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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 alba **Great Egret**

COLOUR PLATE FACING PAGE 965

Ardea alba Linnaeus, 1758, *Syst. Nat.*, ed. 10, 1: 144 — Europe.

Alba (white) is not a useful specific name because there are several other species of white egret.

OTHER ENGLISH NAMES White Crane, White, Great White or Large Egret or Heron.

'Egret' (*Egretta*) is a modern Latinization from the French *aigrette*, the long filiform feathers of the breeding plumage. They were used as an ornament among eastern nations and worn in front of the turban or other head-dress; they became the most distinguished mark of honour that could be bestowed. Nelson is said to have treasured the 'egret' that the Sultan gave him after the Battle of the Nile more than any other gift he got. In the plume trade of a century ago these plumes were called 'ospreys' (Newton & Gadow, *Dict. Birds*, 1896).

As with the scientific name, the epithet **white** simply or combined is uninformative and best dropped. Fortunately our species of white egrets are graded by size and **Great** seems to be in widest use at present.

POLYTYPIC Nominate *alba*, Europe and temperate Asia; *modesta* J.E. Gray, 1831, s. and se. Asia, Aust., NZ; *melanorhynchus* Wagler, 1827, Africa, S of Sahara; *egretta* Gmelin, 1789, Americas.

FIELD IDENTIFICATION Length 83–103 cm, of which body only 40–45 cm; wingspan c. 150 cm; weight c. 700–1200 g. Graceful white egret with flat crown, black or yellow bill and gape extending behind eye. Can be confused with other all-white egrets of our region but distinguishable by colour of bare-parts and on structure. Sexes similar. In breeding condition, birds carry filamentous plumes. Immatures like non-breeding adult.

DESCRIPTION ADULT BREEDING. Wholly white. Head and neck without filamentous plumes (aigrettes). Feathers of chest loose and soft but not filamentous. Long aigrettes on mantle and scapulars extend beyond tail and are usually clearly visible. Plumes raised in agonistic, courtship and greeting displays. Colours of bare parts change during breeding period. During courtship: bill, grey-black, occasionally yellow, basally green-grey; lores, bright pale olive-green to blue-green; iris, red; upper leg, black with red or red-brown wash, lower leg, black. When building: bare parts as when courting but iris, yellow. At hatching: bill, yellow with black tip; lores, dull green; legs, grey-black, paler on upper leg. **ADULT NON-BREEDING.** Like breeding but lacks aigrettes. Bill, yellow, rarely black; lores, yellow; iris, yellow; legs and feet, grey-black; upper leg paler. **IMMATURE.** Like non-breeding adult. **NESTLING.** Wholly white down. Bill, yellow, occasionally with black tip and gape; lores, yellow turning greener; iris, cream-yellow; legs, grey.

SIMILAR SPECIES Likely to be confused only with other all-white egrets: **Little** *A. garzetta*, **Intermediate** *A. intermedia*, **Cattle** *A. ibis* and **white-morph Eastern Reef** *A. sacra*. Most easily confused with **Intermediate** but distinguished by head and neck about 1.5 times length of body (of similar length to body in **Intermediate** Egret); neck long and spindly for entire length and not broadening at base (in **Intermediate**, neck appears thicker throughout, broadening at base and merging smoothly with upperbody); **Great** has distinctly flat-crowned appearance (crown rounder in **Intermediate**) and lacks prominent jowl (present in **Intermediate**); gape extends behind eye (not so in **Intermediate**). These features combine to give general appearance of large slender egret with flat crown, long slender bill with gape that extends well behind eye and, most distinctively, head and long spindly neck about 1.5 times length of body, which ought to distinguish **Great** Egret from all other species. Nestlings distinguishable from above species by flat forehead, gape that extends well behind eye, lores tinged green and feathered chin that extends well forward of nasal slit.

Seen singly, in small parties and large companies, latter particularly on floodplains of n. Aust. in wet season. Frequent

shallows of rivers, swamps, billabongs, sewage farms, irrigation areas, large dams, mudflats, mangroves, lagoons and estuaries; also away from water on moist grasslands. Only egret commonly observed in inland waters in WA. When foraging, wade slowly, stand motionless for long periods, leaning forward with neck extended, then suddenly stabbing at prey with great speed. Most movements slow, deliberate. In flight, stately with deliberate wing-beats, legs extend far behind tail. Long slender neck often crooked in shape of question mark. When disturbed and in flight, utter repeated, rasping, staccato *ar-ar-ar-ar* . . . and, when disturbed at nest, deep guttural croak.

