

Order CICONIIFORMES

Medium-sized to huge, long-legged wading birds with well developed hallux or hind toe, and large bill. Variations in shape of bill used for recognition of sub-families. Despite long legs, walk rather than run and escape by flying. Five families of which three (Ardeidae, Ciconiidae, Threskiornithidae) represented in our region; others — Balaenicipitidae (Shoe-billed Stork) and Scopidae (Hammerhead) — monotypic and exclusively Ethiopian. Related to Phoenicopteriformes, which sometimes considered as belonging to same order, and, more distantly, to Anseriformes. Behavioural similarities suggest affinities also to Pelecaniformes (van Tets 1965; Meyerriecks 1966), but close relationship not supported by studies of egg-white proteins (Sibley & Ahlquist 1972). Suggested also, mainly on osteological and other anatomical characters, that Ardeidae should be placed in separate order from Ciconiidae and that Cathartidae (New World vultures) should be placed in same order as latter (Ligon 1967).

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Family ARDEIDAE bitterns, herons

Medium-sized to large or very large wading birds with long necks and long legs. Various placed in 61-69 species in 10-17 genera (Bock 1956; Curry-Lindahl 1971; Payne & Risley 1976; Hancock & Elliott 1978; Peters) according to choice between many, mainly monotypic genera and a few large genera. Treated here in few large genera, particularly merging *Egretta* into *Ardea* because there is no clear distinction between the two (Mock 1977; van Tets 1977). Two sub-families: Ardeinae (herons) and Botaurinae (bitterns). In our region, 19 species in four genera; all breeding except three accidentals.

Body, slim; neck, long with kink at sixth vertebra. Male larger than female. Wings, long and broad. Flight strong with regular wing-beats, neck retracted. Eleven primaries: p7-p10 longest, p11 minute. Fifteen to twenty secondaries; diastataxic. Tail, short, square or slightly rounded; 8-12 feathers. Under tail-coverts, nearly as long as tail-feathers. Bill, long, straight and sharply pointed, except in *Cochlearius*; often serrated with notch near tip. Nostrils, long slits. Lores, bare. Legs, long; lower part of tibia, bare. Toes, long; small web between middle and outer. Hind and inner toes, broadened at base; claw of middle, pectinate. Stance upright, neck retracted when at rest; gait striding. Perch in trees adeptly (herons) and climb about expertly in reeds (bitterns). Oil-gland small, often with short tuft (longer in night herons *Nycticorax*). Aftershaft well developed. Plumage, loose; feather tracts, narrow; down confined to apteria. Two to four pairs of powder-down patches; down soft and friable, producing fine particles used in care of plumage. Ornamental plumes on head, back or chest in many species; usually more highly developed in breeding season. Bare parts, yellow, brown or black; usually more colourful in season of display and pair-formation. Seasonal differences in plumage, small. Moults, poorly known; mostly two per cycle, but pre-breeding moult often restricted. Moults of primaries irregular or outwards. Young, semi-altricial and nidicolous; single coat of sparse down, white, grey or pale brown. Clamber out of nests when large but unable to fly. Except in *Nycticorax* and *Ixobrychus*, juveniles like adult or duller. Reach adult plumage when 2-4 years old.

Cosmopolitan, with main area of adaptive radiation in Tropics. Absent from Arctic and Antarctic areas; rare vagrants to subarctic and subantarctic regions. Adapted to catch medium-sized prey in shallow water and damp places with short grass, thus rather restricted in habitat. Avoid areas far from marine and inland waters. Otherwise widely distributed from temperate latitudes through Subtropics and Tropics wherever suitable feeding habitat occurs, including forest, mountain and agricultural areas. Usually found at water's edge, especially where gentle slopes and unobstructed bottom makes fishing easy, but some taller, longer-legged species may feed in deeper water. Some smaller species, however, largely arboreal: Cattle Egret *Ardea ibis* now mainly a commensal of large herbivores. Some species (e.g. reef herons *A. sacra* and *A. gularis*) adapted to littoral habitats; others (notably bitterns *Botaurus* and *Ixobrychus*) habitually haunt tall dense vegetation such as reedbeds.

Main breeding and roosting sites, reedbeds, islands, trees and shrubs along banks of rivers, billabongs and lakes (Fullagar & Davey 1983), from which they forage over wide areas. Formerly plumage trade almost annihil-

ated populations of egrets, which have recovered after protection. In Aust. and NZ mainly dispersive, especially those that depend on freshwater habitats.

Food mostly fish, amphibians and insects and their larvae; also, for some species, molluscs and crustaceans, reptiles, small birds and mammals, and their young. Indigestible material ejected as pellets. Prey grabbed by bill; sometimes speared. Feeding methods: (1) stand and wait for prey; (2) wade or walk slowly while stalking prey; (in both methods strike out with neck and bill when within range); (3) movements serving to uncover or startle prey (e.g. foot-shuffling accompanies method 2, at least in Ardeinae); (4) disturb-and-chase technique, in which bird runs and dashes about in shallow water, flushing prey; (5) swimming in deeper water and surface-diving; (6) hovering above water and plunge-diving; (7) plunge-diving from perch (Meyerriecks 1960). Feeding usually diurnal or crepuscular or both (e.g. *Ardea* spp); or crepuscular or nocturnal or both (e.g. *Nycticorax*). Most species solitary feeders, some territorially; where food plentiful may congregate in feeding flocks. Voice, mostly harsh guttural croaks or grunts, unspecialized. With partial exception of some Botaurinae, monogamous pair-bond typical; usually of seasonal duration and not evident away from nest-site or nearby; birds rarely if ever meeting as mates elsewhere. When breeding, both colonial and solitary species typically defend nest-site only. Most species roost communally, often conspicuously at traditional and protected sites; roosts mainly nocturnal but in some species diurnal.

Comfort-behaviour generally similar to other marsh and waterbirds. Bathe while standing in shallow water. Liberal use made of powder-down and oil-gland while preening, with frequent use of pectinate claw in scratching head, neck and bill. In some species, underwing preened by extending wing at right-angle to body. Heat dissipated by gular-fluttering; characteristic sunning posture with upright stance and wings held, shieldlike, out at sides but not fully spread.

