIL, black-brown (119), tipped dull white; rachis, grey-black (82). UPPERWING. Remiges, black-brown (119), with pointed dark-brown (119A) tips. All coverts, including alula, black-brown (119), with subterminal dark-brown (119A) fringes, fringed dull white. UNDERPARTS, mostly all white. Feathers of upper breast have concealed light grey-brown (119C) shaft-streaks, disappearing at lower abdomen. Long lateral breast-feathers moderately long and black-brown (119), with subterminal dark-brown (119A) fringes, broadly fringed white. Outer flanks and thighs, black-brown. Axillaries black-brown (119) with slight dull gloss of black-green (162) on webs. UNDERWING. Greater primary coverts and greater coverts, similar to adult. Rest of coverts, black-brown (119) with narrow slightly darker fringes.

Subspecies *brevirostris*. Juveniles either pied or entirely black; pied juveniles develop into pied-morph adults and black juveniles into white-throated or intermediate morph adults (Dowding & Taylor 1987). **Pied morph**. Similar to juvenile *melanoleucos*. **White-throated, Intermediate morphs**. Juveniles, black; upperparts, similar to *melanoleucos* with underparts entirely dark brown (119A).

IMMATURE L alas (1983) states that immature plumage identifiable in development from black juvenile to white-throated adult; chin and throat white, extending on to malar region, level with eye.

ABERRANT PLUMAGES Underparts prone to

ferrous-oxide staining (e.g. Keast & D'Ombrian 1949). In NZ, bird observed with white head, neck, breast, belly and upper wing-coverts and broken white on upper tail-coverts and rump; another, similar but with two black 'shafts' from back to each side of base of neck; a third had whitish head with thin dark strip from forecrown to centre of back and underparts entirely dirty-yellow (Moisley 1960).

BARE PARTS Based on live birds and photos in NZRD, Lindsey (1986) and unpublished (R. O'Brien), except where stated. Subspecies *melanoleucos* and *brevirostris* similar.

ADULT BREEDING Iris, black-brown (119) or grey-brown; grey-hazel and dark grey-brown also recorded (Morris 1978). Loral skin and eye-ring, dark brown (119A). Gular pouch, orange-buff (118). Palate, light blue (168C). Bill, orange-buff (118), suffused grey-olive (43) to olive-green (150), particularly on lower mandible; culmen, black-brown (119). Legs and feet, grey-black (82).

ADULT NON-BREEDING Colours less intense than in adult breeding.

NAKED YOUNG Bare parts from live birds, except where stated: Crown, sphincter-pink (6). Skin above eye, brown-grey (80). Narrow black-brown (119) eye-stripe extends from bill, broadening and becoming diffuse at ear-coverts. Iris, black-brown (119); grey-brown (Wood-Jones *et al.* 1938). Narrow band at gular pouch, pink (3 or 7). Base of latericorns, pale pink (7); extends distally on upper mandible for one-quarter of length; on lower mandible extends three-quarters of bill length; rest of bill, grey-black (82); small diagonal grey-black (82) mark near base of lower mandible. Egg-tooth, white. Legs and feet, dark grey (83); webs, brown-grey (79) or buff (123D).

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

JUVENILE Iris, grey-brown. Gular pouch, dull yellow. Loral skin, dark brown. Upper mandible, dark brown; lower mandible, dull yellow. At L. Cowal, bill, black with base of lower mandible, red (W.J.M. Vestjens & G.F. van Tets). Bill becomes yellower when nearly adult (Keast & D'Ombrian 1949; Lalas 1983).

MOULTS No definite period of moult can be ascribed; breeding season protracted. Based on skins at MV and SAM.

ADULT Complete; primaries moult outwards in staffelmauser. Duration of moult undescribed. Tail moults irregularly, at same time as wing-moult.

POST-JUVENILE, SUBSEQUENT MOULTS Undescribed.

MEASUREMENTS Nominate *melanoleucos*. (1) Aust., adults, skins (MV, ANWC, SAM, QVM, QM, AM). (2) NSW, fresh (W.J.M. Vestjens & G.F. van Tets).

	MALES	FEMALES
WING	(1) 234.6 (5.55; 226-244; 22)	228.8 (7.85; 215-242; 26) *
	(2) 235 (8; 219-246; 14)	227 (6; 215-238; 19)
BILL	(1) 30.2 (1.15; 28.3-33; 22)	30.4 (1.91; 26-34.4; 27)
	(2) 32 (2; 29-36; 11)	31 (2; 26-33; 21)
TARSUS	(1) 38.6 (1.50; 34.3-40.9; 19)	37.8 (1.36; 33-39.9; 21)
	(2) 40 (1; 36-42; 12)	40 (3; 37-50; 15)

TAIL	(1) 151.2 (6.77; 141-167; 23)	149.4 (8.05; 140-167; 27)
	(2) 163 (13; 150-178; 4)	152 (5; 145-165; 11)
TOE	(1) 58.3 (2.75; 50-63.7; 23)	57.4 (2.47; 50.3-61.2; 26)

Additional measurements of *melanoleucos* in HASB. Subspecies *brevirostris*. (1) Falla (1932); methods unknown. (2) Adults, skins (NMNZ). (3) Skins (AWMM, CM, OM, AM; G.F. van Tets).