HABITAT Terrestrial wetlands, estuarine and littoral habitats, and moist grasslands. Forage by wading in open shallow water (up to 0.3 m deep) (Recher & Holmes 1982; Schulz 1989); generally avoid dry or deeply flooded areas (Morton *et al.* 1989), although can take fish from surface of deep steep-sided waterbodies by plunging from perch or flying low over surface (Mackay 1967; Tucker 1976). Inland, use variety of habitats; prefer permanent waterbodies on floodplains (billabongs, watercourses, pools); shallows of deep permanent lakes, either open or vegetated with shrubs or trees; semi-permanent swamps with tall emergent vegetation (e.g. *Eleocharis*, *Typha*); and herb-dominated seasonal swamps with abundant aquatic flora. Also use freshwater meadows; seepage from springs; flooded grassland, pasture and agricultural land; deep swamps vegetated with canegrass (*Eragrostis*), reeds (*Phragmites*), sedges (e.g. *Scirpus*) or trees (e.g. *Melaleuca*); sewage farms; channels; and large farm dams (Andrew 1963; Boekel 1976; Vestjens 1977; Corrick & Norman 1980; Gosper 1981; Lowe 1981; Corrick 1982; Fjeldså 1985; Schulz 1989). Regularly use saline habitats. Estuarine mudflats mainly as summer-autumn or drought refuges in s. Vic. (Corrick 1981; Lowe 1981). At Waimea Inlet, NZ, birds favour enclosed arm retaining water at low tide, away from open sea and human disturbance (Owen & Sell 1985). Also use mangrove swamps along coasts, estuaries and tidal reaches of watercourses; saltmarsh; bare salt pans; shallows of salt lakes; salt fields; and offshore reefs (Crawford 1975; Corrick & Norman 1980; Gosper 1981; Abbott 1982; Corrick 1982; Schulz 1989).

Breed in wetlands with fringing or flooded trees or other tall vegetation, in which nests are built; along coast, use mangrove forest; inland, freshwater swamps, lakes or rivers (Watson 1953; Braithwaite & Clayton 1976; Falla *et al.* 1978; Gosper 1981; Garnett 1985). At Booligal, NSW, nesting more extensive in swamps with high levels of organic matter, com-

plex flora and diverse invertebrate population, in early stages of succession after drying and refilling (Crome 1988).

Roost in trees in or near wetlands. In tidal areas, roosting determined by tidal cycle; although some birds continue feeding on mudflats at high tide in water deeper than that tolerated by other species of egret and heron (Schulz 1989).

Irrigation schemes and clearing of wooded lands have probably benefited the species (Aust. Atlas), but much nesting habitat in natural freshwater wetlands has been destroyed or modified by drainage, grazing, clearing, burning, increased salinity, groundwater extraction and invasion by introduced plants (Riggert 1966; Goodrick 1970; Corrick & Norman 1980; Corrick 1981, 1982; Jaensch *et al.* 1988; Morton *et al.* 1989). At Murwillumbah, NSW, nest near residential and industrial areas (Pratt 1979).

DISTRIBUTION Aust. and NZ; accidental to Lord Howe, Norfolk and Macquarie Is. Extralimittally: Americas, Africa, Malagasy region, s. Europe, Asia, Indonesia to New Guinea and Solomon Is.

AUST. Widespread, but scarce or absent from drier parts of w. interior (Great Sandy, Gibson, Great Victoria Deserts and Nullarbor Plain). **Qld.** Throughout, including islands in w. Torres Str. (N to Boigu and Saibai) and off e. coast; most numerous coastally or near coast. **NSW, Vic.** Throughout but least common in N. and S. Tablelands of NSW and nw. and e. Vic. **SA.** In se. area N to Murray R. and W to Spencer Gulf. **Tas.** Widespread in N and E, rare in SW; also on islands of Bass Str. **WA.** Throughout coastal and near-coastal areas from Esperance to Kimberleys. **NT.** Widespread in N, S to L. Woods and Barkly Tablelands; most common in coastal plains between Darwin and Alligator Rs, dispersing to s. districts.