In many, specially in colonial species, onset of breeding protracted. Seasonal breeders in coastal and temperate areas but prolonged in inland Aust. if wet conditions prevail. Nest in dense vegetation or in trees. Colonial, often with other Ciconiiformes and Pelecaniformes, or solitary. Displays when forming pairs use long neck and large bill in various distinct ways resembling those of long-necked Pelecaniformes, and birds bob up and down, bending and straightening long legs (Daanje 1950; Meyerriecks 1960). Nest, piles of available vegetation, in tree-nesting species of interlocked twigs; built wholly or mainly by female with material brought by male. Eggs blunt oval, light blue or green, smooth. Clutches 3–5 (1–10). Normally single brood. Replacements laid after loss of eggs or even young. Eggs laid at intervals of 1–3 days. Incubation, 22–30 days; typically by both sexes in roughly equal spells. Single median brood-patch. Incubation starts with first or second egg, so hatching asynchronous. Eggshells removed from nest. Young cared for and fed typically by both parents, by complete and partial regurgitation. Brooded continuously when small; then and later, sheltered from strong sun or rain by parents spreading wings. Older young often guarded by parents in turn. May leave nest before fledging, though often return to be fed. Nestling period 30–55 days; young may become independent soon after, but prolonged periods of post-fledging semi-dependence probably more typical, especially in larger species. Age of first breeding usually 1 or 2 years, occurring in some species before adult plumage attained.

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Ardea pacifica Latham, 1801, *Index orn., Suppl.*: 45 — New South Wales.

Named for its geographical range but not well because the species is not widespread outside Australia.

OTHER ENGLISH NAMES White-necked Heron or Crane.

Pacific is much to be preferred to **White-necked** because momentary confusion often arises with **White-faced** (*A. novaehollandiae*) if the latter is used and because *A. cocoi* of South America is also called **White-necked**.

MONOTYPIC

FIELD IDENTIFICATION Length 76–106 cm; wingspan 147–160 cm; weight 860 g. Large slate-grey to black heron with mostly white head and neck and varying black spots on centre of lower throat and foreneck. When seen head-on in flight, striking white patches at carpal joints. Sexes similar, but female slightly smaller. Seasonal differences in plumages, with lanceolate scapular plumes when breeding. Immatures similar but separable by grey wash to head and neck and no plumes; juveniles similar to immatures but show broad region of black spotting on throat and foreneck.

DESCRIPTION **ADULT BREEDING.** Head and neck, white, usually with prominent dark spots in line down centre of lower throat and foreneck; spots sometimes lost through wear during breeding season. Back, tail and upperwing, slate-grey to black, with iridescent sheen on back and upper wing-coverts; maroon lanceolate plumes on scapulars; distinctive and prominent white patch on upperwing at carpal joint. Long white lanceolate feathers at base of foreneck overhang upperbreast; breast and belly, brown-grey streaked with white; flanks, brown-grey. Bill, black; gape-notch, at base of bill, extends below and behind eye. Lores, black; skin round eye, dark grey; light blue for short time during breeding period. Iris, lemon-cream to green. Legs and feet, black. **ADULT**

NON-BREEDING. Like breeding but head and neck have grey wash and spotting on central foreneck heavier, sometimes forming almost continuous line down centre of throat; may lose plumes. **JUVENILE.** Head and neck similar to adult non-breeding but throat and foreneck have small black spots, not restricted to midline as in adult. **IMMATURE.** Like non-breeding adult but can have dark-capped appearance; no scapular plumes.

SIMILAR SPECIES Distinctive. Quite unlike smaller **White-faced Heron** *Ardea novaehollandiae*, with its pale-grey neck and body, white face and yellow legs. Adult **Pied Heron** *A. picata* much smaller with dark crown and yellow bill and legs; juvenile Pied often has white head and neck but never black spots on lower throat and foreneck nor black legs and bill. Head-on, in flight, Pacific Heron distinguished by distinctive white patches on carpal joint of wing (though juvenile Pied Heron shows white patches on leading edge of underwing).

Seen singly or in small groups in water at margins of freshwater swamps, dams or in moist grasslands, rarely in brackish or salt water. Forage by stalk or stand-and-wait techniques. In flight, look large, heavy and long-winged with head drawn back into hunched shoulders. Fly with slow wing-

beats and glide or circle effortlessly. When alarmed, utter loud, guttural croak.

HABITAT Widespread in terrestrial wetlands, grasslands and, less often, in estuarine habitats; less common in arid interior, although use permanent or ephemeral waters where available (Badman 1979). Forage in shallow water (<70 mm deep) or wet grassland over soft substrate (Recher & Holmes 1982), in sparse or dense vegetation (Hobbs 1961; Recher & Holmes 1982); able to forage in deep, steep-banked waterbodies by plunging from perches (Tucker 1976). Mainly freshwater; strongly opportunistic, readily using floodwaters, artificial waterbodies and small transient waters formed by rainfall or seepage. Prefer shallow swamps, pools, watercourses and flooded land sparsely vegetated with grasses, herbs or sedges; wet meadows; grassland and agricultural land; open lakes and reservoirs; and deep rush-dominated (*Eleocharis*) swamps. Also on swamps with other tall emergent vegetation (e.g. *Typha*); and shallow parts of shrubby or wooded lakes, swamps and watercourses (e.g. *Casuarina*, *Melaleuca*, *Eucalyptus*, *Muehlenbeckia*); farm dams, roadside ditches and irrigation channels (Tucker 1976; Vestjens 1977; Corrick & Norman 1980; Corrick 1981, 1982; Gosper 1981; Recher & Holmes 1982; Fjeldsà 1985; Jaensch *et al.* 1988; Morton *et al.* 1989). Enter forested tracts where opened up by clear-felling, using small rainwater pools (Pescott 1983). Rarely use saline habitats, but recorded from estuarine mudflats, bare saltpans and shallows of saline lakes (Corrick & Norman 1980; Corrick 1981, 1982).

