

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 PELECANIDAE pelicans

Very large aquatic birds on marine and inland waters. On all continents except Antarctica. Absent from polar regions, oceanic islands and inland and e. coast of South America. One (or two) genera with seven species, one species breeding in our region. Six species of white pelicans: one in North and Middle America and five in the Old World, now that *crispus* and *phillipensis* are regarded as separate species because their breeding ranges overlap and because, like other species, the colour-pattern of their throats differ at the onset of breeding. The brown pelicans of North, Middle and nw. South America *P. occidentalis*, are sometimes placed in the sub-genus *Leptopelicanus* (sic) and have been separated variously into two species or into 3-5 subspecies depending on size and colour-patterns of plumage and gular pouch (Wetmore 1945; Harrison 1983). Very long bill with terminal hook and huge gular pouch. Males are larger with longer bills than females. Rami of lower bill very slender and flexible; muscles of

tongue bend mandibular rami to form pouch into basket for catching fish or rain-water (Vestjens 1970). Long neck; huge body; large broad wings; short round broad tail with 20–24 rectrices; short stout legs with large feet. Look heavy but really quite light because there are air pockets in skeleton and under skin. Built for soaring and float high on water. Travel by gliding from one thermal to another and in V-formation. Feed mainly co-operatively in lines of one to three birds deep, beating wings on water, driving and surrounding prey in shallow water and then, in synchrony, dipping their heads and scooping up food. Large fish grabbed with tip of bill, tossed in the air and then slid head first into the gullet. Brown pelicans forage only in marine waters and plunge-dive for prey off the coasts of North, Middle and w. South America. Plunge-diving rare in other pelicans including Australian Pelican (c.f. Clayton 1969).

Typically gregarious. Monogamous; pair-bonds for a breeding season, mates not associating away from nest-sites. Roost and loaf communally on shore, sandbanks or in shallow water; sometimes in trees. Sexual displays apparently rather simple. Copulate at nest-site. Voice unspecialized; non-vocal bill-clapping chiefly heard in nesting colonies. Dissipate heat by gular-flutter. Scratch head directly. Breed in dense colonies on ground or on bushes. Heap up available material to form nest; material brought by males in bill, females building. Eggs oval, rough, white. Clutch-size 1–3, rarely 5–6. Single brooded. Replacement laying after loss. Incubation period, 30–36 days; eggs incubated on feet by both sexes in equal shares or mostly by female. No brood-patch. Hatching asynchronic and incubation starts with first egg. Both parents attend and feed young by incomplete or complete regurgitation. Young leave nest at about 25 days and form crèches. Fledge at 70–80 days old, when usually independent. Mature when 3–4 years old.

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Pelecanus conspicillatus Australian Pelican

COLOUR PLATE FACING PAGE 740

Pelecanus conspicillatus Temminck, 1824, *Planches col. Oiseaux* 47: Pl. 276 — Australia = New South Wales fide Mathews, 1912, *Novit. zool.* 18: 244.

The generic and English name come direct from the Greek (πελεκάν) or late Latin (*pelecanus*) name for these birds, the specific name means *spectacled* and no doubt refers to the bare skin round the eye, which in this species is separated by feathers from naked parts of bill and throat.

OTHER ENGLISH NAMES Pelican, Spectacled Pelican.

MONOTYPIC

FIELD IDENTIFICATION Length 1.6–1.8 m; wingspan 2.3–2.5 m; weight 4.0–6.8 kg. Large mainly white bird with short legs and tail, black and white wings and huge pale bill with fleshy pouch. Sexes similar but females smaller with much shorter bill. Immatures similar to adults; juveniles dull brown rather than black on wings, lower back and tail.

DESCRIPTION ADULT BREEDING. Head, white with grey, black or white nuptial crest on back of head and nape; neck, white with yellow wash on lower foreneck; hind-neck, grey. Back, white with black V across rump, apex pointing to rear; tail, black occasionally tipped white. Upperwing, black with broad white alar patch and long secondary coverts. Underparts, white; underwing mostly white; in some birds, prominent black line across centre of primary coverts, extending part way across middle of coverts of innerwing but separated from leading-edge of wing by band of white. During courtship, bill, pale pink-blue with pink central ridge; margins of bill, slate-blue for proximal three-quarters, orange for distal quarter; nail, orange. Pouch, dark blue along proximal edge, then pink, distal two-thirds, scarlet; blue stripe from proximal

edge to centre of pouch. Eye-ring, orange-yellow. Iris, brown. Legs and feet, dark blue-grey. When nesting, pouch, orange-pink, pouch-stripe, bright red. **ADULT NON-BREEDING.** Like breeding but lacks yellow wash on neck; margins of bill and nail, pale yellow, pouch, pink-yellow or pink-brown with faint red stripe. Eye-ring, pale yellow. **IMMATURE.** Similar to adults but with short coverts at alar patch. Bill and pouch, pale pink-yellow; legs and feet, grey. **JUVENILE.** Plumage, white and brown in similar pattern to adult, but with short coverts at alar patch. Head, white, grey or brown. Bill, pink with orange tip; throat and ring round eye, pink; legs and feet, brownish-grey.

SIMILAR SPECIES Unmistakeable. When soaring at great heights, possibly confused with Black-necked Stork *Ephippiorhynchus asiaticus* and White-bellied Sea-Eagle *Haliaeetus leucogaster*; Black-necked Stork differs in black head, extended neck and long trailing legs; White-bellied Sea-Eagle in upswept wings, lack of huge bill and white, grey or dark plumage.

Seen in flocks, swimming buoyantly on rivers, estuaries,

billabongs and lagoons, resting on sand or mud banks or soaring. Feed in flocks, simultaneously plunging heads below water. Laborious take-off from water with strong wing-beats and both feet kicking in unison. Head drawn back in flight with bill resting on breast. Fly with powerful wing-beats alternating with glides on slightly depressed wings. Flocks during long-distance movements fly in lines or V-formation, break up to circle in thermals and soar on flat slender wings to great heights. Ungainly, waddling gait on land. Normally wary and silent away from nest. Voice mostly gruff croaks.

HABITAT Terrestrial wetlands, estuarine and marine habitats; range extending into arid zone, where large numbers gather on ephemeral wetlands after flooding. Mainly found on waterbodies with large sheets of open water, free of dense aquatic vegetation; can use waters where depth, low temperature, exposure, or fluctuating turbidity and salinity limit food supply and inhibit use by other waterbirds. Nature of fringing vegetation unimportant, provided stretches of open shoreline with bare ground or patchy or short vegetation available for loafing (Fjelds  1985). Prefer large lakes, reservoirs, billabongs and rivers (Corrick & Norman 1980; Gosper 1981; Fjelds  1985); in dry season on NT floodplains, feed most effectively in deep pools and channels, small enough to concentrate fish but with room for co-operative feeding (Morton *et al.* 1989). Also use deep open water and channels in swamps and lakes vegetated with tall emergents (e.g. *Phragmites*, *Scirpus*, *Eleocharis*, *Typha*), shrubs (e.g. *Muehlenbeckia*) or trees (e.g. *Melaleuca*, *Eucalyptus*, *Casuarina*); shallow freshwater swamps; and large dams and drainage channels in farmland (Sharland 1957; Vestjens 1977a; Gosper 1981). Gather at receding floodwaters or seasonal wetlands to feed on trapped fish (Hobbs 1961; Crawford 1972), but avoid newly flooded areas where prey not yet abundant or concentrated (Morton *et al.* 1989). Saline habitats much used, provided salinity not above c. 130 ‰, which is limit of tolerance of fish (Lane 1984). Particularly on open estuarine waters, salt pans, lakes and coastal lagoons (Corrick & Norman 1980; Gosper 1981; Corrick

1982; Jaensch *et al.* 1988); but also frequent pools in saltmarsh, saltfields, and bays and inshore marine waters, where beaches, sandbanks, rock platforms and reefs used for loafing (White 1917; Crawford 1975; Corrick & Norman 1980; Gosper 1981, 1983). Readily enter urban areas, using ornamental waters in parks, and marine waters near wharves and boats (Wheeler 1959; McEvey 1965).

