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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 intermedia **Intermediate Egret**

COLOUR PLATE FACING PAGE 965

Ardea intermedia Wagler, 1829, *Isis von Oken* 6: col 659 — Java.

The size in the range of white egrets is identified by the specific name.

OTHER ENGLISH NAMES Plumed or Yellow-billed Egret.

Choice of name is difficult. **Plumed** is uninformative because other species develop aigrettes when breeding. *Ardea garzetta* has even more showy plumes than this species. The colour of the bill varies and becomes black during breeding in some subspecies. Therefore a simple translation of the scientific name seems best, putting the species on size in its place in the series of white egrets.

POLYTYPIC Nominate *intermedia*, Pakistan, India, se. Asia, Japan, Indonesia, New Guinea, Aust.; *brachyrhyncha* (Brehm, 1854), Africa S of Sahara.

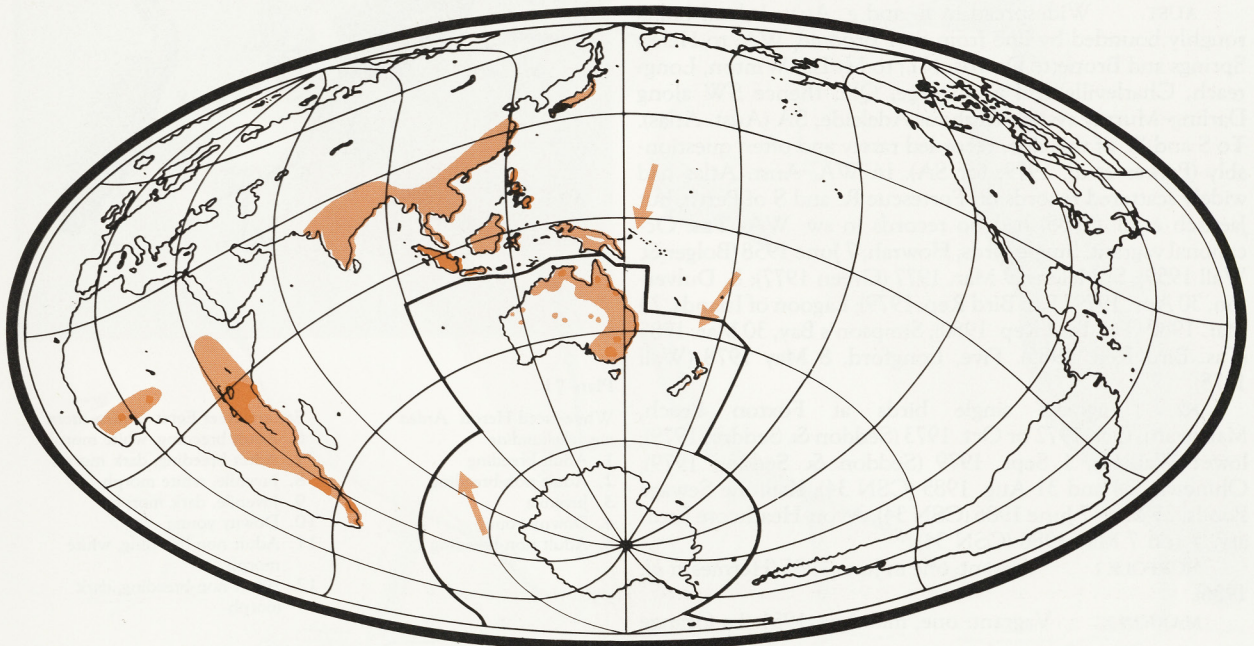
FIELD IDENTIFICATION Length 56–70 cm, of which head and neck about half; weight 400 g. Slender white egret with long neck and dark legs; colour of bill changes according to season. Similar in size to White-faced Heron *A. novaehollandiae*. Sexes similar. Seasonal changes in plumage (plumes on back when breeding) and colour of bare parts. Juveniles like non-breeding adults, with faint yellow wash.

DESCRIPTION ADULT BREEDING. Wholly white with sleek appearance in normal roosting, feeding and flying positions. Pronounced bib on upper breast formed by long dense plumes. Train of long filamentous aigrettes rising among scapulars, extending up to 10 cm beyond tail. Plumes lifted and fanned during courtship, greeting and agonistic displays. Colours of bare parts change during breeding cycle. During courtship: bill, deep pink to bright red with yellow tip; base of lower mandible, green. Lores, bright green. Iris, red. Tibia, bright ruby-red; rest of leg varies (ruby-red, with or without black anteriorly, or black with red wash). By time of laying: bill, dull red. Lores, dull pale-green. Iris, yellow. By time of hatching: bill, dull orange-yellow. Lores, green-yellow to yellow. Iris, yellow. Upper leg, yellowish; lower leg, grey-black. Line of gape extends back from greenish lores to end below rear of eye, not extending beyond as in Great Egret *A. alba*. **ADULT NON-BREEDING.** Like breeding but without plumes on scapulars and no long breast-feathers. Bill, yellow-orange to buff. Lores, green-yellow to yellow. Iris, horn. Tibia and hind tarsus vary: yellow, brown, green or grey; rest of legs and feet, black. **JUVENILE.** Like non-breeding adult. **NESTLING.** Down, wholly white. Bill varies: bright yellow, yellow with varying amounts of black at base and gape, yellow with black tip and gape, wholly black. Lores, bright yellow or yellow and black. Iris, pale yellow. Tibia, green; tarsus, grey-green to black; soles, pale grey.

SIMILAR SPECIES Similar to other all-white egrets in Aust. **Little Egret** *A. garzetta* has long fine black bill and is quick and flighty in movements. **Great Egret** has head and neck 1.5 times length of body, flat profile of head without prominent jowl; distinct gape that extends behind eye. **Cattle Egret** *A. ibis* is shorter, stockier with stout bill and has yellow-grey rather than black legs. **White morph of Eastern Reef Egret** *A. sacra* has heavier bill with horn-coloured upper mandible, shorter yellow-green legs, shorter neck and crouched stance; occurs mostly in coastal habitats unlike Intermediate Egret. Nestlings distinguished from above species by straight robust bill with mean length:depth ratio of 3:11 and gape that extends below rear of, but not behind, eye. Cattle Egret nestlings also have this feature but slightly downcurved bill (Maddock 1989).