	MALES	FEMALES
WING	(1) 233.6 (4.92; 228-240; 3)	228.5 (4.62; 223-235; 7)
	(2) 237.1 (6.11; 228-245; 8)	223.8 (3.31; 220-229; 5) *
	(3) 232 (7; 221-246; 13)	225 (6; 214-239; 28)
BILL	(1) 30.6 (1.02; 29.5-32; 3)	29.7 (0.45; 29-30.5; 7)
	(2) 31.6 (1.04; 29.8-33; 7)	29.9 (1.58; 27.4-32.4; 5) *
	(3) 30 (2; 26-33; 13)	30 (2; 27-33; 28)
TARSUS	(1) 36.3 (0.47; 36-37; 3)	35.5 (0.46; 35-36; 7)
	(2) 41.9 (3.00; 36.7-46.4; 8)	40.4 (1.40; 39-42.8; 5)
	(3) 40 (2; 35-42; 13)	39 (2; 36-45; 26)
TAIL	(1) 157.3 (6.59; 150-166; 3)	153.5 (5.62; 143-162; 7)
	(2) 156.5 (4.09; 152-165; 8)	152.8 (1.83; 151-155; 5) *
	(3) 150 (12; 131-164; 13)	145 (7; 133-153; 28)
TOE	(2) 58.8 (2.46; 55.4-62.1; 7)	54.8 (2.11; 51.7-57; 5) *

WEIGHTS Nominate *melanoleucos*: adults, label data, skins (ANWC, SAM, MV): males 659 (143; 487-825; 4); females 660 (106; 500-830; 6). NSW, fresh (W.J.M. Vestjens; G.F. van Tets): males 800 (100; 700-900; 17); females 700 (100; 400-900; 30). Morris (1978) gives range 425-830 g. Details of seasonal changes of weight and additional weights in Serventy (1939).

P.m. brevirostris: label data from adult skins at NMNZ: males 796 (48.8; 715-877; 6); females 586 (105; 413-704; 5); males significantly heavier ($P < 0.05$).

STRUCTURE Wing, long and broad. Eleven primaries: p8 usually longest, p10 4-10 mm shorter, p9 0-5, p7 1-2, p6 5-13, p5 24-29, p4 34-47, p3 44-56, p2 52-68, p1 59-63, p11 minute. P10-8 emarginated on inner web; p9-8 on outer web. Tips of remiges, pointed in juveniles, rounded in adults. Tail, wedge-shaped; 12 rectrices, t1 longest, t6 22-60 mm shorter. Bill, short; maxillary unguis hooked at tip. Upper mandible gently curves to gape. At base of upper mandible, some 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. Feet, totipalmate. Outer toe c. 129% of middle, inner c. 70%, hind c. 47%.

RECOGNITION In Aust., naked and downy young of *melanoleucos* and Little Black Cormorant may present some confusion, as birds nest in same trees; *melanoleucos* distinguished by having orange, or rusty-brown, crown (blue or pale bluish in Little Black Cormorant) (HASB; Lane 1988). In NZ, black juvenile *brevirostris* may be confused with adult Little Black Cormorant; latter distinguished by having longer and more slender bill (Taylor 1987). Adult and juvenile pied morph *brevirostris* distinguished from adult *melanoleucos* also on bill-length. Downy young have white spot on black down on side of upper neck in *melanoleucos*, not present in *brevirostris* (G.F. van Tets).

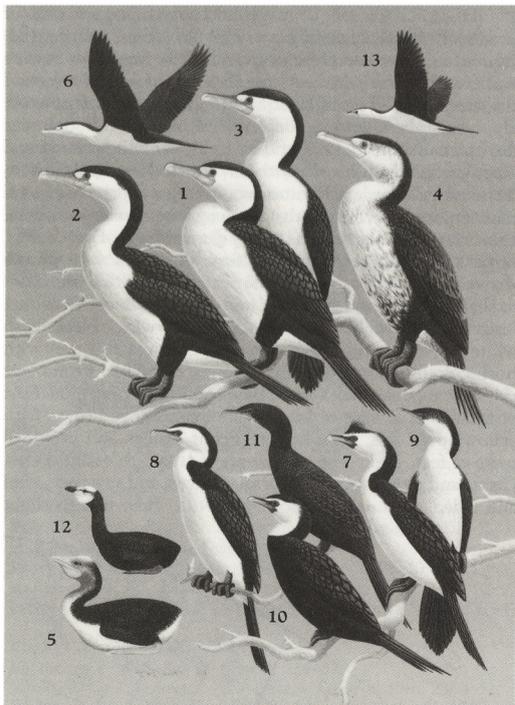
GEOGRAPHICAL VARIATION Three subspecies

recognized: *melanoleucos*, *brevirostris* and *brevicauda*. Subspecific differences based on plumages and, supposedly, measurements of bill and wing (Amadon 1942; *q.v.* for details). Subspecies *brevirostris*, polymorphic, with pied, white-throated and intermediate morphs (see Plumages). Mating between these morphs occurs non-assortatively (Dowding & Taylor 1987). Phenotypes illustrated from such matings in Lalas (1983). Frequencies of morphs show N-S gradient, with dark birds more common in S; climate appears to contribute to clinal polymorphism (Dowding & Taylor 1987). Polymorphism due to one way gene-flow from Aust. suggested by von Boeticher (1937) but doubted by Serventy (1939). For discussion of genetics of polymorphism see Dowding & Taylor (1987), Galbreath (1989) and Dowding (1989). According to G.F. van Tets, *brevirostris* sufficiently distinct morphologically and behaviourally to be regarded again as distinct species.

RMO

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Volume 1 (Part B), Plate 61

Pied Cormorant *Phalacrocorax varius*

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

Little Pied Cormorant *Phalacrocorax melanoleucos*

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

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