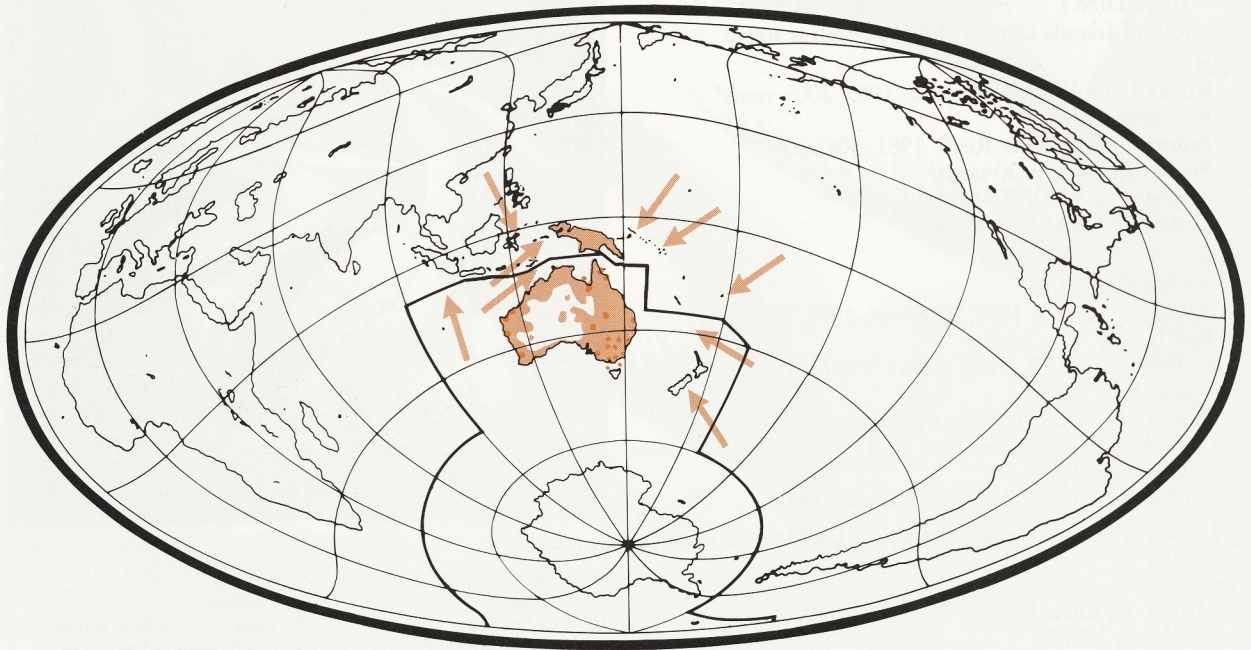
Breed on low secluded sandy islands, islets or shores, where nest on bare ground, or among low or patchy vegetation (e.g. grass, saltmarsh, lignum) (Lang 1927; Lansell 1940; Serventy & Shugg 1964; Eckert 1965; Loyn 1975; King *et al.* 1985). In WA, breed on coastal islets or in inlets or estuaries; elsewhere, also breed inland on permanent or ephemeral lakes, swamps and rivers (Aust. Atlas). Need undisturbed site with abundant and assured food supply for 3 months for successful colonial breeding (Vestjens 1977b). In ephemeral waters, high mortality may occur if evaporation increases salinity to levels above which fish die or if falling water levels allow predators access.

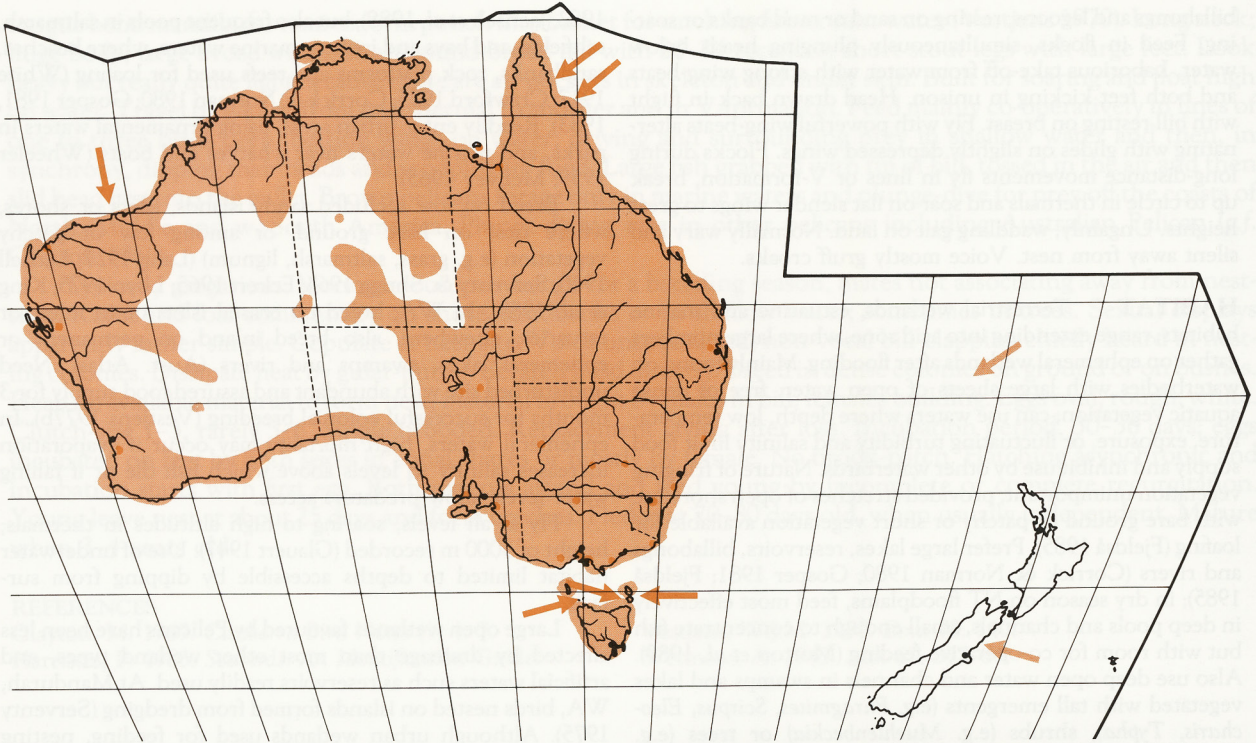
Fly at all levels, soaring to high altitudes in thermals; height of 3000 m recorded (Glauert 1947). Use of underwater habitat limited to depths accessible by dipping from surface.