BREEDING Few localities known. **Qld.** Perhaps mostly in e. coastal areas N to Townsville and inland in S to near Thargomindah (L. Bullawarra); also in deltas of Mitchell and Staaten Rs. **NSW, Vic.** Most breeding recorded in Murray-Darling basin; in NSW, also Shortland Wetlands Centre

(e. NSW), Seaham and Lawrence. **SA.** Known only at L. Bonney, Bool Lagoon, L. Alexandrina and Shag I., Spencer's Gulf (Parker *et al.* 1979). **WA.** In SW, at Ls Australind, Toolibin and Chandala (Jaensch *et al.* 1988); near Carnarvon; Broome and Wyndham area. **NT.** N. coastal area E of Darwin.

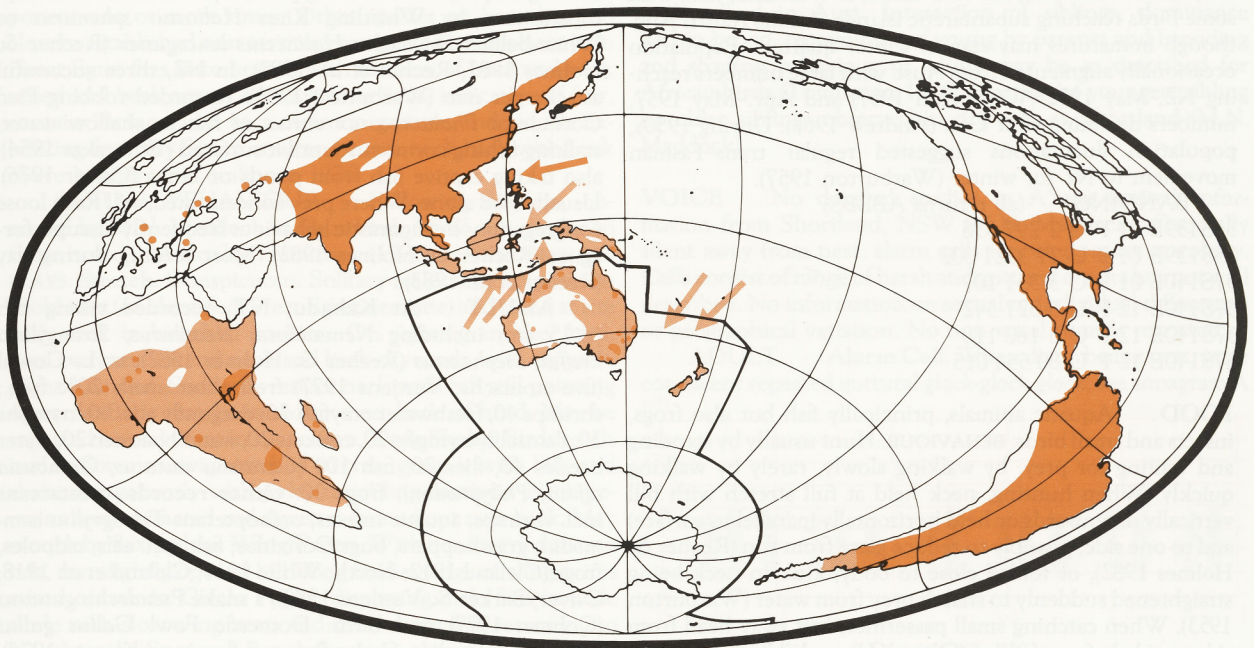
NZ Widespread, including Stewart I., straggling to Auckland, Campbell and Chatham Is; numbers small. Breeding only near Okarito, SI; most records in coastal or near-coastal areas (Andrew 1963; Falla *et al.* 1978; NZCL; NZ Atlas).