Seen singly or in open companies, sometimes in hundreds, foraging mostly in freshwater wetlands, shallows of rivers, swamps, lagoons, dams, sewage farms, irrigation areas and among cattle in pastures; in Kakadu, also observed foraging over deeply flooded areas by walking slowly over dense matted vegetation (Morton *et al.* 1989); rarely in coastal habitats. Hunt by standing and waiting, gleaning, peering and foot-stirring; with neck extended either vertically or horizontally or sometimes held close to body. Gait when foraging and walking, graceful and slow (much more deliberate than other Aust. egrets). Fly with head drawn back and feet extended. Nest colonially with other species of waterbirds; during breeding season, elaborate scapular plumes and breast feathers raised and fanned in display. Generally silent though utter rattling croaks and guttural calls at nest-site.

HABITAT On terrestrial wetlands, wet grasslands and, rarely, in sheltered coastal habitats. Prefer to forage in still



fresh water <80 mm deep, among dense aquatic and emergent vegetation (Recher & Holmes 1982; Garnett & Bredl 1985; Morton *et al.* 1989); but also in deep water by walking on matted vegetation or diving for fish near surface (Klapste 1976; Morton *et al.* 1989). Usually seen on billabongs, pools, swamps and watercourses on floodplains, with short or tall emergent vegetation of grass, herbs, sedges, reeds or rushes (e.g. *Hymenachne*, *Pseudoraphis*, *Ludwigia*, *Phragmites*, *Eleocharis*, *Typha*) and abundant aquatic flora; and wet meadows. Also in swamps or on shallow margins of large lakes vegetated with shrubs (*Muehlenbeckia*) or trees (e.g. *Eucalyptus*, *Melaleuca*), open fresh waters, and moist pasture (Hobbs 1961; Goodrick 1970; Crawford 1972; Vestjens 1977; Corrick & Norman 1980; Gosper 1981; McKilligan 1984; Fjelds 1985; Schulz 1989). Occasionally in saline habitats: estuarine mangrove swamps, saltmarsh, intertidal flats and tidal reaches of rivers and creeks (Gill 1970; Goodrick 1970; Gosper 1981; Schulz 1989).

Nest in trees standing in or near water; in freshwater swamps inland or in mangrove forest along coast (Gosper 1981; Garnett 1985). At Booligal, NSW, breed in swamps with climax vegetation of ribbonweed and abundance of fish; if swamps dry out, breeding does not start until maximum flooding reached (Crome 1988).

Roost in trees fringing wetlands.

Clearing of low-lying wooded areas has extended feeding habitat, and species has benefited from irrigation schemes (Aust. Atlas). Many natural freshwater wetlands used for feeding and breeding have been destroyed or modified by drainage, clearing, grazing, burning, increased salinity and invasion by introduced plants, particularly *Mimosa* (Goodrick 1970; Morton *et al.* 1989; Schulz 1989). In NT, feral buffalo break down levees and allow salt intrusion and accumulation of tidal sediment in floodplain wetlands favoured by Intermediate Egrets (Schulz 1989).

DISTRIBUTION Africa; Pakistan to Japan, S through Philippines, Indonesia, and s. New Guinea to Aust. Vagrant to Tas., NZ, Norfolk I., Marion I. and, extraliminally, to Cape Verde Is, Dead Sea, and central Asia.

AUST. Widespread in n. and e. Aust. Inland limits roughly bounded by line from S of Broome, WA; to Helen Springs and Brunette Downs, NT; to Mt Isa, Winton, Longreach, Charleville and St George, Qld; thence SW along Darling-Murray system to about Adelaide, SA (Aust. Atlas). To S and W of this line, recorded rarely and often questionably (Parker *et al.* 1979; for SA). In WA, Aust. Atlas had widely scattered records on Fortescue R. and S of Perth, but Jaensch *et al.* (1988) had no records in sw. WA. Tas. Occasional vagrant. Single birds, Howrah, 7 June 1958 (Bolger & Wall 1959); St Helens, 9 Mar. 1977 (Green 1977); L. Dulverton, 30 Apr. 1979 (Tas. Bird Rep. 1979); Lagoon of Islands, 24 Mar. 1980 (Tas. Bird Rep. 1980); Simpson's Bay, 30 Mar. 1985 (Tas. Bird Rep. 1985). Five, Longford, 8 May 1978 (Wall 1978).

NZ Vagrant: single birds at Foxton Beach, Manawatu, Oct. 1972 or Oct. 1973 (Seddon & Seddon 1979); lower Waikato, 1 Sept. 1979 (Seddon & Seddon 1979); Ohinewai, 24 and 31 Aug. 1985 (CSN 34); Kaikohe Sewage Ponds, 25 May-7 June 1986 (CSN 34); Avon-Heathcote Estuary, 5 and 7 May 1986 (CSN 34).

NORFOLK I. Vagrant: one in June 1985 (Hermes *et al.* 1986).

MARION I. Vagrant: one, mid-Apr. 1951 (La Grange

1962). Eight white egrets identified by observer as Cattle Egrets (Crawford 1952) may have been Intermediate Egrets (Watson 1975).

BREEDING Assumed to breed widely throughout regular range on mainland but little information. Known or suspected colonies on Behn R., WA; lower Adelaide R. and mouth of Roper R., NT; Uanda, SE of Hughenden, Qld, and coastally in Qld on Edward and Mitchell Rs, C. York Pen., in district of Townsville and Ayr, in Brisbane area and se. corner of Qld and ne. corner of NSW; Macquarie Marshes, Koorang I. and Shortland Wetlands Centre, Newcastle, and along Murray R., E to Albury; only record in Vic. at Gunbower I., Murray R. (Aust. Atlas; Aust. NRS; Vic. Atlas; NSW Bird Repts 1985, 1986; Morris *et al.* 1981; Draffan *et al.* 1983).