Large open wetlands favoured by Pelicans have been less affected by drainage than most other wetland types, and artificial waters such as reservoirs readily used. At Mandurah, WA, birds nested on islands formed from dredging (Serventy 1975). Although urban wetlands used for feeding, nesting birds seek secluded sites and are susceptible to human disturbance.

DISTRIBUTION AND POPULATION Aust., PNG, Indonesia and Fiji. Accidental to NZ.

AUST. Widespread coastal and inland waters, especially E and N of line from Adelaide through Alice Springs to Tennant Creek to Broome, then S to Esperance. Qld, NSW, Vic., Tas.: generally widespread except desert areas when water absent. SA: E of 138°, coastal areas and waters in





desert areas (Aust. Atlas). WA: nw. coast Wyndham to Broome and Port Hedland to Exmouth; Gascoyne R. and Murchison R. valleys; sw. coast Perth to Recherche Arch. NT: widespread Top End and desert areas when water present.

NZ Accidental. One, Wanganui R., 1890 (NZCL); one, N. Wairoa R., 23–28 Aug. 1976 (Edgar 1978); one, dead, Southland, Nov. 1977 (Sagar 1978); 1–3, Canterbury, 18 Dec. 1977 to 4 June 1978 (Sagar 1978).

NORFOLK I. Accidental (Schodde *et al.* 1983).

CHRISTMAS I. Accidental 1981 (Stokes *et al.* 1987).

BREEDING From Aust. NRS (°), Aust. Atlas (+) or Seabird Islands Corella (1985) (1), unless stated.

QLD

Rocky I., Gulf of Carpentaria: 1965, 200+ nests*

Karumba: 1978+

Pelican I. (Gt Barrier Reef): 1981, 30+ nests*

Stainer I.: 1984, c. 30 nests¹

Stapleton I.: 1983, 20+ pairs¹

Combe I.: 1984, 40–100 pairs¹

NSW

Mt Nullum: 1978+

Wallis L., Forster: 1984, 97 nests*; 1985, 352 nests*

Five Is (G.F. van Tets)

L. Brewster: 1985, 1000 pairs*; 1989, 2000 adults, 345 nests*

Moulamein: 1939, 150 nests (Chapman 1963)

Cawndilla L. (Menindee Ls): 1921, 50 000–100 000 nests (Chapman 1963)

L. George: 1968, 427 nests (Chapman 1963)

L. Cowal: 1964, 800–1500 nests*; 1971, 144 nests; 1975, 67 nests

VIC.

Mallacoota Inlet: 1978+

Nambrook: 1980*+



Plate 54

Australian Pelican *Pelecanus*

conspicillatus

1. Adult breeding

2. Adult non-breeding

3. Juvenile

4. Nestling

5. Adult non-breeding, ventral

6. Adult non-breeding, dorsal

- Jack Smith L.: 1989, 112 young; 1990, 37 young (G. Jago).
 French I.: 1970 (S.J. Cowling); 1971, 128 nests*; 1974, 100 nests*; 1979, 31 nests*+; 1983, 57 pairs (Vic. Bird Rep. 1983)
 Mud Is: 1983 (first nesting), 10 nests* (Vic. Bird Rep. 1983); 1985-89* (Vic. Bird Rep. 1985)
 L. Corangamite: Nov. 1971, 50 (S.J. Cowling); 1979, c. 23 nests*
 L. Hindmarsh: 1967, 750 nests*
 Kaniva area (Vic. Atlas)
 Nhill Swamp (Vic. Atlas)
 E of Wail (Vic. Atlas)
 Hattah Ls: Mournpal, Lockie Ls: 1977-78+
 TAS. all Whinray 1978
 Baynes I.
 Foster I.
 Pelican I.
 Penguin I.
 Clarkes I. (Furneaux Grp): 100 nests
 SA
 The Coorong: 1981: many nests*
 Pelican I.: 1929, 200 nests (Chapman 1963)
 Policemans Pt+
 L. Alexandrina: 1963, 300 nests (Chapman 1963)
 Kangaroo I.: Kingscote+
 Outer Harbour: 1988, 120 adults*
 Pt Pomanda (Chapman 1963)
 Carpamoonganna: 1981+
 Goyder's Lagoon (Chapman 1963)
 L. Geolangirrie (Chapman 1963)
 L. Eyre: 1977, c. 4000 pairs*; 1984: 3130 nests*(Lane 1984)
 L. Eyre N.: 1984, 3890 pairs on two islands*(Lane 1984)
 L. Harry: 1000 pairs*
 L. Marion: 1964, 40-50 pairs*
 Cooper's Ck: 1000 pairs*
 WA
 Mandurah: 1977**
 Peel Inlet: 1974, 88 nests*
 N. Turtle I.: 1975, 240 pairs (Kolichis 1977); 1981, 1200+**
 Pelican I.: 1977**+, 1978**

MOVEMENTS Dispersive; numbers in wetter parts of Aust. varying with inland rainfall. Reporting rate in Vic. suggests no regular seasonal variation in numbers (Vic. Atlas) though peaked on Hunter R. during summer 1971-72 (Gosper 1981) and in Top End, NT, regular immigration to pools in Alligator R. region, possibly from S, during winter dry season (Morton *et al.* 1989). Apparently almost absent from Brisbane area during 1974-76 when L. Eyre full and the Murray-Darling system in flood but large numbers recorded 1978-79 (Woodall 1985) when spectacular departure from central Aust. with thousands seen along coastal Gulf of Carpentaria (Garnett & Bredl 1985) and Torres Str. (Draffan *et al.* 1983). Birds left inland areas as they dried and spread well beyond Aust. Only one record NZ until Nov. 1977-June 1978 when several seen (see Distribution); reported Fiji, Aug.-Dec. 1978 (Clunie 1979), Christmas I. (Ind.), Oct. 1978 (Stokes *et al.* 1987) and flock of 150 reached Palau, N of Equator (van Tets 1978). Similar exoduses have occurred earlier: numerous flocks apparently blown from Qld to Solomon Is and Vanuatu, 3-7 Mar. 1952 by high-level winds at 2000-3000 m (Laird 1954) when also more common than usual sw. Aust.

(Serventy 1953); left sw. NSW, 1922 (MacGillivray 1923) and one recorded Indonesia, Sept. 1960 (Voous 1967) and one, Christmas I. (Ind.), July 1981 (Stokes *et al.* 1987).

BANDING Returns (all ABBBS) from all over Aust. and s. New Guinea, though little E-W movement detected. Recoveries from The Coorong, SA, summarized Fig. 1; from Five Is, NSW, Fig. 2; from sw. WA, Fig. 3; from nw. WA, Fig. 4.