Breed in freshwater wetlands (rivers, lakes, swamps) with flooded or fringing trees, in which nests are built; occasionally nest in trees or small groups of trees left in cleared paddocks near dams and small waterbodies (Hobbs 1961; Riggert *et al.* 1965; Braithwaite & Clayton 1976; Marchant 1988). In Booligal, NSW, nesting more extensive in swamps with high levels of organic matter, complex flora and diverse invertebrate population; in early stages of succession after drying and refilling (Crome 1988).

Circle to high altitude in thermals (Watson 1955) but usually fly at moderate heights (30–100 m). Roost in trees.

The species has benefited from clearing of wooded lands, conversion to pasture, irrigation schemes and construction of artificial waterbodies. Many natural freshwater wetlands used for breeding have been destroyed or modified by drainage, grazing, burning, increased salinity and groundwater extraction (Riggert 1966; Goodrick 1970; Corrick & Norman 1980; Corrick 1981, 1982; Jaensch *et al.* 1988).

DISTRIBUTION Apparently breeding endemic to mainland Aust.; visits Tas. and s. New Guinea. Vagrant NZ, Norfolk I.

AUST. Widespread throughout mainland except e. part of WA and w. SA (areas of Great Sandy, Gibson and Great Victoria Deserts, and Nullabor Plain) roughly between latitudes 20° and 35°S and between longitudes 125° and 133°E, where apparently rare or absent (Aust. Atlas). Scarce visitor or irruptive to Tas. (Green 1977; Sharland 1958) and islands of Torres Str. (Draffan *et al.* 1983). Irruptive habits and general ignorance of details of movements make it impossible to be sure of status within its range. No doubt greatly affected by water conditions, which lead to irruptions and fluctuations of numbers after wet periods in main breeding areas inland. Often considered to be more common inland than in coastal areas and to move into n. Aust. in winter and return S for summer. For further details see Movements.

Breed widely in e. Aust., E and SE of line from about Townsville, SW to Winton and Thargomindah and thence to mouth of Murray R.; also in sw. Aust., SW of line from Geraldton to Esperance. Few scattered breeding records in rest of WA, N to Kimberleys, in Top End, C. York Pen. and n. SA suggest wider spread of nesting (Aust. Atlas).

NZ Vagrant: one, Methven, mid-Canterbury, Apr.–July 1952 (Stidolph 1952); one possible, L. Benmore, Feb. 1972 (CSN 19); one, Matamata, e. Waikato, 12 July 1978 (Lacey 1979); one, Houhura, Northland, 3 Oct. 1981 (Hensley 1982); one, Waipu E., 3 Jan. 1984 (CSN 32).



NORFOLK I. Vagrant: one, Kingston, July–12 Sept. 1978 (Moore 1981).

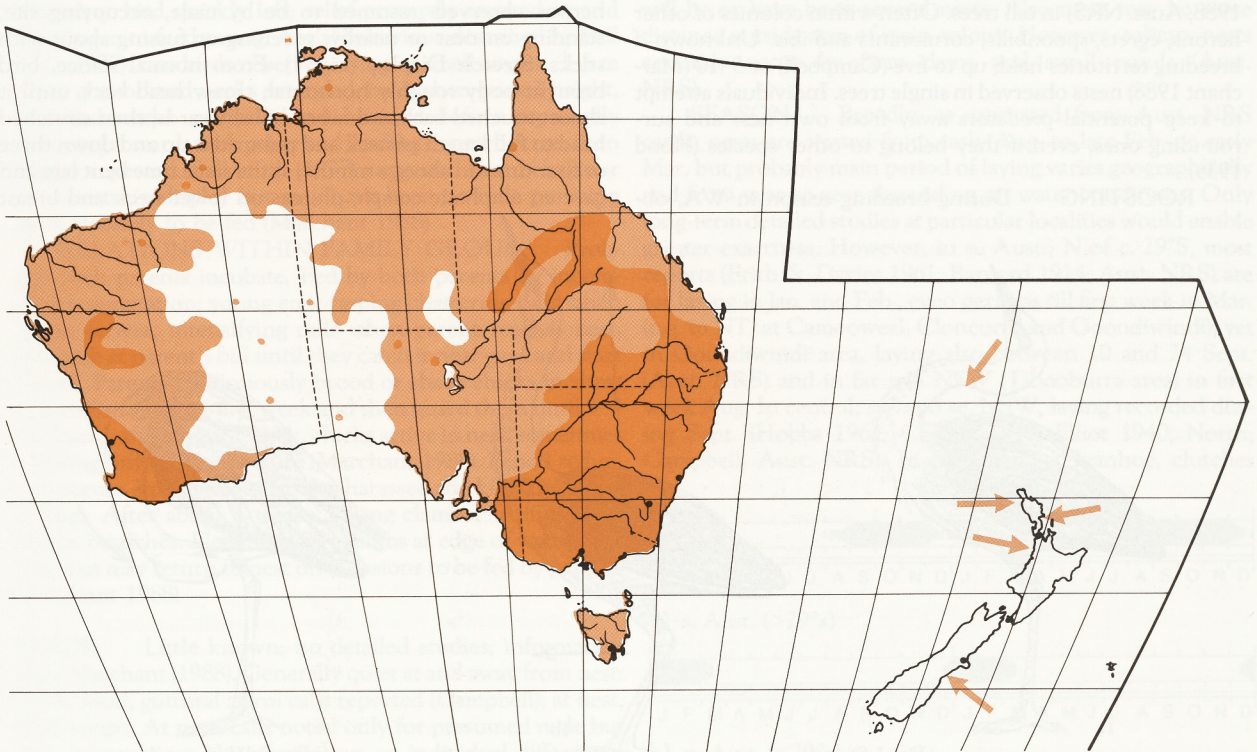
POPULATION No estimate but apparently stable. Expansion into sw. WA may have occurred since the 1950s before which breeding there was apparently not known (Riggert *et al.* 1965; Serventy & Whittell 1962).