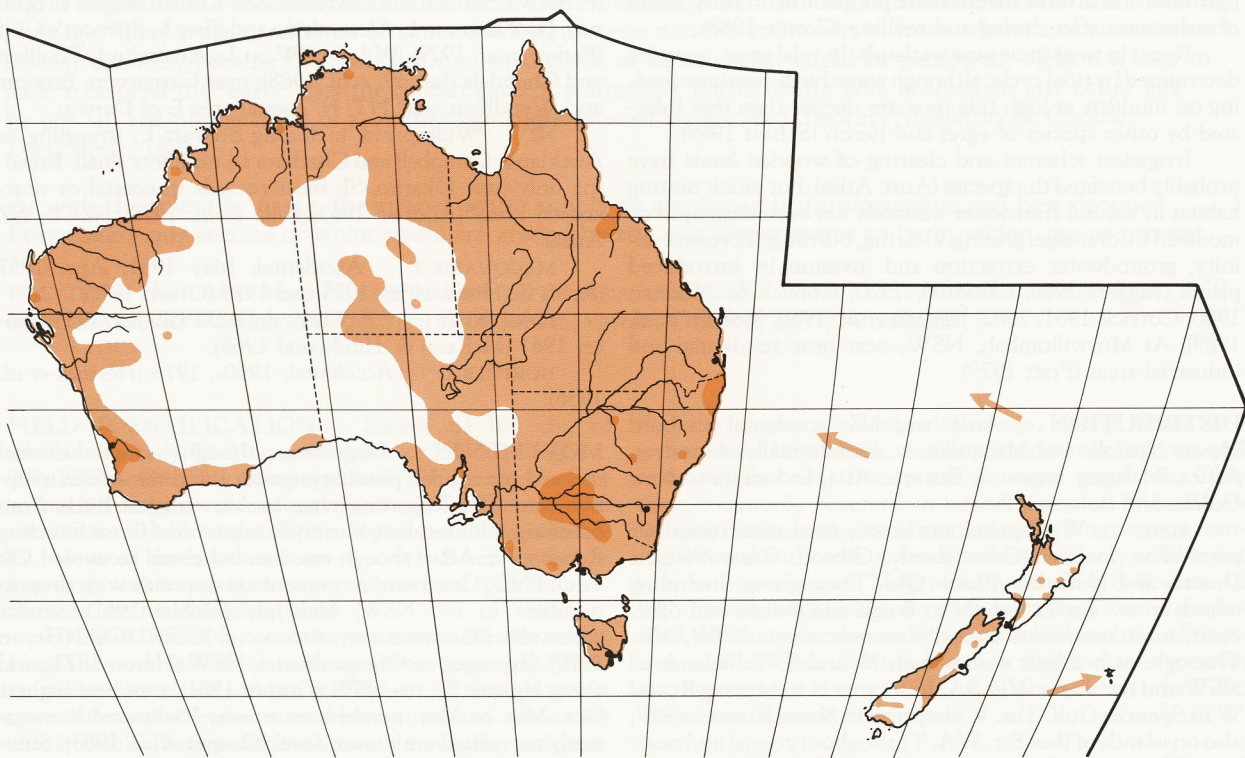
MACQUARIE I. Accidental; May 1951, Apr. 1957 (Keith & Hines 1958), 1975 and 1976 (Green 1977).

LORD HOWE I. Accidental; Dec. 1952-Jan. 1953, winter 1961 (McKean & Hindwood 1965).

NORFOLK I. Accidental; 1950s, 1976 (Hermes *et al.* 1986).

MOVEMENTS Dispersive, though some seasonal movements regular, possibly migratory, and sometimes irruptive into NZ. Reporting rates in Vic. suggest birds from breeding colonies along Murray R. winter S of Great Dividing Range (Vic. Atlas) though one banded chick recovered Ok Tedi, PNG. Coastward movement corresponds with drop in numbers in sw. NSW, May-July (Hobbs 1961); similar coastward movement may also occur in sw. Aust. (Heron 1970). However, in Orange district, NSW (Heron 1973), and along Hunter R., ne. NSW (Gosper 1981), numbers highest Oct.-Mar. or May; numbers on nearby Richmond R. negatively correlated with water level (Gosper *et al.* 1983). Similarly in se. Qld, numbers present during Oct. negatively correlated with winter rainfall (Woodall 1985). In n. Qld, flocks visit Magnetic I., Oct.-Nov. when conditions dry inland (Wieneke 1988) whereas near Darwin, NT, numbers lowest on coast Aug.-Nov., although always present on inland swamps (Crawford 1972). In Alligator Rs district, locally breeding birds congregate on deeper swamps in dry season and apparently little movement into or out of the area (Morton *et al.* 1989). Leave Atherton Tableland, Jan.-Mar., when





possibly at coastal breeding colonies (Bravery 1970) though present throughout year at nearby Innisfail (Gill 1970). In Torres Str. small numbers present throughout year but population peaks in winter (Draffan *et al.* 1983). Flocks of ≤ 30 birds seen flying S across Torres Str. early Dec. possibly to breeding colonies along se. coast of Gulf of Carpentaria (S.T. Garnett). Some irruptive movement from inland to coasts during droughts (White 1919). NZ population disperses from only known breeding site at Okarito, s. Westland, Jan., with some birds reaching subantarctic islands. Adults return Aug. though immatures may stay in winter quarters. Population occasionally augmented from Aust. with large numbers reaching NZ, May 1952 (Warburton 1957) and Apr.–May 1957, numbers declining after Oct. (Andrew 1963). During 1950s, population fluctuations suggested regular trans-Tasman movement to NZ for winter (Warburton 1957).