Fig. 1. 36S 139E 2X2 ABBBS

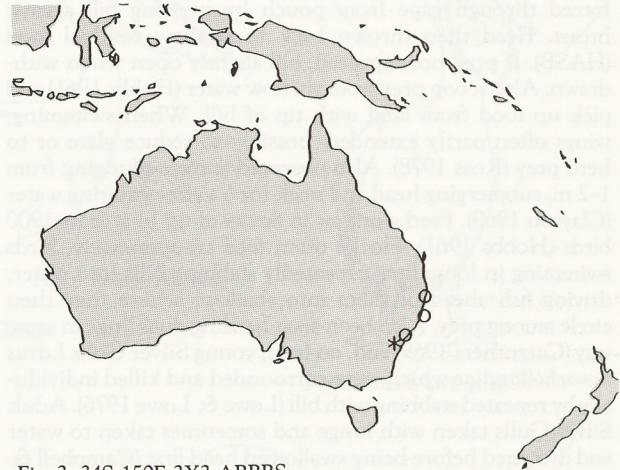


Fig. 2. 34S 150E 2X2 ABBBS



Fig. 3. 33S 115E 2X2 ABBBS

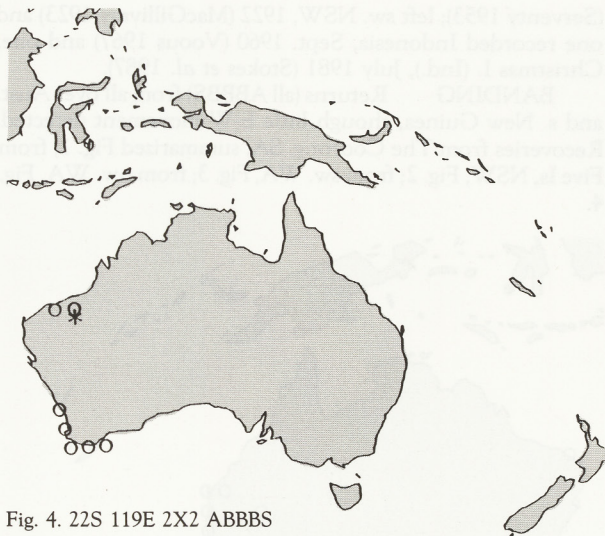


Fig. 4. 22S 119E 2X2 ABBBS

FOOD Probably mostly fish but an eclectic carnivore and scavenger taking anything from insects and small crustaceans to ducks and small dogs. **BEHAVIOUR** When feeding alone, swim surreptitiously towards prey with head held low and neck cocked, plunging head into water when prey encountered (Pizzey 1980). Bill then lifted vertically, water being forced through gape from pouch by pressing bill against breast. Head then thrown back to swallow residual food (HASB). If prey not captured, bill slightly open when withdrawn. Also scoop prey from shallow water (Hobbs 1961) and pick up food from land with tip of bill. When swimming, wings often partly extended, possibly to reduce glare or to herd prey (Ross 1978). Also observed surface-plunging from 1–2 m, submerging head and neck for 5 s after entering water (Clayton 1969). Feed alone or in flocks of up to at least 1900 birds (Hobbs 1961). Flocks often feed co-operatively, birds swimming in loose line, repeatedly stabbing bills into water, driving fish ahead of them into shallows where they then circle among prey. Also been seen herding ducklings in same way (Carruthers 1969) and, on land, young Silver Gulls *Larus novaehollandiae* which were surrounded and killed individually by repeated stabbing with bill (Lowe & Lowe 1976). Adult Silver Gulls taken with lunge and sometimes taken to water and drowned before being swallowed head first (Campbell & Sonter 1985). Occasionally rob cormorants *Phalacrocorax* spp (MacGillivray 1923), Black-faced Shag *Phalacrocorax fuscescens* (Ap-Thomas 1986), Great Egret *Ardea alba* (Hobbs 1987), Australian White Ibis *Threskiornis molucca* (Morris 1973), and Caspian Terns *Hydroprogne caspia* (Mayo 1933) and take fish from nets (Gogerley 1924). Sometimes feed in mixed flocks with Little Black Cormorants *Phalacrocorax sulcirostris* (Carruthers 1969). Most feeding daytime but will also feed by moonlight or even on dark nights between 01:00 and 04:00 (Stone 1913; Vestjens 1977a). Occasionally obtain drinking water by raising bill to 60° and keeping distended lower mandible horizontal during rain (Vestjens 1970).

ADULT No detailed studies. Observed taking insects (North); crustaceans: decapods shrimps *Macrobrachium* (Barker & Vestjens 1989), freshwater crayfish (Hobbs 1961; Eckert 1965; Barker & Vestjens 1989); fish (Stone 1913) incl. *Cyprinus carpio* (Vestjens & van Tets 1969), *Leiopotherapon unicolor* (Carruthers 1969), *Perca fluviatilis* (Vestjens & van Tets 1969), perch (Anon 1903), whitebait (Hirth 1976),

tadpoles (North); reptiles: small tortoises (NZRD); birds: Silver Gull (Lowe & Lowe 1976; Campbell & Sonter 1985); ducklings (Morse 1922) including Grey Teal *Anas gracilis* (Carruthers 1969); adult Grey Teal (Cambridge 1983); mammals: small dogs probably (Campbell & Sonter 1985; M.A. Cameron); plant fragments (Barker & Vestjens 1989); carrion (North; Barker 1955; Perry 1971; Campbell & Sonter 1985).

NESTLING At L. Cowal fed fish (6.0–24.7 cm, 17–320 g), mostly *Carassius auratus* with some *Perca fluviatilis*, *Platyodon* and crustaceans decapod shrimps *Macrobrachium*, freshwater crayfish *Cherax destructor*. One meal contained eight *C. auratus* weighing 870 g (Vestjens 1977a). Other records of food at nest-sites include common carp (LeSouëf 1920; Lansell 1940; 1.8 kg, Eckert 1965), *Tinca tinca* (Eckert 1965), *Macquaria australasica* (≤ 27 cm; MacGillivray 1923), minnows, bream (Eckert 1965).

SOCIAL ORGANIZATION Gregarious; usually in small to large (several thousand birds) groups; occasionally solitary.

BONDS At least seasonally monogamous. No systematic information from marked birds. No co-operative breeding. Both parents tend young until contact lost some time after fledging.

BREEDING DISPERSION Nest in dense colonies. Only nest-site defended.

ROOSTING Solitary or communal on sand banks, logs and rocks near water. May have separate diurnal and nocturnal roosts, depending on locations of food and shelter. No systematic information on times of arrival and departure from roosts.

SOCIAL BEHAVIOUR Based mainly on Vestjens (1977a). Displays obvious, though care needed not to disturb displaying birds. Individual distance just out of pecking reach. Flocks integrated when flying and when foraging.

AGONISTIC BEHAVIOUR During courtship males threaten and drive away other males. **THREATENING:** by Pointing (mild threat), Gaping (medium) and Thrusting (strong). **Pointing:** closed bill raised slightly above horizontal towards opponent; neck stretched slightly and pouch expanded to pennon-shape. **Gaping** (Fig. 5): bill opened wide at opponent or other intruders. **Thrusting:** proceeds from Pointing and Gaping with head thrust forward and bill snapped shut in Pointing position.