MOVEMENTS Dispersive, sometimes irruptive, over most of range but movements apparently more regular in N. Irruptions follow exceptionally wet seasons in arid Aust., with populations increasing rapidly on ephemeral wetlands then being forced to coast as swamps dry. Irruptions have occurred e. NSW 1918–19 (White 1919; Norton 1922), se. Aust. 1951 (Watson 1952; Boehm 1953; Learmonth 1953), sw. Aust. 1923, 1926 (Serventy 1948), 1933 (Carnaby 1933), 1941 (Serventy 1948), 1952 (Sedgwick 1953; Serventy 1953) and 1975 (Dell 1985) and throughout e. Aust. 1978–79 (Aust. Atlas) when birds reached Torres Str. (Draffan *et al.* 1983) and Tas. All irruptions in s. Aust. have occurred between winter and early summer. Fluctuations along Richmond R., ne. NSW, 1974–77 correlated with discharge of inland rivers (Gosper *et al.* 1983); congregations on permanent waters of New England Tableland during drought (White 1987). Seen most often winter and spring at Perth (Alexander 1921), Middle Swan (Heron 1970) and Northam (Masters & Milhinch 1974), sw. Aust., where flock of 26 seen flying SE in May in invasion year with peak in numbers July and returning to normal population size Nov.–Dec. (Dell 1985). Reporting rate in Vic. highest Aug.–Jan. with numbers particularly low Feb.–Apr., especially S of Great Dividing Range (Vic. Atlas). Seen most often winter, least in spring at Marburg (Leach & Hines 1987) and Peel I. (Agnew 1921), se. Qld. Conversely in sw. NSW, least common Apr.–Aug. (Hobbs 1961). Although considered resident near Innisfail (Gill 1970) seen less often in n. Aust. in wet season

than during dry (Aust. Atlas). Apparently absent Atherton Shire (Bravery 1970) and scarce Beatrice, near Darwin, Jan.–May., where most numerous June–Aug. (Crawford 1972) and at Edward R. Settlement, C. York Pen., June–Sept. (Garnett & Bredl 1985). Similar pattern on Alligator Rs, where numbers peak Aug. (Morton *et al.* 1989). Scarcity at Townsville Town Common during dry season (Garnett & Cox 1983) may reflect local conditions; earlier observations there suggested arrival Mar.–June, departure Dec. (Hopkins 1948). No observers record complete absence in wet season and apparent population decline may reflect greater dispersion over increased area of suitable habitat or emigration to S. The few records from NZ (see Distribution) mostly correspond to irruptions in Aust.

BANDING 37S143E 12 P U 4 207 357 ABBBS

FOOD Mainly small aquatic and terrestrial animals, rarely fish. **BEHAVIOUR.** Most food taken after standing and waiting before seizing but will also walk slowly or quickly, glean from foliage, peer among foliage and wing-flick (Recher & Holmes 1982; Recher *et al.* 1983). Body and neck sometimes extended nearly horizontally, with neck slightly angled towards ground but may also scan larger area, walking quickly to prey once detected. Neck shorter than other herons in same habitat so has to stand particularly tall (Recher & Holmes 1982). May also plunge into water from overhanging limb, spearing bill forward but keeping wings out of water (Tucker 1976; Klapste 1976), rake with feet (Hancock & Elliott 1978), pick dead food from surface of water (Sanders 1923) and steal food from ibis (Hopkins 1948). Also observed breaking open mussel shells (Jackson 1919) and repeatedly bashing crayfish against hard objects (Hobbs 1957). At Kakadu, NT, 73.6% of time spent standing still, travelling mean distance of 6.1 m at 0.4 ± 0.03 steps/s when moving, averaging



0.6 attacks/min with 64.4% success; foraging birds flew only in <5% of observations (70 observations over 175 min; Recher & Holmes 1982; Recher *et al.* 1983).

ADULT No detailed studies. Recorded taking molluscs freshwater mussels *Unio* (Jackson 1919); crustaceans (Lea 1917) incl. shrimps (Vestjens 1977), freshwater crayfish (North) incl. *Euastacus armatus* (Hobbs 1957); spiders (Barker & Vestjens 1989); insects dragonfly nymphs, damselflies, praying mantids (Vestjens 1977), orthopterans (North) incl. Tettigoniidae (Barker & Vestjens 1989), short-horned grasshoppers, bugs incl. Notonectidae (Barker & Vestjens 1989), Corixidae (Vestjens 1977), beetles incl. water beetle ads. (Lea 1917; Vestjens 1977), beetle larv. (Vestjens 1977), Hydrophilidae, Staphylinidae, Dynastinae (Barker & Vestjens 1989), lepidopteran larv., flies incl. larv. (Vestjens 1977), Stratiomyidae (Barker & Vestjens 1989); fish (North; most <3 cm; Recher & Holmes 1982; Recher *et al.* 1983) incl. *Carassius auratus* (Vestjens 1977), *Neosilurus* (10 cm; Recher & Holmes 1982; Recher *et al.* 1983), frogs (Hopkins 1948); lizards; young duckling; young Water Rat *Hydromys leucogaster* (North); mice (Lowe 1970); carrion (dead fish; Sanders 1923).

NESTLING One regurgitated tadpoles (Riggert *et al.* 1965).

SOCIAL ORGANIZATION Little known. Usually seen foraging singly, sometimes in pairs (Bourke & Austin 1947); occasionally form small flocks, although flocks of 200 observed (Hobbs 1961). Defend feeding territories against conspecifics and other species.

BONDS Assumed monogamous. Both parents probably incubate and both certainly tend young until fledging.

BREEDING DISPERSION Colonial; occasionally nest alone. Loose breeding colonies, of 2–30 pairs, occasionally to several hundred pairs (Campbell; Storr 1977; Marchant 1988; Aust. NRS) in tall trees. Often within colonies of other herons, egrets, spoonbills, cormorants and ibis. Unknown if breeding territories held; up to five (Campbell) or 5–10 (Marchant 1988) nests observed in single trees. Individuals attempt to keep potential predators away from own nest and surrounding ones, even if they belong to other species (Hood 1935).