MOVEMENTS Poorly known, apparently sedentary in some areas but large seasonal variations in populations suggest much dispersion in others, possibly migration; one immature

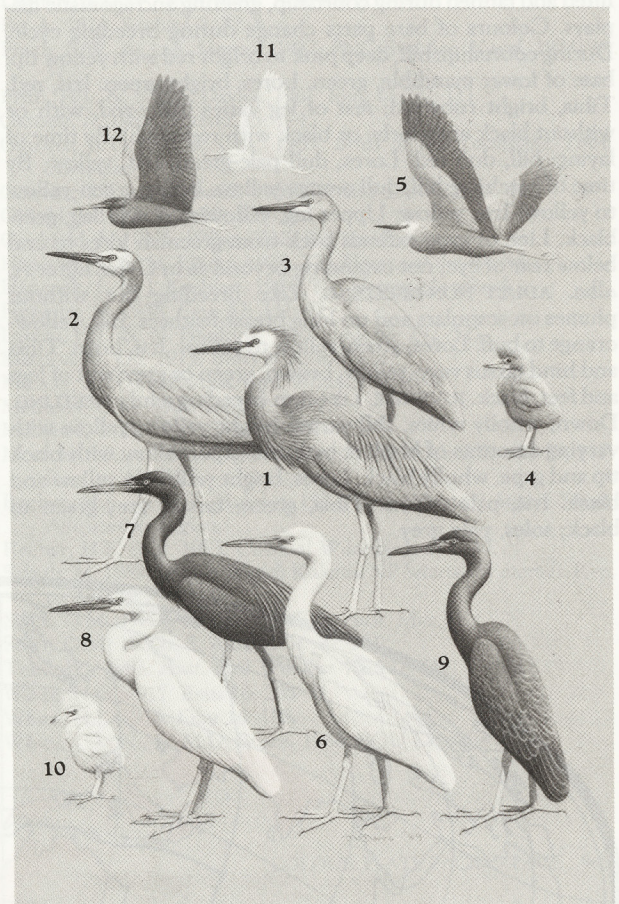


Plate 71

White-faced Heron *Ardea novaehollandiae*

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

Eastern Reef Egret *Ardea sacra*

6. Adult breeding, white morph
7. Adult breeding, dark morph
8. Juvenile, white morph
9. Juvenile, dark morph
10. Downy young
11. Adult non-breeding, white morph
12. Adult non-breeding, dark morph

from Vic. recovered Irian Jaya. Fluctuation of population in district of Alligator Rs, NT, could be accounted for by concentration round breeding colonies in wet season and at permanent waterholes in dry (Morton *et al.* 1989). Tagged birds at Shortland, central e. NSW, mainly recorded <30 km from banding site over 4 years; but one third-year bird sighted live at Hawks Nest, NSW, and one first-year bird near Kurnell, Sydney. Tagged bird from Lawrence, NSW, sighted in Williams R. valley, NSW, in second year of life (M.N. Maddock). Apparently resident Innisfail (Gill 1970) and Magnetic I. (Wieneke 1988), Qld, and reporting rates in Vic. suggest no long-distance seasonal movements (Vic. Atlas). However possibly migrates N-S along C. York Pen.: winter visitor to Torres Str. (Draffan *et al.* 1983), where flocks seen crossing S in Nov.-Dec.; occupy breeding sites in se. corner of Gulf of Carpentaria until Mar.-Apr. (S.T. Garnett) and numbers peak Edward R., w. C. York Pen., Mar.-June (Garnett & Bredl 1985), which suggests gradual movement N as more s.

ephemeral swamps dry out. Also winter visitor to Pilbara (Serventy & Whittell 1976). Most abundant near Darwin June-Aug. (Crawford 1972) and absent from Atherton Tableland Feb.-Mar. (Bravery 1970). On ne. NSW coast numbers show slight negative correlation with local rainfall and water-levels (Gosper *et al.* 1983) with marked peak Mar.-May (Gosper 1981) possibly corresponding to absence in sw. NSW May-July (Hobbs 1961). Similar negative correlation with local rainfall shown for numbers recorded during Oct. counts in se. Qld (Woodall 1985). Congregate at permanent water on New England Tableland during drought (White 1987). The few NZ records (Seddon & Seddon 1979; NZCL) show no seasonal pattern.

BANDING 35S144E 01 P U ? 3977 339 ABBB

FOOD Aquatic animals, principally fish but also frogs, with lizards and grasshoppers main food in drier habitats. **BEHAVIOUR** Hunting either by standing and waiting for prey, gleaning, peering or foot-stirring (Recher & Holmes 1982; Recher *et al.* 1983). Individuals hunted with neck extended either vertically or horizontally into vegetation or held close to body. Observed hunting small skinks by series of fluttering hops (M.N. Maddock). At Kakadu, NT, 78.8% of time spent standing and waiting; when moving, travels mean distance of 6.1 m at 0.5 ± 0.02 steps/s, averaging 0.7 attacks/min with 67.5% success (213 observations, 214 min; Recher & Holmes 1982). When hunting grasshoppers, swayed head from side to side, then grabbed prey, catching 8-10 per min (J.E. Wajon). Hunts alone but more usually in loose congregations, sometimes >250 birds (Gosper 1981). Also seen hovering briefly, then diving vertically onto fish like terns (Klapste 1976). Noted feeding only during day (Recher *et al.* 1983).

ADULT Recorded taking insects (Mathews 1910; Recher & Holmes 1982; Recher *et al.* 1983) incl. crickets (Hall 1974), grasshoppers (Hall 1974; J.E. Wajon), waterbugs (Vestjens 1977), larvae (Hall 1974); spider egg-case (Hall 1974); fish (White 1917; ≤10 cm; Recher & Holmes 1982; Recher *et al.* 1983) incl. *Carassius auratus*, *Gambusia affinis* (Vestjens 1977); frogs (13 cm; Hall 1974; Recher & Holmes 1982; Recher *et al.* 1983) and a snake *Pseudechis porphyriacus* (38 cm; Gill 1963). At Kakadu most prey <3 cm (Recher & Holmes 1982; Recher *et al.* 1983).