SEXUAL BEHAVIOUR **COURTSHIP:** breeding sequence begins with **Courtship Walks** and **Swims:** female leads two to eight males round area of colony on land, water and in air until accompanied by only one, who, in turn, threatens and drives away other males. Female eventually leads male to vacant site near occupied nests where **COPULATION** may occur. Nest material (nearby debris) gathered by male and presented to female who builds it into nest. During courtship, **Pouch-rippling** (Fig. 6) performed by both sexes: pouch resembles flag in strong wind; three or four waves at a time move forward from throat to tip of bill and, simultaneously, upper mandible may move up and down by few degrees in clapping motion about three times per s. While Pouch-rippling, head held high with slightly curved neck, bill slopes down and forward, sides of lower mandible close together and pouch hangs in deep sagging fold. Clapping motion most prominent in males and produces clapping sound. **Pouch-swinging** (Fig. 7): pendulous swinging of open bill from side to side with neck

held high, straight and vertical. Open bill directed forwards and downwards, sides of lower mandible wide apart and pouch smooth basket shape. Rate of swings about one or two per s with slower up-and-down movement of bill. **Throwing-and-Catching**: picking up stick, feather, dry fish or egg, throwing it up into air and catching it, several times; if dropped, object picked up again. Pouch-swinging and Thrusting performed in Courtship Walks and Swims whereas Throwing-and-Catching performed only during Courtship Walks; these displays by males only. **Strutting** (Fig. 8): by pair, as female leads male to nest-site; resembles slow high-stepping gait with bird maintaining body upright, head raised, neck arched backwards, bill resting on base of neck, and wings slightly raised and partly open. **Crouch-bow** (Fig. 9): by males before copulation while female sits on nest; bird crouches and touches ground with breast and bill while rump and tail are raised; wings then raised and moved outwards by humeral rotation, bill closed and pouch folded so that it sags downwards. **GREETING**. When approaching nest-site or mate on nest, birds Bow and give Head-up displays as signs of recognition. **Bowing** (Fig. 10). Closed bill pointed vertically downwards, neck arched and sometimes with sideways move-

ment of bill. **Head-up** (Fig. 11): raising closed bill c. 60° above horizontal with breast also raised, neck straight and vertical, and pouch drawn in.

RELATIONS WITHIN FAMILY GROUP During hot sunny weather, eggs and small chicks depend on parental shade for survival. When required, webbed feet used to warm eggs and small chicks. Young call for food while under brooding parent. In response, parent stands and regurgitates liquid food, which flows down inside of vertical upper mandible. Chick feeds inside bill near tip. Older chicks have long begging call and reach up higher into the mouth and eventually into throat of adult.

VOICE Not well known; no detailed studies; behaviour examined by Vestjens (1977a) who described vocalizations. Generally quiet at and away from breeding sites. Soft grunts given away from colonies. When breeding, range of hoarse or guttural groans associated with displays at nest-site (Vestjens 1977a) and in flight (MacGillivray 1923), described as sonorous belching. Colonies not very noisy before hatching; large colonies very noisy when chicks present and begging for food; one colony could be heard 'half a mile away' (MacGil-

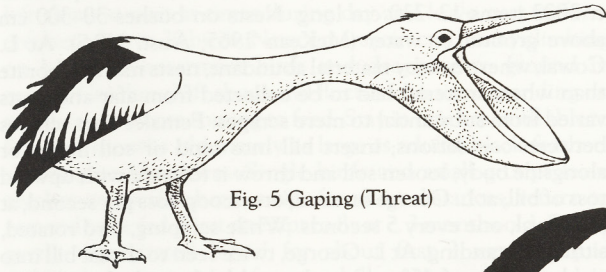


Fig. 5 Gaping (Threat)

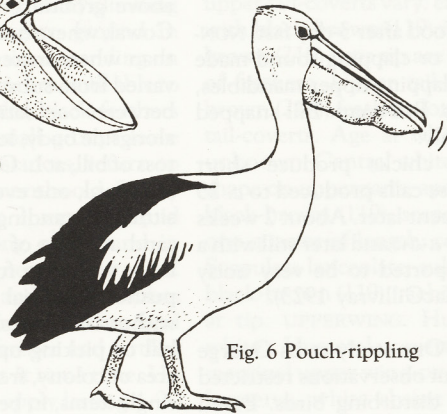


Fig. 6 Pouch-rippling

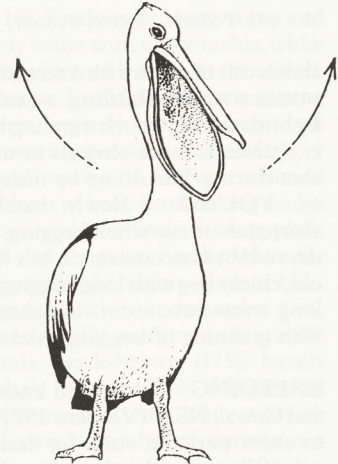


Fig. 7 Pouch-swinging

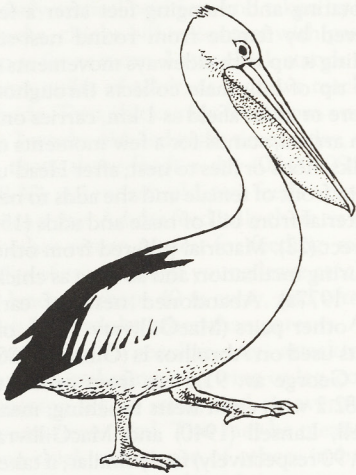


Fig. 8 Strutting

Fig. 9 Crouch-bow

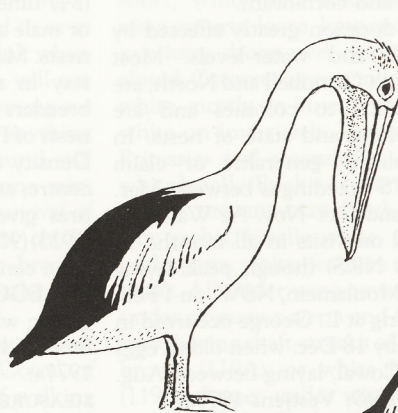
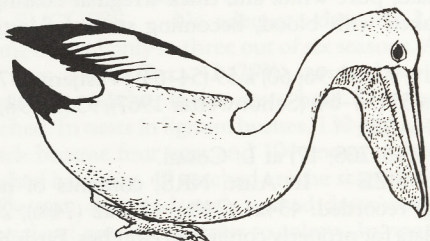


Fig. 10 Bowing

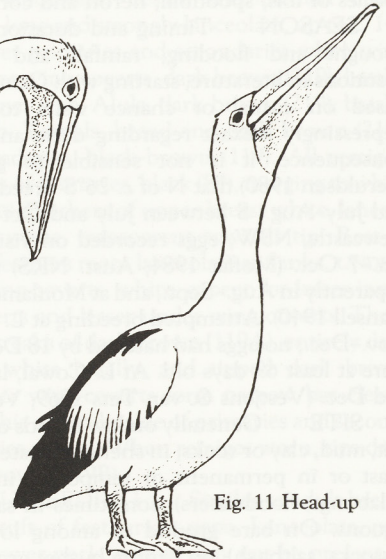
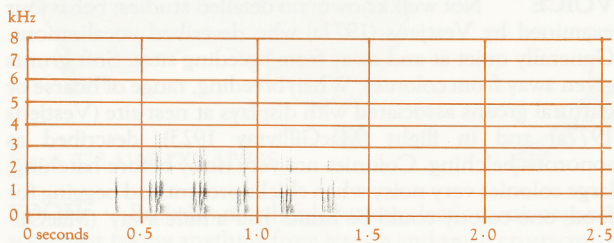


Fig. 11 Head-up

livray 1923). Apparent sexual differences in vocabulary; females do not give Thrusting Display and associated call. No information on individual differences or geographical variation. Non-vocal sounds: birds make rattling or clapping sound with mandibles; bill snapped shut during Thrusting display.

ADULT (1) Hoarse *orrh-orrh-orrh* given during Head-up, Bill-raising, Pouch-swinging, Gaping and Thrusting Displays and Fighting. (2) During Thrusting by males (only), give *thu-thu-thu*. (3) During Pointing, utter *ah-ah-ahha*. (4) During Greeting at nest-site, give *uh-uh-uh-uhhr*. (5) Soft, short *oh-oh-oh* given by pairs or single birds at nest; when preening, turning eggs or touching nestling. Sonagram A



A H. Pollock; captive, Sydney, Jan. 1966; B139

shows call of captive bird receiving food after 3-day fast. **NON-VOCAL SOUNDS:** **Rattling:** a rattling or clapping sound made by birds during Pouch-rippling by clapping upper mandibles, c. 3 times/s; more obvious in males. **Bill-snap.** Bill snapped shut during Thrusting; by males only.