ROOSTING During breeding season in WA, ob-

served roosting in pairs (Sedgwick 1949). Often roost in trees. Communal roosting not recorded at communal nesting sites.

SOCIAL BEHAVIOUR Little known; some information from Marchant (1988) at Moruya, NSW, and observations of one pair at Seaham Swamp, NSW (M.N. Maddock). Feeding territory aggressively defended from conspecifics (Le Souëf 1919); may feed with White-faced Herons (Serventy 1953). Observed harassing ibis and raptors and stealing their prey (Sanders 1923; Hopkins 1948). As small ponds dry up, may be forced to congregate at more permanent water (White 1919; Serventy 1953). When alarmed fly to nearby tree, croaking hoarsely (Campbell), or high into air and circle or soar away (Walters 1926; Bridgewater 1932).

AGONISTIC BEHAVIOUR No aggressive behaviour observed at nests by Marchant (1988). Reluctant to move if disturbed at nest (Aust. NRS) but also said to be timid at nest (Chaffer 1940).

SEXUAL BEHAVIOUR At Moruya, during early stages of breeding, mostly solitary male at incipient nest; stand on or near structure for long periods, preening, displaying or fiddling about with nesting material. At Seaham Swamp, pair observed perched high in tree, male higher than female and female standing passively; no nest was seen (M.N. Maddock). At Moruya, occasionally **Circle-flight**: fly out and circle round site, not calling and with measured, deeply flapping wing-beats and neck extended fully or partially. Bird may return to nest or to shore of dam, select a twig after several trials and return to nest with it; it may have been tentative building behaviour of this sort that McCulloch (1967) described. Solitary birds also dropped down from perches or from nests and daintily picked up twigs from water while in flight, or filched them from nearby unattended nests. Stretch and Wing-touch Displays similar to those of males of other herons observed: assumed to be by male, occupying site, standing on nest or nearby, preening or fussing about with sticks. **Stretch Display** (Fig. 1). From normal stance, bird brought body roughly horizontal, threw head back until it almost touched back and raised bill skywards; then stretched head to full length of neck and pumped it up and down three or four times in about a minute; at the same time bent legs and gave an emphatic *oomph*; plumes on lower neck and breast

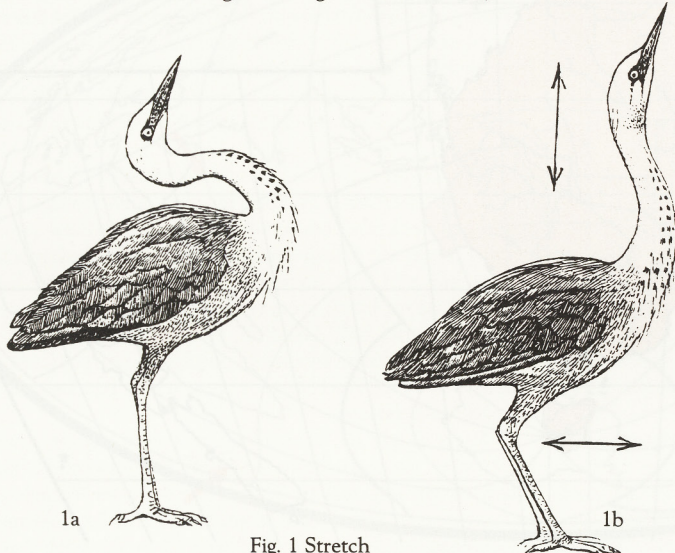


Fig. 1 Stretch



Fig. 2 Wing-touch

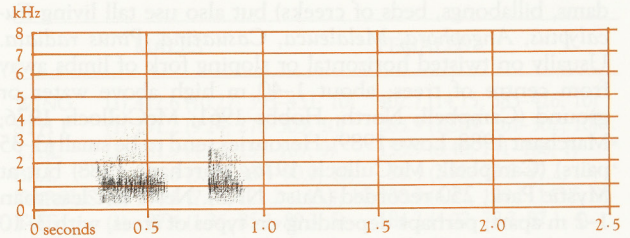
erected during display. At Seaham Swamp, away from nest, **Stretch** and **Wing-touch** observed but upward movement of head weak with body held forward and down and leg-bend also weak; combined or alternating with **Body-shake** (feathers ruffled and body shaken vigorously) and **Twig-shake**. Bird then relaxed, drooping wings slightly; sometimes after short pause gave apparent **Wing-touch Display** (Fig. 2): bird arched head and neck forwards and downwards under breast, apparently running beak down primaries or leading edges of wings in preening movement. Displays usually repeated several times before reverting to normal preening, inactive standing, **Body-shake** or building activities. After pair-formation, when both birds at nest, female stood on or near nest continuously, fussing about with nest structure or preening, while male perched nearby, usually higher. At intervals, male flew off to shore of dam or to large trees 100–150 m away, selected a twig, brought it back and gave it to female, which added it to nest with tremble-shove movements, typical of building herons. **Twig-shake**: at Seaham Swamp, bird reached down and grasped thick branch with gentle **Twig-shaking**. **COPULATION**. At Moruya observed once, partly obscured; female on nest with body horizontal and perhaps crouched; male moved up to her, without ceremony, stepped onto her back and, spreading and waving his wings, copulated; lasted no more than half a minute; male then stepped off, walked up a branch, still waving wings, and took up normal stance about 1 m from nest; then hopped to another branch, purloined twig from neighbouring nest, flew out and round to his own nest and presented it carefully to female; female stayed on nest, ruffling feathers and preening. **GREETING DISPLAY**. Brief display noted at guard-stage but not before: brooding bird quickly stood up; birds faced each other or stood partly alongside each other with bodies horizontal, stretched up heads and necks, keeping heads horizontal, erected feathers of necks and gave one or two raucous cackles. Attendant bird quickly left; relief promptly stepped in and soon began to feed young. Aerial behaviour described by Bell *et al.* (1977): two birds observed flying in small circles, 3–5 m above ground and necks extended; birds then gained height, extended necks vertically and hovered before repeatedly swooping towards each other and landing in nearby tree; then display repeated. Bell *et al.* (1977) suggested that behaviour was courtship display but may have been juvenile pursuing adult, possibly to be fed (Marchant 1988).