NESTLING Summarized Table 1. At Shortland, e. NSW (33 boluses; Baxter & Fairweather 1989) animals 98.1% bolus wt., 100% freq.: spiders 3.6% live wt., 2.3% bolus wt., 0.58 cm cephalothorax (Atyidae <0.1% bolus wt., 6% freq., Parastacidae -, 3, *Geolycosa*, Pisauridae), insects 25.3% bolus wt., 2.13 cm incl. odonatan 0.1, 2.93 cm, orthopterans 22.4, 2.26 cm less terminalia (Tettigoniidae 0.8% live wt., 1.0%

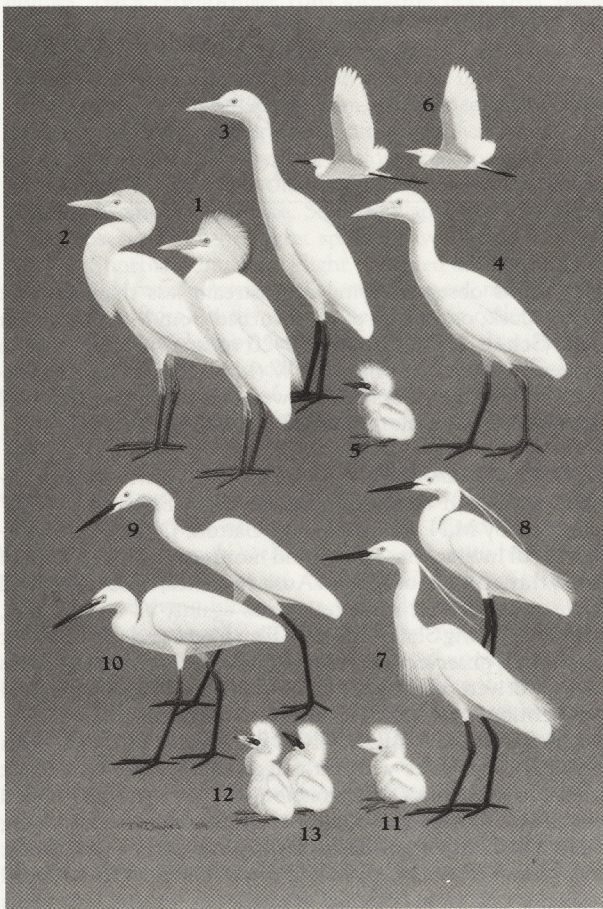
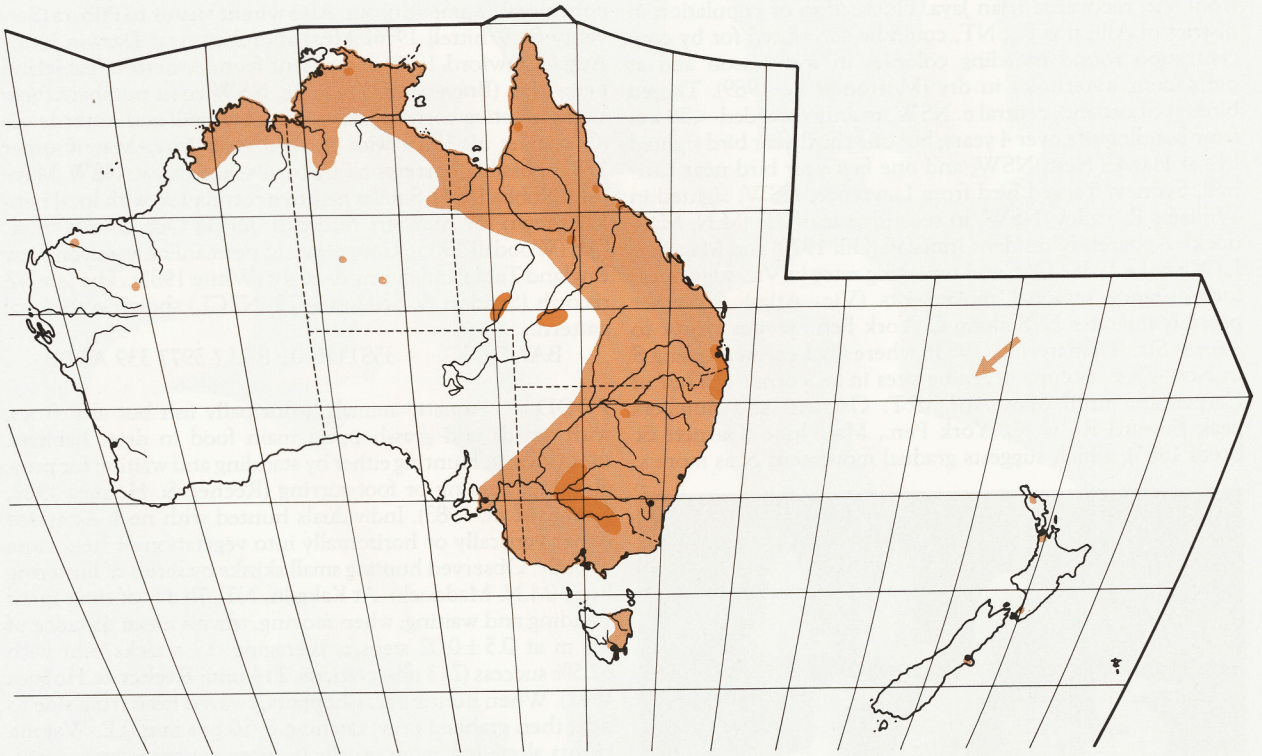


Plate 72
 Little Egret *Ardea garzetta*
 Cattle Egret *Ardea ibis*
 1. Adult breeding (with courtship flush)
 2. Adult breeding (without courtship flush)
 3. Adult non-breeding
 4. Juvenile
 5. Downy young
 6. Adult non-breeding
 7. Adult breeding (with courtship flush)
 8. Adult breeding (without courtship flush)
 9. Adult non-breeding
 10. Juvenile
 11. Downy young, light form
 12. Downy young, intermediate form
 13. Downy young, dark form
 14. Adult non-breeding

Table 1. Diet of nestling Intermediate Egret.