YOUNG Newly hatched chicks produce short sharp *tjuh* or *cue* when begging; these calls produced to c. 25 days old but become much less frequent later. About 2 weeks old, chicks beg with long begging *krr-a-aw* and later still with a long *wraow-woa-waor*. Colonies reported to be very noisy with groaning of begging chicks (MacGillivray 1923).

BREEDING Not well known. One study at Ls George and Cowal, NSW (Vestjens 1977a) but observations restricted to short periodic visits for fear of disturbing birds. Breed colonially in simple pairs on sandy islands or spits on inland or coastal lakes and on islands offshore; often associated with species of ibis, spoonbill, heron and cormorant.

SEASON Timing and duration greatly affected by drought and flooding, rainfall and water-levels. Most mentions in literature, starting with Campbell and North, are based on casual or chance visits to colonies and are depressingly inexact regarding dates and state of nests. In consequence, it is not sensible to generalize or claim (Beruldsen 1980) that N of c. 26°S breeding is between Mar. and July-Aug., S between July and Oct-Nov. At Wallis L., Newcastle, NSW, eggs recorded on visits in all months 10 Jan.-7 Oct. (Moffat 1984; Aust. NRS) though peak laying apparently in Aug.-Sept., and at Moulamein, NSW, on 1 Feb. (Lansell 1940). Attempted breeding at L. George occurred in Nov.-Dec.; no eggs had hatched by 18 Dec. when oldest eggs were at least 69 days old. At L. Cowal, laying between Aug. and Dec. (Vestjens & van Tets 1969; Vestjens 1977a).

SITE Generally on low islands or spits of sand, shell grit, mud, clay or rocks; in sheltered waters offshore and near coast or in permanent or temporary inland waters (lakes, billabongs, floodwaters); sometimes in sandhills round tidal lagoons. On bare ground or among low vegetation (grass tussocks, saltbush); on lignum bushes growing in water. May

be just above high-water mark or near water's edge so that nests may be flooded if water rises. Colonies not necessarily conspicuous, nesting birds appearing merely as if resting on sandbanks. Erratic use of site of colony; may be used for several years, abandoned and recolonized (Campbell; North; White 1909; Eckert 1965; McKean 1965; Battam *et al.* 1986; Vestjens 1977a; Aust. NRS).

NEST, MATERIALS Nests on ground are hollows or shallow depressions, encircled or sparsely lined with material or covered by roughly constructed, elaborate flat circular or oval platform of material; consisting of all manner of plant stems, sticks, seaweed, water-weed, ribbon-grass, leaves and rubbish (feathers, carcasses of dead birds, chicks, fish and reptiles, bones, stones, coral, cow manure, guano) (Campbell; White 1909; Beruldsen 1980; MacGillivray 1923; Vestjens 1977a; Aust. NRS). On bushes, not much more material used than on ground, birds trampling the bushes to form support for eggs (Eckert 1965). Scrapes measured 315 (210-370; 28) across and 54 (45-70; 28) deep (Vestjens 1977a); in diameter similar to measurements by MacGillivray but shallower, his being 102-152. At L. Cowal, platforms of material were 625 (510-720; 21) in diameter, if circular, rather larger than those of MacGillivray, 480-510; 66 (40-100) thick; one composed of c. 2000 items 12-220 cm long. Nests on bushes 30-300 cm above ground or water (McKean 1965; Aust. NRS). At L. Cowal, where nearby material abundant, nests more elaborate than where material had to be collected from afar and nests varied from substantial to mere scrapes. Females start scrapes between copulations; insert bill into sand or soil under or alongside body; loosen soil and throw it forward with upward toss of bill; at L. George on sand, one scoop-toss per second, at L. Cowal, one every 5 seconds. While scraping, bird rotated, sitting or standing. At L. George, twice seen to thrust bill into sand at angle of 45° and push sand backwards from under body with one foot, rotating and changing feet after a few pushes. Material gathered by female from round nest-site without leaving, shovelling it up with sideways movements of bill or picking up with tip of bill; male collects throughout area of colony, from shore or as far afield as 1 km, carries only single items, in beak; on arrival, stands for a few moments on edge of nesting area; walks, hops or flies to nest; after Head-up Display, drops material in front of female and she adds to nest (247 times), or takes material from bill of male and adds (151) or male adds to nest direct (22). Material pilfered from other nests. Material added during incubation and so long as chicks stay in nest (Vestjens 1977a). Abandoned nests of early breeders taken over by other pairs (MacGillivray 1923); old nests of Pied Cormorants used on Abrolhos Is (Gibson 1908). Density of nests: at L. George av. 91.6 cm from centre to centre; at L. Cowal av. 82.2 with eight nests touching; measures given by Campbell, Lansell (1940) and MacGillivray (1923) (90-120, 120-150, 90 respectively) fairly similar, if taken from centre to centre.

EGGS Elliptical to elongate oval; coarsely textured, glossy; when laid, pure white and thick irregular coating of lime and streaked with blood, becoming stained (Vestjens 1977a).

MEASUREMENTS: 90 (83-96; 60) x 59 (54-63) (Vestjens 1977a); 90 (81-96; 32) x 57 (54-64) (Schönwetter 1967); 93 (85-98; 15) x 57 (53-59) (HASB).

WEIGHTS: 168 (148-208; 17) at L. Cowal.

CLUTCH-SIZE In Aust. NRS, contents of nests (eggs or young) recorded: 434x1 (24%), 1309x2 (74%), 20x3 (1%), 3x4. No data for properly confirmed clutches. Birds have

been seen to retrieve eggs from neighbouring females and add them to their own clutch (Vestjens 1977a).

LAYING First egg 2–3 days after birds settle at nest-site; second, within 3 days of first. Thirty-two birds laid second egg 2 days and four birds, 4 days after first (Vestjens 1977a). Campbell claimed that replacements after eggs taken were made at different colony site. MacGillivray (1923) asserted that second clutches were not laid but that other birds laid in used vacant nests.

INCUBATION By both sexes alternately; males usually in morning, females in afternoon. Stints of 2–10 h but up to 13 h (18:00–07:00) once with marked bird. Reliefs usually 06:30–08:00, 12:30–14:00, and 17:00–19:00; none recorded during night. Adults do not feed each other on nest (Vestjens 1977a). **INCUBATION PERIOD:** at L. Cowal, 32–35 days for 64 marked eggs. One, hatched by domestic fowl, 32 days.