RELATIONS WITHIN FAMILY GROUP Probably both parents incubate. Fed by both parents by incomplete regurgitation; young emit rasping chattering calls when parent arrives, intensifying calls when parent reaches nest, then stab at parent's bill until they catch it near gape and start to feed. Parents continuously brood or shade chicks in alternate shifts for about first week and then guard them until 3–4 weeks old; after about 1 week, chicks active in nest, sometimes adopting bittern-like posture (Marchant 1988). Brood reduction occurs, smallest young being harassed and killed by larger siblings. After about 3 weeks, young clamber from nest to nearby branches. Fledglings form clubs at edge of water near nest, but may return to nest on occasions to be fed by parents (Marchant 1988).

VOICE Little known; no detailed studies; information from Marchant (1988). Generally quiet at and away from nest: harsh, loud, guttural alarm calls reported (Campbell); at nest, loud *oomph*. At nest, calls noted only for presumed male but little information. No information on individual differences

or geographical variation.

ADULT (1) During **Stretch** and **Wing-touching** Displays, presumed male gave an emphatic *oomph*; display and call usually repeated several times in a few minutes (Marchant 1988). (2) During change-over at guard-stage, both birds gave one or two raucous cackles. (3) **Alarm Call**. Birds give harsh, guttural *croak* when flushed and in flight (Campbell). Sonagram A shows one of a series of double *croaks*. Birds silent during other observed displays.

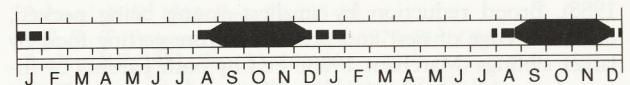


A L. Gillard; P43

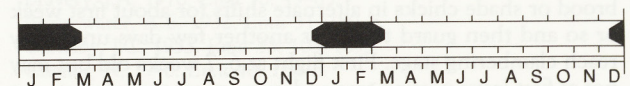
YOUNG After brood stage, young make *chattering rasping* call; either call continuously or start to do so as soon as adult flies to nest or nearby.

BREEDING No detailed field studies. Usually breed colonially, often associated with spoonbills, egrets and cormorants; occasionally solitary. Secondary references (e.g. Aust. Atlas; Frith 1969; Aust. RD) persistently claim or imply that solitary nesting is normal or more usual than colonial. Primary references (Campbell; North; Hobbs 1961; McCulloch 1976; Marchant 1988; Aust. NRS) show the opposite. The mistaken idea may arise because early or late nesters can have active nests and seem to nest solitarily where in mid-season there will be or have been several nests. Also nests may be some distance outside area of main colony. However, solitary nests certainly occur by farm dams and small ponds (Aust. NRS).

SEASON Broadly, as estimated from Aust. NRS cards, nests are started from early Aug. to late Feb. or early Mar. but probably main period of laying varies geographically and from year to year depending on water conditions. Only long-term detailed studies at particular localities would enable greater exactness. However, in n. Aust., N of c. 29°S, most reports (Frith & Davies 1961; Barnard 1914; Aust. NRS) are for laying in Jan. and Feb., even perhaps till first week in Mar. (e.g. in NT, at Camooweal, Cloncurry and Goondiwindi); yet in Goondiwindi area, laying also between 10 and 24 Sept. (Aust. NRS) and in far nw. NSW (Tibooburra area) in first week Aug. In central, sw. and se. NSW, laying recorded during Sept. (Hobbs 1961; Chaffer 1940; Elliot 1940; North; Campbell; Aust. NRS). In particular, at Ivanhoe, clutches



a) s. Aust. (>29°s)



b) n. Aust. (<29°s)

started 1–7 Oct., 23 Nov.–8 Dec., 28 Dec., 25–30 Jan. (Aust. NRS); at Forbes, from mid-Feb. at earliest (McCulloch 1976); at Balranald, NSW, 22 clutches started from about 10 Oct. to 20 Nov. (Lowe 1989); at Moruya, mid-Sept. and from last half Nov. to early Dec. (Marchant 1988). In Vic., laying records from early Aug. to 1 Sept. in Shepparton area; elsewhere (Nhill, Mystic Park, Swan Hill, Bacchus Marsh) in Sept., Oct. and Nov. to 1 Dec. In WA, clutches started 1 Sept. to early Dec. and 1 Feb. (Riggert *et al.* 1965; Aust. NRS).

SITE Often in dead trees standing in water (floods, dams, billabongs, beds of creeks) but also use tall living *Eucalyptus*, *Angophora*, *Melaleuca*, *Casuarina*, *Pinus radiata*. Usually on twisted horizontal or sloping fork of limbs away from centre of trees; about 1–40 m high above water or ground (Campbell; North; Hobbs 1961; McCulloch 1976; Marchant 1988; Lowe 1989). Heronries tend to be small (3–35 pairs) (Campbell; McCulloch 1976; Marchant 1988) but at Mystic Park, 250 recorded (Aust. NRS). Nests not less than 1–2 m apart; perhaps depending on types of trees, with 3–10 nests/tree (Campbell; Marchant 1988). Heronries may persist from year to year (Marchant 1988).

NEST, MATERIALS Bulky, loosely constructed platform with central depression, of sticks and twigs 1–2 cm in diameter; sometimes lined with finer twigs; 30–60 cm across (Aust. NRS). Nests from a previous year may be reoccupied if they survive or new nests built each year, which probably accounts for difference in size of nests. Males select site and start initial structure or begin to repair old nest. When mate found, she remains at nest and male collects twigs from distances of up to 150 m, on ground, from nearby trees and even from water or by pilfering from unoccupied nests, brings them to mate who adds them to nest with tremble-shove movements (Marchant 1988).

EGGS Rounded oval or elliptical; smooth unglazed close-grained shell; uniform pale greyish-blue (North).