Percentages	live wt. ¹	no. ²	freq. ¹
FISH	57.9	11	30-91
FROGS	1.8	11	18
SKINKS	12.3	48	24
SPIDERS	3.6	36	
INSECTS	24.4	30	79
Odonatans	<0.1	19	21
Orthopterans	24.4	11	58

¹ Shortlands (Baxter & Fairweather 1989); ² Se. Qld (N.G. McKilligan).



bolus wt., 18% freq., 1.43 cm, Gryllidae 18.4, 17.7, 33, 2.35 cm, Acrididae 5.2, 3.7, 27, 2.26 cm), bugs (Naucoridae <0.1, 0.3, 24, Belostomatidae 1.25 cm), beetles <0.1, 0.5, 12, other insects <0.1, 2.0, 27, fish 2.74 cm (*Anguilla* 2.9% bolus wt., 12.1% freq., *Gambusia affinis* 19.8% live wt., 8.6% bolus wt., 30% freq., other fish 46.5% bolus wt., 49% freq. incl. *Macquaria colonorum*, Eleotridae), frogs 2.6% bolus wt., 2.24 cm snout-vent length, lizards 8.2% bolus wt., 4.31 cm snout-vent length, birds <0.1% live wt., 0.1% bolus wt., 3% freq., mammals <0.1, 0.7, 3; plants 1.9% bolus wt., 55% freq. Fish probably scavenged from heronry floor. Preliminary observations at same site (Maddock 1986) had noted fish, incl. eels (8 cm), *Gambusia affinis*, early in breeding season, and spiders, crickets, lizards *Lampropholis delicata* (Maddock 1986; M.N. Maddock) later. In se. Qld, nestlings (4–24 days old, 27 items; N.G. McKilligan); insects incl. odonotans 19% no.; lizards were all skinks.

SOCIAL ORGANIZATION Not well known and no detailed studies in Aust.; information from Shortland, NSW (supplied by M.N. Maddock) and Gatton, Qld (N.G. McKilligan).

BONDS No detailed data. Observations at Shortland and Gatton indicate monogamous pair-bond, at least for nesting season. However, at Gatton, at one nest, three birds initially; third bird, thought to be female, was accepted by male and sat on eggs but was chased off by female when attempting to approach closely; extra female not seen after early incubation (N.G. McKilligan). Both sexes take part in building, brooding and care of young.

BREEDING DISPERSION Colonial; in dense colonies among other waterbirds; in Kakadu, 1800 and 3000–4000 nests reported from two known colonies. Defend territory round nest-site.

ROOSTING Communally, at night. In Kakadu,

NT, egrets observed flying downstream less than an hour before dusk; one group of 35 disturbed from *Melaleuca* after dark (Schulz 1989). Group of >20 roosted in casuarinas in swamp, Williams R. valley, NSW (M.N. Maddock). Also observed roosting in trees besides wetlands during day, in small flocks, sometimes more than 20 (Schulz 1989).

SOCIAL BEHAVIOUR Not well known and no detailed studies in Aust.; information from Shortland, NSW (supplied by M.N. Maddock) and Gatton, Qld (N.G. McKilligan). All interactions slower and more sedate than typical of other three species of egret in Aust. In Africa, males select and aggressively defend small territories against all conspecifics, with Snap, Twig Shake, Stretch, Flap Flight and Circle Flight displays all observed, and females repeatedly approach males and are driven off (Blaker 1969). This kind of aggression and competition for mates not observed at Shortland.

AGONISTIC BEHAVIOUR At Shortland, birds usually occupy sites with little aggression. **THREAT.** Thrust head towards object of aggression, all body-feathers fluffed out and plumes erected. Opponents often displaced by flying directly at them. Agonistic displays against Cattle Egrets (adult and young) observed, including displacement. Protect small young or eggs from potential predator (e.g. raven): bird tucks neck close to body, points beak towards threat, enlarges profile by fluffing out feathers and plumes, and crouches close to nest. At Gatton, once observed to defend young from Brown Goshawk that landed within few metres of nest: male Egret flew from where it was perched to crouch over chicks with plumes raised, wings partly extended and calling *kroo-kroo*...

SEXUAL BEHAVIOUR Birds in courting colours (red-eyed) take up position at or close to final nest-site and spend much time standing and preening. Mate (also red-eyed) eventually joins bird at site, and both spend considerable time

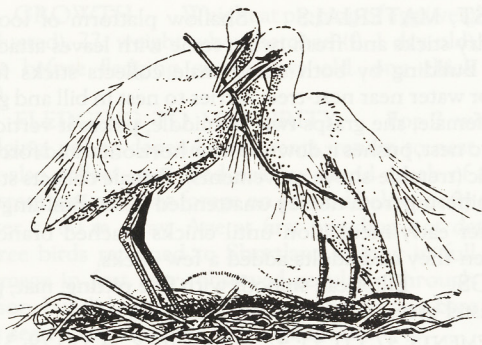


Fig. 1 Change-over at nest

standing at site. **COURTSHIP.** Not well studied; displays observed include elaborate erection of scapular and pectoral plumes. **Back-biting:** male runs vibrating beak over back-feathers of mate; twining of necks; and **Curtsey (Bob):** bird arches neck, tucks beak close to breast and then quickly lowers tarsus to horizontal position and bobs up again one or more times in curtsey-like rhythm, performed at intervals; Curtsey, elaborate and performed often; significant feature of social interaction. Long periods of slow preening occur with both birds at nest. **PAIR-FORMATION** takes 1–4 days, before building begins. Twig Shake, Stretch, Flap Flight and Circle Flight observed in other egret species have not been recognized at Shortland but Flap Flight observed at Gatton. Both sexes build, female remaining at or near nest, male ferrying sticks stolen from nearby unattended nests or collected from ground or water close by; female sometimes steals sticks from nearby nests. Elaborate arching of neck and display of plumes accompanies hand-over of sticks. Builder places stick with **Tremble-shove** action. Long periods of inactivity and preening often follow delivery of sticks. Curtsey often performed during building. **GREETING DISPLAY** always takes place at nest-relief (Fig. 1): scapular plumes raised and fanned; pectoral plumes and feathers of crown and nape raised. Sitting bird extends neck, strongly arched into S-curve, with bill directed towards approaching mate, then stands; sitting bird, and sometimes arriving bird, Curtsey slowly, repeated up to 12 times and occasionally accompanied by forward tilting of body. Male often mandibulated head and upperneck of returning female (**Back-bite**) and once probed her back-feathers briefly. Arriving bird always gave series of soft croaks *cro-cro-cro*. . . or quiet rasping calls (see Voice) as it stepped onto nest; relieved bird replied on at least one occasion. Birds depart silently. When returning to feed advanced chicks and when leaving at end of feeding session, raising of plumes and Curtsey components of Greeting Display given in perfunctory manner. When nearly fledged, chicks observed using Curtsey during interactions with siblings. **COPULATION.** Few observations; accompanied by elaborate display of plumes. At Shortland, one observation: female crouched, male stood upright on her back and very slowly made treading motions as if balance precarious, making gentle pecks at head of female. Female stretched head upwards. After several minutes, male crouched down, cloacal contact took place and male stepped off, followed by slow dance by one bird and three Curtseys by other. In another observation, male perched about neck-length from female, performed **Back-Biting** repeatedly over several minutes, before quickly mounting. Observed twice at Gatton at one nest, on successive days with third egg being