YOUNG Altricial, nidicolous. Hatched naked, orange-pink in colour, eyes open. Within a week, covered in short grey down. Area of head and bare parts varies greatly from white and grey to pink and black. Cared for and fed by both parents. At first, brooded continuously; move out from under adult for short periods within week. At c. 25 days old left alone in nest at times during day and leave nest to form crèches of up to 30 birds. Newcomers join crèches by climbing on backs of outermost birds and dropping to ground in centre. Crèches shift about and fluctuate in size depending on number of parents coming to feed. Stay in crèches until able to fly. At 2 months old, nearly as large as adults; black feathers showing on shoulders. Single birds and small groups leave crèches and walk about, swim for short distances, return to rest and to be fed. First attempt to fly at c. 3 months old. Fed by partly regurgitated liquid for about first 2 weeks, liquid dribbled down inside of upper bill, resting on ground in nearly vertical position, and taken by chick near tip. After c. 2 weeks, chicks bill in contact with parent's and chick reaches up as far as it can. Later chick stands in pouch and takes food from gullet of adult, as it grows reaching farther and farther inside. Two chicks may feed from one adult at same time. Up to 2 weeks old, fed eight times a day, each supply lasting 4–20 s; then, three feeds a day (07:00–09:00, 13:00–14:00, 17:00–18:30); at 1 month old, two feeds a day; at 3 months and more, once a day. Adults feed only their own young. Small young in crèches return to nest for feeding; medium-sized fed in or at edge of crèche; large young leave crèche and meet adult when it lands, perhaps 40 m away, and often fed in water; will not beg from adults other than parents. After feeding, young are convulsed in peculiar way, attacking and biting anything nearby, including own wing or leg, collapsing on ground, still grasping leg or wing, and recovering after about one min; spasm never fatal. This may be means of ensuring survival of one chick at expense of others in brood but solitary chicks convulse no less than largest member of bigger broods. Perhaps, otherwise, result of not being able to breathe well during feeding (Vestjens 1977a).

SUCCESS No adequate data. At L. Cowal some young fledged only in three out of six seasons. At L. Cowal, of 144 eggs laid in Oct., 42 (29%) survived period of walking displays by adults; those nests held 73 eggs of which 68 hatched. In nests in lignum bushes, 130 eggs recorded in Dec., which became four eggs and 104 young in Jan.; of which 86 reached hatching, 49 reached crèche stage and 38 fledged. At L. George, dogs and cattle caused destruction when falling water-level gave them access to colony. In one season, at both

lakes rising water flooded nests and covered eggs or drowned young. Interference by humans contributes to losses elsewhere (Wheeler 1968) but at L. George local inhabitants co-operated to try to save colony and at L. Cowal colonies generally too isolated for interference until chicks well grown. Loss of eggs caused chiefly by walking display of courting birds. Loss of chicks, mainly caused by starvation of second chick (Vestjens 1977a).

PLUMAGES

ADULT BREEDING HEAD AND NECK. Circular ring round eye, naked. Naked gular pouch over chin and throat. Crown, cheeks and foreneck, white; feathers slightly open, pennaceous. Central feathers from hindcrown to base of hindneck, loose; open, pennaceous, lacking barbs towards tip of each feather. Tips of feathers, white; basally brown (119B); rachis, dark brown (119A). At nape, feathers longest, forming tuft. Rest of sides of neck, white; feathers loose, merging to hindneck. At base of foreneck, feathers lanceolate and pale yellow; rachis long, exposed with no barbs; rachis transparent and like glistened threads. **UPPERPARTS.** Mantle and back, white. Feathers of outer and lower mantle, long and lanceolate. Feathers of outer and lower back, dark brown (219); rachis, black-brown (119). Feathers of lower rump and upper tail-coverts vary: entirely white with white rachis, white with black-brown (119) rachis, white with shaft streak of dark brown (219) near tip are common. In old adults, no variation of feathers. Upper tail-coverts, entirely white; rump, dark brown (219), feathers long, covering portion of base of upper tail-coverts. Age at which uniformity of feathers achieved unknown. Central white feathers of back form strong wedge shape on upperparts; apex towards lower back. Subscapulars, black-brown (119); scapulars slightly paler; basally white for one-quarter of length; correspondingly, rachis white at base. Scapulars lanceolate, subscapulars with rounded webs. **TAIL,** black-brown (119); rachis white basally, merging to black (89) at tip. **UPPERWING.** Humeral, black-brown (119), basally white. Humeral coverts, dark brown (219). Uppermost marginal upper wing-coverts near carpal joint, white; towards humerus, white absent and narrow wedge of dark-brown (219) feathers gradually widens towards inner wing; fringes, dark brown (119A). Lowermost marginal upper wing-coverts, short, white and lanceolate. Lesser and median upper wing-coverts, loose, long and strongly lanceolate, up to c. 145 mm long; droop over primaries and secondaries when wing closed. Greater upper wing-coverts, dark brown (219); basally white, mostly on inner web. Alula, dark brown (219); basally white on inner web. Tertiaries, broad and dark brown (219). Primaries and secondaries, black-brown (119). All remiges, white basally. Rachis of primaries, black (89), merging to white at base. **UNDERPARTS.** Feathers of upper breast white, lanceolate; rachis, basally white, transparent towards tip. Rest of underparts, white; feathers more lanceolate at flanks. **UNDERWING.** All under wing-coverts, white, except for lesser inner under primary coverts and lesser under wing-coverts. These vary, having shaft-streaks of dark brown (119A), entirely dark brown (119A), or white basally, and tipped dark brown (119A). Lesser under wing-coverts form narrow bar clearly visible in flight. Rachis on underside of primaries and secondaries, white. Axillaries, white. When remiges worn, tips dark brown (119A) to brown (119B).

ADULT NON-BREEDING Similar to adult breeding but lacks long tuft of feathers at nape. Lanceolate, pale yellow feathers of lower neck, may or may not be present or

shorter and less intense. Difference largely involves colours of bare parts.

DOWNY YOUNG Naked at hatching. At c. 1 week, covered in greyish down, which becomes white and woolly with age. Down on head and neck, varies; grey, white or brown (see Vestjens 1977a, 1983, for details), becoming dark-brown in older birds (119A). Scapular feathers appear first, then primaries; prominent at c. 2 months old (MacGillivray 1923).

JUVENILE HEAD AND NECK, similar to adult, except feathers shorter and white with little brown (119B) bases. No pale yellow feathers at base of neck. **UPPERPARTS**. Mantle and back, entirely white; feathers short and lanceolate. Outer back, lower back and rump feathers vary: all dark brown (119A) fringed white; feathers basally white; some feathers with terminal or subterminal dark-brown (119A) patches. Lowermost feathers of rump, lanceolate; rachis, black-brown (119), prominent with dark-brown (119A) patches along its length. Upper tail-coverts, lanceolate and white. Subscapulars, black-brown (119) with pointed tips to webs; basally white. Scapulars, dark brown (119A) with dull white tips. **TAIL**, dark brown (121); basally white, more so on inner web; rachis white at base, rest black-brown (119). **UPPERWING**. Humeral, dark brown (121), basally white. Humeral coverts, dark brown (121). Alula, dark brown (121). All remiges have white base to inner web. Marginal upper wing-coverts near base of primaries, white; feathers with rounded shaft-streaks of dark brown (119A). Rest of marginal upper wing-coverts, white; near humerus, dark brown (121), fringed dull white, forming narrow wedge becoming progressively wider towards inner wing. Median and lesser upper wing-coverts, white; short and lanceolate. Innermost greater, median and lesser, upper wing-coverts dark brown (121); rachis black-brown (119); some subterminal patches on webs, dark brown (119A). All greater primary coverts, dark brown (121) and with narrow white fringes; basally white. Tertiary coverts, dark brown (121), fringed white. Primaries, secondaries and tertiaries, dark brown (121); tips of webs more pointed than in adults. **UNDERPARTS** entirely white. **UNDERWING**. All under wing-coverts and axillaries, white, apart from dark brown (119A) shaft streaks on outer greater under primary coverts, and entire lesser under wing-coverts, dark brown (119A); forms narrow bar on underwing, as in adult.