MEASUREMENTS: 54 (52–58; 15) x 38 (37–41) (Campbell); 52.9 (51.6–53.8; 12) x 39.4 (38.1–40.1) (North).

CLUTCH-SIZE Few ($n=18$) acceptable clutches in Aust. NRS, mostly from Ivanhoe, NSW: 2xC/2, 3xC/3, 6xC/4, 7xC/5. At Balranald, NSW: 3xC/2, 16xC/3, 8xC/4, 1xC/5, with mean 3.2 (Lowe 1989). Six eggs seen once in nest at Cloncurry, Qld.

LAYING No information, but almost surely at intervals of 48 h.

INCUBATION Probably both parents incubate but change-over not observed (Marchant 1988). **INCUBATION PERIOD:** estimated as 30 days (Lowe 1989), 28–30 days (Marchant 1988).

NESTLING Altricial, nidicolous. Hatching asynchronous, as seen by different sizes of members of brood. Hatched with long greyish white (or dove-coloured?) down. At about 2.5 weeks old, wings well feathered but with down retained on head and neck. Start clambering out of nest when about three-quarters grown and probably 3 weeks old (Marchant 1988). Brood reduction by smallest young being pecked, driven to edge of nest and prevented from getting food by larger siblings (Marchant 1988). Fed by both parents by incomplete regurgitation. All active chicks of brood usually fed during each bout (Marchant 1988). Parents continuously brood or shade chicks in alternate shifts for about first week or so and then guard them for another few days until they reach clambering stage. First flight at 6–7 weeks old but may not at first leave nesting tree and may return to be fed at nest even after leaving nesting tree and forming a club at edge of

water nearby (Marchant 1988).

SUCCESS Estimated as 0.3–1.8 young fledged on average (Lowe 1989); probably brood reduction common except in very favourable conditions and only two young reared from most successful nests (McCulloch 1976; Marchant 1988).

PLUMAGES

ADULT BREEDING Definitive; perhaps alternate (see non-breeding); age attained unknown. **HEAD AND NECK.** Mostly white; pale grey-brown (pale 79) to pale brown (c119D) wash restricted to tips of feathers; seen on close inspection and lost with wear. No brownish wash on chin and throat. Double row of small grey-black (82) spots down centre of throat; central 2–4 rows of feathers of throat have grey-black (82) tips, often lost with wear. Feathers at base of hindneck, chestnut (c32). White feathers of foreneck, long and lanceolate, obscuring upper breast. **UPPERPARTS.** Most scapulars lanceolate; maroon (c31) when fresh, slightly more chestnut when worn; outer scapulars have dark grey (83) outer web and most have dark grey (83) tips. Longest scapulars broad, with rounded tips; these, uppermost scapulars and rest of upperparts dark grey (c83) to grey-black (82), with slight blue-black (c73) or dark green (c162A) iridescence in some direct light; rump lacks iridescence. Back feathers long, rather pointed. **TAIL,** dark grey (83) to grey-black; in some lights, upperside has slight blue-black (c73) or dark green (c162A) iridescence. **UPPERWING,** mostly dark grey (83) to grey-black (82); alula and most coverts have similar iridescence to back. Large white patch at leading edge of wing formed by marginal coverts near carpal joint, and by four outermost median and lesser coverts. **UNDERPARTS.** Upper breast, maroon (c31); central feathers have lanceolate white shaft-streaks, usually concealed by elongate foreneck-feathers. Centre of lower breast, belly, vent, all under tail-coverts and insides of thighs, dark brown (121) with bold white streaking; feathers have dark brown (121) edges and broad white centres that taper somewhat at tip. Rest of underparts, dark greyish brown (121) to dark grey (83). **UNDERWING.** Remiges and greater coverts, dark grey (83) to grey-black (c82); some greater secondary coverts sometimes have small white rosethorns. Other coverts, dark brownish grey (c83); some inner median coverts have white shaft-streaks or inner webs. Marginal coverts outside carpal joint white, forming narrow white leading edge.

ADULT NON-BREEDING Definitive, basic? Head and neck have pale grey-brown (c79) to pale brown (119D) tinge to ends of feathers, which looks more intense than in adult breeding. Rows of grey-black (82) spots on centre of throat heavier than in adult breeding, sometimes forming continuous stripe from mid-throat to foreneck; central 2–4 rows of throat-feathers have grey-black (82) tips, broader than in adult breeding. Unclear if head and neck plumage appears as adult breeding when worn, or whether breeding plumage brought about by partial moult. Claims that adults lose maroon scapular plumes in non-breeding plumage (e.g. Hancock & Kushlan 1984) not adequately reported; perhaps based on incorrect ageing of immatures. Five skins collected in winter (MV, HLW) had lanceolate maroon (31) scapulars; these perhaps less extensive than in adult breeding, but difference not clear.

DOWNY YOUNG Down is long, especially on crown, and sparse. Head and neck, white. Upperparts and upperwing, light grey-brown (c119c) when young; these areas appear dark grey when juvenile feathers begin to emerge.

Down on underparts, pale grey (c86).

JUVENILE Differences from adult: **HEAD AND NECK.** Broad strip of grey-black (82) spots runs down central throat and foreneck; feathers white with grey-black (82) spot on inner web. Most of head and neck has brownish-grey tinge, caused by partly veiled dark brown (121) subterminal bands, narrowest near shafts of white feathers. When fresh, forehead, crown and nape feathers have grey-brown wash at tips, causing capped appearance, lost with wear. Foreneck feathers long with rounded tips. Base of hindneck, mottled dark grey, white and light rufous; feathers, dark grey (83) with narrow white tips and indistinct brown (223C) shaft streaks. **UPPERPARTS,** uniform brownish black; all feathers short with rounded tips; feathers, dark grey (brownish 83), with indistinct brown (223C) shaft-streaks and narrow white tips rapidly lost with wear. **UPPERWING.** Coverts like feathers of back, without slight iridescence of adults; marginal coverts of some have narrow white shaft-streaks. **UNDERWING.** Most coverts, especially primary median coverts, have small white rose-thorns.