laid during intervening late afternoon or night. Once, preliminaries simply involved female standing up on nest, shaking body and preening, whereupon male, who had been preening nearby, mounted. In both copulations, female then raised folded wings to horizontal, flexed legs slightly and raised tail. Male curled toes round leading edge of female's wing and as copulation proceeded, raised wings to about 45° above horizontal and flapped them jerkily.

RELATIONS WITHIN FAMILY GROUP Both parents incubate, brood and feed chicks. When temperatures > 30 °C and sun directly on nest, adult protects young from heat by turning its back to sun, squatting on tarsi and drooping wings to cast shadow (latter not observed at Gatton), also opens bill and pants. Once observed protecting young from very strong winds at Shortland, by pointing head towards wind, flattening body low in nest and trailing wings backwards over edge of nest. From about 21 days old, chicks **THREATEN** parents as they return to nest: head held low and bill stabbed horizontally towards parent, wings lifted from sides, crown-feathers raised and splayed in central parting and feathers of upperbreast and back raised (Forward Display; Meyerriecks 1960). Between stabs, wings lowered and series of hoarse croaks given. This display also given to other intruding birds. Chicks, 4–10 days old, stabbed at observer; from 10–20 days old they covered; when older, tried to escape. **HOSTILITY BETWEEN SIBLINGS.** Overt aggression usually consisted of hard stab with bill at head of another. Chicks occasionally fenced bills and often grabbed each other's bills but latter action usually appeared to be part of begging display and neither action counted as being aggressive unless it resulted in withdrawal of one of combatants. Between 5 and 12 days old, chicks gave aggressive display: body raised, neck extended vertically and bill directed downwards towards sibling (Stiff-Necked Upright Display; Meyerriecks 1960); sibling sometimes returned display. Such confrontation ended after few seconds with one bird lowering head and facing away with closed or half-closed eyes, sometimes after receiving single hard peck. Older chicks not seen giving this display and only rarely pecked one another; they did, however, jockey for central position on nest. Of 48 aggressive encounters among chicks, 46 occurred when they were 6–12 days old and only two between surviving chicks aged 19–48 days: one chick won all its 35 fights, four of them by display only; two other chicks won ten and three respectively and on at least four occasions, these chicks started fights that they lost. Most (83%) fights not during feeding bouts (defining bout as encompassing period of continuous begging). Chicks fed at nest for c. 3 weeks after fledging (7–10 weeks old), then left heronry.

VOICE Not well known; no detailed studies in Aust.; information for Aust. supplied by M.N. Maddock (from Shortland, NSW) and N.G. McKilligan (Gatton, Qld); some extralimital information in Blaker (1969) and BWP. Generally silent, especially away from nest; quiet at nest-site, giving a few soft rasping, croaking or buzzing calls. Much quieter than other three species of egret in Aust. and calls differ somewhat in quality (as found for African birds [Blaker 1969]). All calls difficult to hear amid chatter and noise of rest of colony. Non-vocal sounds: males make exaggerated wing-noise during Flap Flight Display. No information on sexual or individual differences or geographical variation.

ADULT Greeting Call. Series of soft croaking *cro-cro-cro*. . .; described as soft and rasping at Shortland. Always given by arriving bird (both sexes) as it stepped onto nest;

performed throughout courtship, and at change-overs during incubation, brooding and feeding; sitting bird replied only once. Quite unlike buzzing sound described by Blaker (1969) (N.G. McKilligan). At Shortland, when birds arriving at nest for change-over or to feed unattended young, calls described as sequence of two-syllable calls made in form of soft rasping *grrrrk grrrrk*. No call on leaving nest. **Alarm Call.** At Shortland, when disturbed at nest, utter soft repeated *glock glock*. At Gatton, in response to Brown Goshawk perched nearby, male uttered repeated throaty *kroo-kroo*, each *kroo* lasting c. 1.5 s; similar to but less prolonged than alarm *kreow* of Cattle Egret. No alarm calls reported in Africa (Blaker 1969). **NON-VOCAL SOUNDS.** Males engage in noisy Flap Flight Display, making exaggerated wing-noise; given when leaving female on nest during egg and nestling stages (cf. Blaker's [1969] statement that Flap Flight occurs only in unmated and newly-paired birds).

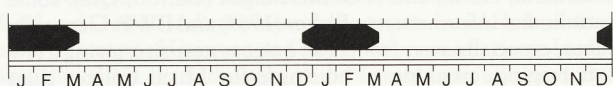
YOUNG Begging Call. Repeated high-pitched sing-song *chi-chi*; becomes lower-pitched *cro-cro* or *khe-khe* as chick becomes older; rate of calling sometimes lessens as feeding session continues, at least in older chicks. **Greeting Call.** Chicks returning to nest greet sibling with throaty *kroh* repeated about twice/s (slower than repetition rate of Begging Call). **Threat Call.** given to intruding birds, similar to Greeting Call but harsher. When stabbing with bill towards antagonist, young chicks give single sharp *chee* and older chicks utter duller *thok* with each stab.