BARE PARTS Based on Serventy (1973), Deichmann (1985–86), and photos in Lindsey (1986) and unpublished (R. O'Brien).

ADULT BREEDING At courtship: iris, dark brown (221). Naked skin round eye, yellow-orange. Base and central ridge of upper mandible, pink (7), merging to pink (4) near tip. Upper mandible at edge, grey (87) for three-quarters of length; outer edge at tip, dark blue-grey (78). Nail, yellow-orange. Lower mandible similar at base to upper mandible; halfway along edge, grey (87), merging to dark blue-grey (78) at tip. Distal half of gular pouch, red (10), rest cream (54). Midway on gular pouch, narrow double (joined) arterial blue-black (73) line connects with distal half of gular pouch, running parallel to bill. Narrow light violet (170C) line at base of pouch, adjoining feathers. Legs and feet, grey (87). Courtship colours recorded in one captive bird at 4 years old. In others, not until after 6 years old. Colours appear in wild at c. 3 weeks before pair-formation, fading after selection of nest-site. In incubating birds, bill and gular pouch fade gradually to orange-pink. Dark line across gular pouch changes from dark

blue to red, thus distinguishing incubating and non-breeding adults (Vestjens 1977a, 1983).

ADULT NON-BREEDING Similar to adult breeding, except, naked eye-ring paler, sometimes almost white. Base of upper and lower mandibles paler; edges at tips, dark grey (87). Nail, yellow. Gular pouch, pale flesh (5); arterial line, vinaceous (3). Narrow line at base of gular pouch, adjoining feathers, grey (87). Legs and feet similar to adult breeding.

DOWNY YOUNG Naked skin of body and bill, vinaceous (3). Iris, tawny (223D). Skin above eye, light blue-grey (88). Tarsus, pink (3) with grey (87) tone. Colour of iris, naked skin round eye and bill varies (see details in MacGillivray 1923; Condon 1941; Vestjens 1977a, 1983).

JUVENILE Iris, brown (119B). Naked skin round eye, pale yellow or dark brown (119A). Bill, dark brown (121) merging to light grey-brown (119C) at tip. Gular pouch, pink-brown (219D) or pink-buff (121D). Legs and feet, pink-buff (121D) with light grey-brown (119C) shade.

MOULTS Largely undescribed.

ADULT Staffelmauser: primaries moult outwards. Duration and onset of moult series unknown. Before breeding, ornamental breast feathers, bearing elongate exposed transparent rachis, developed; reduced or lost after breeding.

POST-JUVENILE Undescribed.

MEASUREMENTS (1) Live birds; methods unknown (ABBBS). (2) Skins (MV, AM, QM, QVM, SAM). (3) Methods unknown (Vestjens 1977a). (4) Vestjens (1983).

	MALES	FEMALES
WING	(1) 637.8 (21.36; 560–690; 132) (2) 659.6 (13.08; 642–682; 6)	581.2 (14.13; 541–605; 25) 606.6 (28.02; 580–641; 5) *
8TH P	(2) 365.5 (11.5; 354–377; 2)	347.5 (3.5; 344–351; 2) *
TAIL	(2) 181.8 (24.03; 154–225; 6)	165.7 (12.61; 147–182; 4) *
BILL	(1) 453.3 (16.76; 410–495; 260) (2) 459.5 (20.22; 430–496; 6) (3) (420–460; 7) (4) (409–500; 18)	382.3 (14.06; 355–408; 34) 407.4 (35.58; 363–456; 5) * (360–410; 7) (346–398; 9)
TARSUS	(1) 115.4 (7.08; 100–150; 98) (2) 133.8 (4.88; 126.1–141; 7)	107.5 (6.81; 95–125; 21) 124.5 (2.84; 120–127.7; 5) *
TOE	(2) 135.4 (2.15; 132.4–138.5; 6)	124.2 (6.26; 112.5–131.3; 5) *

(5) Unsexed birds; methods unknown (HASB).

WING	(5) 590 (567–612; 8)
TAIL	(5) 155 (146–170; 8)
BILL	(5) 401 (340–370; 8)
TARSUS	(5) 121 (116–129; 8)
TOE	(5) 126 (116–134; 8)

WEIGHTS Few data. Weights of adults (in kg): label data from skins: males 5.82 (AM), 5.4 (QVM); female weighed without stomach 3.3 (AM). Morris (1978) gives a range of 4–6.8. No data on seasonal changes.

STRUCTURE Wing, long and broad. Eleven primaries: p8 longest, p10 39–48 mm shorter, p9 2–5, p7 0–9, p6 30–41, p5 85–116, p4 148–183, p3 186–227, p2 218–237, p1 238–243, p11 252–265 concealed beneath greater primary coverts. P9 and p8 emarginated on outer webs near base; emargination hidden under coverts; p10 and p9 emarginated on inner webs;

outer web of primaries narrow. Primaries and rectrices more pointed in juveniles. Slight horny bump on anterior margin of wing, before carpal joint. Thirty secondaries, ten of tertial form, six humerals. Tail, wedge-shaped; 14–22 broad rectrices (usually 20), outer c. 21 mm shorter than central. Bill, long and broad with large hooked nail at tip and ridge across culmen. Large gular pouch. Distensible gular pouch has holding capacity of 9–13 l (Serventy 1973); also see Vestjens (1970) for further measurements. Bill, flaky in juveniles, smooth in adults. Nostrils small and slit-like, concealed in nasal groove at extreme base of culmen. Large circular patch of bare skin round eye. Lower quarter of tibia, bare. Hexagonal scales on legs. Legs, short and robust. Feet, totipalmate. Claw of middle toe, slightly serrated. Outer toe c. 99% of middle, inner c. 69%, hind c. 42%.

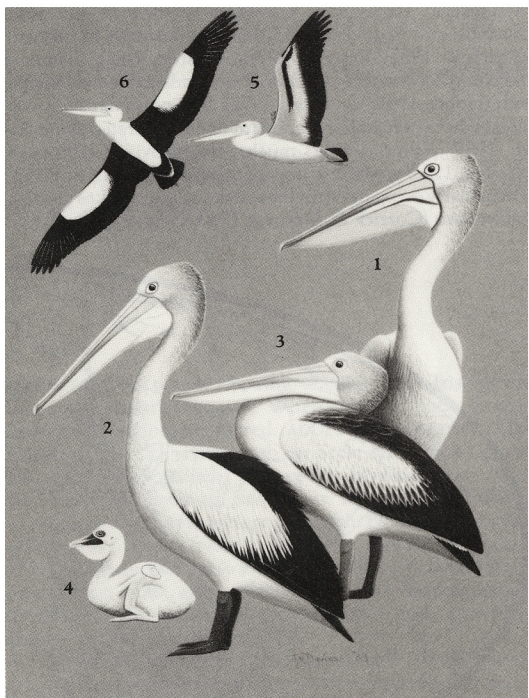
AGEING Age categories on plumage and bare parts: bare parts of downy young similar at c. 132 days (see above, and Vestjens 1977a, 1983 for details). Adults distinguished on measurements. Juveniles separable on structural features (see that section).

RMO

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Australian Pelican *Pelecanus conspicillatus*

1. Adult breeding
2. Adult non-breeding
3. Juvenile
4. Nestling
5. Adult non-breeding, ventral
6. Adult non-breeding, dorsal

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