IMMATURE Age attained and lost unknown. Only two specimens examined, collected June, Sept.; thought to be immature because body plumage considerably more worn than adults at same time of year. Similar to adult non-breeding, but dark grey (83) wash to tips of feathers of crown and nape gives dark-capped appearance, perhaps lost with wear. No maroon scapulars; shape of back feathers intermediate between adult and juvenile.

BARE PARTS Based on label data (ANWC) and photos in Pringle (1985) and unpublished, except where stated.

ADULT Iris, light yellow (c157); pea-green also recorded (Serventy & Whittell 1962). Bill, mostly grey-black (82), with cream (92) mandibular rami and sometimes cream (92) patch behind nostrils. Bare facial-mask, rictus and base of upper mandible, usually dark grey (83), becoming light blue (67) for short period during breeding season. Creamy-green or pale yellow streak from eye to lower mandible has been reported (Hall 1974); facial skin also described as greenish yellow (Gould 1865). Legs and feet, grey-black (82); tibia often has olive-yellow tinge that sometimes extends down front of tarsus.

DOWNY YOUNG Iris, buff-yellow (c53); eyelids, straw-yellow (57). Bare facial-mask, dark grey (c83); greenish (-) also reported. Lower mandible, buff to greenish grey (-) with grey-black (82) tomlia and tip; upper mandible, grey-black (82). Feet, greenish grey (-).

JUVENILE Iris and bill as non-breeding adult. Bare facial-mask, grey-black with broad olive to olive-yellow stripe from iris to base of nostrils; this apparently narrows with age. Legs and feet, black (HLW; CSIRO).

IMMATURE Eye, yellow. Upper mandible and tomlia of lower mandible, black; rest of bill, yellow. Facial skin, olive; legs and feet, black (HLW).

MOULTS

ADULT POST-BREEDING Probably complete. Primaries irregular and moult probably rather prolonged; slight, irregular differences in wear between primaries can be detected in most birds. Active primary moult recorded Nov., Dec., Mar., June (MV, HLW). Wear of body feathers in individuals usually fairly uniform, suggesting body moult more rapid than primary moult.

POST-JUVENILE Partial; body, head and neck.

Probably occurs in first winter; only two specimens examined in post-juvenile moult were collected June and Sept. (when almost complete). Moult of upperparts completed before that of throat and underparts. Unknown when primaries replaced.

SUBSEQUENT MOULTS No information.

MEASUREMENTS (1) Aust., adults, skins (ANWC; MV; HLW). (2) Aust., juveniles, skins (ANWC; MV; HLW).

	MALES	FEMALES
WING	(1) 412.6 (10.27; 395-431; 10)	402.7 (14.15; 383-426; 10)
8TH P	(1) 291.2 (9.24; 276-305; 10)	283.9 (10.69; 267-302; 10)
TAIL	(1) 161.9 (4.52; 155-169; 9)	153.9 (8.48; 141-166; 7) *
BILL	(1) 84.8 (3.58; 80.4-90.0; 10)	81.4 (2.92; 75.8-87.2; 10) *
TARSUS	(1) 134.1 (7.15; 121.2-146.4; 10)	130.3 (6.32; 120.2-143.5; 9)
TOE	(1) 87.4 (1.36; 85.1-89.3; 5)	84.2 (4.07; 78.2-87.1; 4)
UNSEXED		
WING	(2) 399 (12.76; 388-420; 4)	
8TH P	(2) 273, 275, 290	
TAIL	(2) 148.3 (4.44; 141-153; 4)	
BILL	(2) 71.9 (2.30; 70.1-76.2; 5)	
TARSUS	(2) 131.8 (9.34; 115.7-143.6; 5)	

WEIGHTS Combined adults and juveniles, Vic.: 881 (170.1; 600-1220; 9; MV; ANWC).

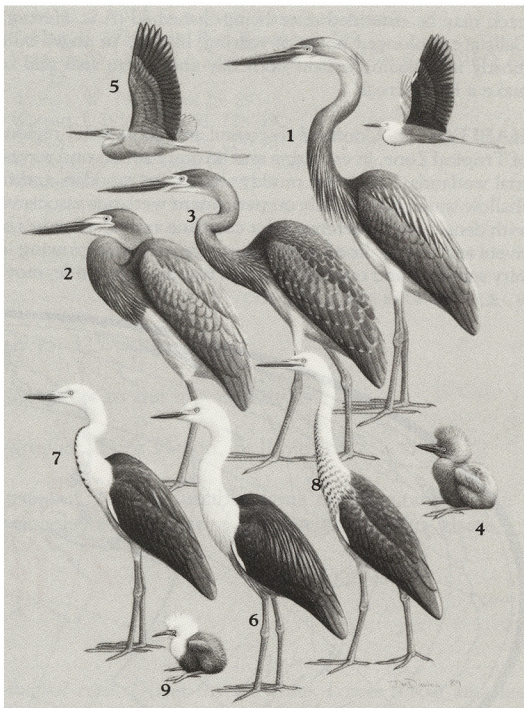
STRUCTURE Wing, broad. Eleven primaries, p8 usually longest. p10 13-27 shorter, p9 0-8, p7 0-8, p6 11-19, p5 36-57, p4 72-83, p3 94-113, p2 113-123, p1 125-144; p11 minute. Inner web of p8-p10 emarginated, slight emarginations outer web p7-p9. Eighteen secondaries, including 5-6 tertials. Tail, square; 12 feathers; t1 c. 7 mm longer than t6. Pair of powder-down tracts on sides of upper breast, pair on sides of rump and pair on insides of thighs. Lores, eye-ring and skin above gape, bare. Bill, fairly long and narrow; culmen and tomlia, slightly convex; underside of lower mandible almost straight, slightly upturned at gonys. Nostrils, narrow and slit-like, below culmen. Legs, long, scutellate, upper third of tibia feathered. Middle toe longest; outer c. 83%, inner c. 74%, hind c. 60%. Middle claw, pectinate.

DIR

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Volume 1 (Part B), Plate 69

Great-billed Heron *Ardea sumatrana*

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

Pacific Heron *Ardea pacifica*

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

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