BREEDING Poorly known, except for study of two nests by N.G. McKilligan at Gatton, Qld, in 1987-88; additional information from M.N. Maddock and Aust. NRS. Information mostly supplied by N.G. McKilligan and M.N. Maddock. Breed in simple pairs, colonially, with other species of herons, ibises, spoonbills, cormorants; in trees in or near water. Proportions of nests in mixed colonies; 8-20% of 350-550 nests at Shortland, NSW; elsewhere c. 1% of small (100+) colony at Seaham; 16-50% of large (2000-3000) colonies at Macquarie Marshes and in NT (Aust. NRS).

SEASON At Gatton, laying from Oct., depending on occurrence of heavy rains to replenish swamps. At Shortland, Nov. to early Apr., laying completed by mid-Jan., last young early Apr. Elsewhere, active nests recorded (Aust. NRS): NSW, Nov.-Apr.; Vic., Nov.-Jan.; NT, Jan.-Apr. Use of colonies erratic, depending on rainfall and water conditions; in Lockyer Valley, Qld, nested only in 4 of 10 years (1979-89).



a) se. Aust.



b) n. Aust.

NEST, MATERIALS Shallow platform of loosely woven, dry sticks and fresh twigs, some with leaves attached (North). Building by both sexes; male collects sticks from ground or water near nest-tree; carries to nest in bill and gives them to female; she grasps twig in middle, pokes it vertically down into nest, pushes it down to near horizontal and forces it into fabric (tremble-shove movements). Female collects sticks only by pilfering from nearby unattended nests. Building not noted after early incubation until chicks reached brancher stage when they and adults added a few sticks.

EGGS Elliptical; smooth with fine pitting, mat; pale green, pastel-green or sea-green to greenish white.

MEASUREMENTS: 47.1 (1.95; 42.9-50.0; 16) x 34.3 (0.79; 33.2-35.8) (N.G. McKilligan); 46.6 (46.0-47.5; 8) x 32.2 (31.2-34.8) (North).

CLUTCH-SIZE No quantified data. Generally said to be 3-4 but 2-6 recorded. Estimated minimum average 2.41, from definite broods of 45 x 2, 31 x 3 (M.N. Maddock).

LAYING No information.

INCUBATION By both sexes in alternating shifts, virtually continuous, with about equal share. Attendance at two nests, including overlap of birds at change-over (1858, 3300 mins observation time respectively): males 63.9, 57.6%; females 42.6, 52.7%. Hatching asynchronous. **INCUBATION PERIOD** of one marked egg in C/3: 26 ± 1 day. Said to be 21 days in India (Ali & Ripley 1973, probably mistakenly). In Africa, 24-27 days (Priest 1933). Hatched shells removed from nest.

YOUNG Semi-altricial, nidicolous. Hatched in down; pin-feathers appear at Day 4, start to burst at Day 8-12; at Day 24 chicks well feathered but filoplumes persist on head till Day 40. Bill, at first yellow; by Day 10 becomes brownish proximally and brownish part continues to encroach on orange-yellow distal area. Iris, yellow-white at hatching to pale yellow in first week. Palate and tongue, dark brown; rest of buccal skin, at first flesh-coloured, becoming purplish by Day 10. Legs, olive-green at first, becoming paler green on tibia and soles of feet by Day 14; at fledging, back of legs, green or grey-green; front, blackish. Attended and fed by both parents. Continuously brooded (brood-stage) for 12 days; partially sheltered or brooded (guard-stage) for another 8-14 days. Male attends slightly less than female; male 44.5 48.1%, female 54.6, 51.6% of 2430, 2980 min observation respectively. At Gatton, young started to scramble out of nest from Day 24 and attendance by parents greatly reduced to total of 12.5 and 61% of observation time. **NESTLING PERIOD.** Three marked young left heronry at 69-75, 68-74 and 62-70 days, having been able to fly at 42, 48-53 and 37-45 days. Fed by complete and incomplete regurgitation in equal shares by male and female; about four times/day up to 20 days old and 6-7 times thereafter, for brood of three reduced to two by 20 days; averaged three regurgitations for each feeding bout. At first, adult lowers head and holds bill vertically downwards, regurgitates bolus onto nest, whence chicks take it, up to 6 days old; at 8 days old they were taking some items direct from parent's bill; by 18 days old always fed direct from parent's bill. From about 10 days, adult holds bill progressively higher and less vertically, as chicks begin to grab it and eventually grasp it by its sides in scissors grip. Feeding bouts lasted for 1-83 min; feeding visits from 05:55 to 18:25 but more (31) before than after (20) noon. Adults ate remains of boluses left in nest by young chicks. Chicks defecated over edge of nest, once per day per chick.

SITE In forks, on horizontal branches, in canopies of eucalypts, mangroves *Avicennia*, broad-leaved *Melaleuca*, casuarinas, usually standing in water; 1.5-15 m above water or ground (>20 m; North); 0.5 m distant from nests of other species or conspecifics, spread throughout colony, not concentrated into groups.

GROWTH Weight at pipping of egg (weight of shell deducted), 22; weight when hatched (0–1 day old), 27. Two days before fledging or 40 days old. one chick weighed 380.

FLEDGING TO MATURITY For 3 weeks after fledging, young depend on parents, return to nest to be fed but also collect own food nearby; spend much of day a few metres from nest but forage on ground below or fly to nearby water c. 80 m away. Age at first breeding not determined. Three birds returned to Shortland colony in full breeding plumage in first year; observed regularly through breeding season, but did not assume breeding colours on bare parts and not seen to be nesting (M.N. Maddock).

SUCCESS At Shortlands, of 94 nests, 88% fledged at least one young (96% of hatchlings survived). Broods definitely recorded: 7 x 1, 45 x 2, 31 x 3 = 2.29 ± 0.62 minimum average reared by each successful pair. **PREDATORS.** Adults defend nests from close approach of Cattle Egrets and protect young, 29 days old, from Brown Goshawk by crouching over it with plumes raised, wings partly extended and giving throaty *kroo-kroo*. . . call (N.G. McKilligan). May be infested by ticks *Argas robertsi*.

PLUMAGES

ADULT BREEDING Plumage entirely white. Breast-feathers long (up to 146 mm) and loose. Among scapulars, 20 to 40 aigrettes extending up to 100 mm beyond tip of tail; fanned during display.

ADULT NON-BREEDING Similar to adult breeding but without long breast-feathers and aigrettes. Unknown if non-breeding birds in A'asia can have aigrettes as observed in nominate *intermedia* (Chapin 1932).

NESTLING At hatching, down white; hairy and erect on crown.

JUVENILE Similar to adult non-breeding; body-feathers with slight pale-yellow shade.

BARE PARTS Based on photos in Slater (1987).

ADULT BREEDING Colours of bare parts change over breeding season. Iris, yellow; red during courtship (Hindwood *et al.* 1969); red (11). Eye-ring, green (162D). During courtship, bill, deep pink to red (11) with orange-yellow (18) tip; base of lower mandible, green. At time of laying, bill, dull red; at hatching, dull orange-yellow. Loral skin, green (162D); bright green; dull pale-green; or green-yellow to yellow. During courtship, tibia, ruby (10); tarsus, ruby (10), with or without black (89) anteriorly, or black with red wash. At hatching, tibia, yellowish; tarsus, grey-black.

ADULT NON-BREEDING Iris, horn (92). Eye-ring, yellow (57). Bill, buff (118). Loral skin, yellow (57). Mouth, pink or purplish (Hall 1974). Tibia and hind tarsus, tawny (223D); varying: dull yellow, dull grey, yellow-brown, yellowish green, olive-green, mottled yellow, brownish (Hindwood *et al.* 1969; Hall 1974). Rest of legs and feet, black (89).

NESTLING Described in Maddock (1988) as: Iris, white; cream; yellow. Bill, yellow; black, tipped yellow; variegated black gape line, sometimes black. Tongue, black or grey; pink or yellow with black approaching fledging. Hard palate, black; yellow or pink, black approaching fledging. Skin-colour of nestling generally yellowish green. Loral skin, yellow; yellow and black. Tarsus, black; soles pale grey.

JUVENILE Similar to adult non-breeding.

MOULTS Largely undescribed. Breeding season protracted; no definite moult period can be ascribed. Worn plumage in one female, Apr., Grafton, NSW (Hall 1974).

ADULT POST-BREEDING Presumably complete; duration and sequence unknown. Probably involves loss of aigrettes. One bird observed carrying plumes one month after breeding ended (M.N. Maddock).

ADULT PRE-BREEDING Presumably partial: involves development of aigrettes.

POST-JUVENILE Unknown.

MEASUREMENTS Few data. Shortland, NSW, juveniles, live (M.N. Maddock). (2) Skins, ANWC (G.F. van Tets).

	UNSEXED	FEMALES
WING	(1) 240, 285 (2) 299 (3.68; 295–304; 4)	284, 306
TAIL	(2) 114 (4.03; 109–118; 4)	114, 121
BILL	(1) 54.5, 56.3 (2) 82 (1.9; 79–83; 4)	–, 81
BILL D	(1) 16.3, 17.0	
TARSUS	(1) 87.3, 94.5 (2) 110 (3.70; 106–114; 4)	102, 105
TOE	(2) 93 (2.4; 91–96; 4)	83, 88

WEIGHTS Few data. One male, 401.4 (Hall 1974). Shortland, NSW, juveniles, live: 365, 405 (M.N. Maddock).

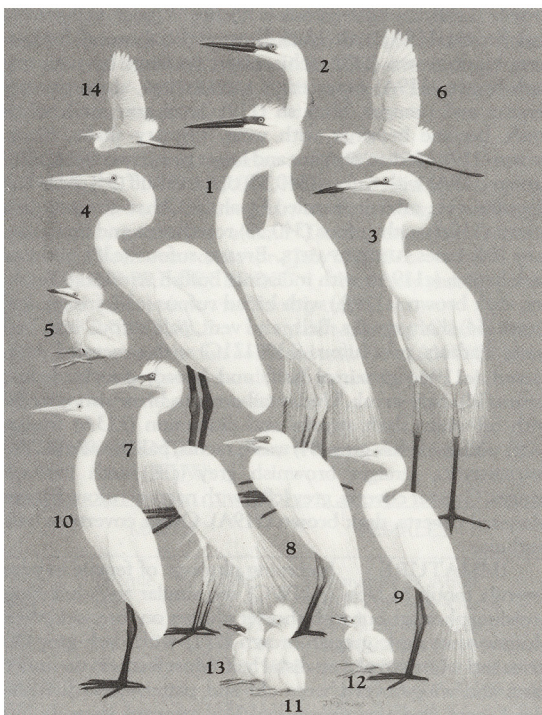
STRUCTURE Wing, broad. Eleven primaries: p9 longest, p10 4–10 mm shorter, p8 0–4, p7 2–5, p6 11–13, p5 27–30, p4 43–48, p3 58–68, p2 67–74, p1 77–86, p11 minute. P10 emarginated on outer web; slight on inner web of p9–p7. Tail square; 12 rectrices, t1 longest, t6 1–5 mm shorter. Bill, long, pointed; deep nasal groove near base. Loral skin triangular in shape. Neck, long; when outstretched, as long as body; crown rounded (Cox 1973). Two-thirds of base of tibia bare. Legs and feet, long and slender. Outer toe c. 88% of middle, inner c. 73%, hind c. 46%. Claw of middle toe pectinate. Three pairs of powder-down tracts: pair on sternum, either side of interclavicular space; on flanks; and on inner margin of upper thighs; powder-down, dense, and yellowish cream. In nestling, loral notch behind gape ends below back of eye. Bill robust and has straight profile (Maddock 1988).

RMO

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Volume 1 (Part B), Plate 70

Great Egret *Ardea alba*

1. Adult breeding (with courtship flush)
2. Adult breeding (without courtship flush)
3. Adult non-breeding
4. Juvenile
5. Downy young
6. Adult non-breeding

Intermediate Egret *Ardea intermedia*

7. Adult breeding (with courtship flush)
8. Adult breeding (without courtship flush)
9. Adult non-breeding
10. Juvenile
11. Downy young, light form
12. Downy young, intermediate form
13. Downy young, dark form
14. Adult non-breeding

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