BANDING (all returns ABBBS)

35S139E 01 P U 2 297 338
 35S139E 01 P U 21 3321 002
 37S140E 01 P U 3 331 107
 37S140E 12 P U 5 327 342
 37S140E 12 P U 6 160 118
 37S140E 12 P U 80 554 015

FOOD Aquatic animals, principally fish but also frogs, insects and small birds. **BEHAVIOUR.** Hunt usually by standing and waiting for prey, by walking slowly, rarely by walking quickly. When hunting, neck held at full stretch with bill vertically downwards or held horizontally (parallel to surface) and to one side, possibly to reduce glare from sun (Recher & Holmes 1982), or folded close to body, kink in neck being straightened suddenly to snatch prey from water (Warburton 1953). When catching small passerines, first sway head from side to side before striking (Oliver). Have also been observed

plunging onto fish from air, snatching them while flying (Mackay 1967) or entering water (Tucker 1976). At Kakadu, NT, 77.6% of time spent standing and waiting; when moving, travelled mean distance of 6.7 m at 0.4 ± 0.02 steps/s, averaging 0.2 attacks/min with 23.6% success (535 min; 106 observations). In $<10\%$ of observations birds walked quickly or took short flights. Fish >12 cm handled with difficulty, taking several minutes to kill and swallow though selective feeding on prey <12 cm long probably occurs to avoid kleptoparasitism by Whistling Kites *Haliastur sphenurus* or White-bellied Sea-eagles *Haliaeetus leucogaster* (Recher & Holmes 1982; Recher *et al.* 1983). In NZ, three successful attacks per min (Warburton 1953). Recorded robbing Pied Cormorant *Phalacrocorax varius* of fish in shallow water, stalking fishing cormorant until it surfaced (Whittaker 1954); also taking captive fish from ponds or tanks (Carter 1976). Usually feed alone. Where prey concentrated, will form loose congregations but agonistic behaviour frequently disrupts foraging (Recher & Holmes 1982). Most feeding during day (Recher *et al.* 1983).

ADULT At Kakadu, NT, recorded taking fish (≤ 15 cm) including *Nematalosa*, *Neosilurus*, *Strongylura krefftii*, *Hephaestus* (Recher & Holmes 1982); at L. Cowal (five stomachs; Vestjens 1977) freshwater snails 20% freq.; shrimps 40, freshwater crayfish 20; dragonfly ads. 40, nymphs 20, damselfly nymphs 20, crickets 20, water boatmen 20, water beetles 40, flies 20; fish 100 (*Carassius auratus*, *Gambusia affinis*, *Philypnodon*); frogs 20. **Other records:** crustaceans incl. shrimps; aquatic insects, orthopterans *Teleogryllus commodus*, grasshoppers, bugs Corixidae; fish incl. eels; tadpoles, frogs (Cleland 1912; North; White 1917; Cleland *et al.* 1918; Oliver; Barker & Vestjens 1989); a snake *Pseudechis guttatus* (Coburn 1977) and birds: Domestic Fowl *Gallus gallus* (Oliver), Australian Crane *Porzana fluminea* (Klapste 1976),

Baillon's Crake *Porzana pusilla* (M.A. Cameron), Sacred Kingfisher *Halcyon sacra*, Silvereye *Zosterops lateralis*, House Sparrow *Passer domesticus* (Oliver).

NESTLING At Shortland Wetlands Centre, e. NSW, only fish (seven boluses; Baxter & Fairweather 1989); whole mullet (20 cm) and crab carapace (10 cm diam.) found under nesting tree (Maddock 1986; M.N. Maddock). Food in NZ probably largely fish *Galaxias maculatus* and possibly take fish regurgitated by cormorants (Oliver).

SOCIAL ORGANIZATION Information supplied by M.N. Maddock from observations at Shortland, NSW. Often seen singly or in small parties. Occasionally in flocks of up to 150 (Hobbs 1961). Breed in colonies. Sometimes feed in mixed flocks.

BONDS BWP reports monogamous pair-bond, probably of mainly seasonal duration only, for Palearctic. No detailed bonding data available for Aust., but observations support monogamous pair-bond for at least one season. Clearly identified sites (same fork in same tree) have been used for nine seasons, but in absence of banding, impossible to determine whether used by same individuals. Ejection of occupiers (one Little Pied Cormorant *Phalacrocorax melanoleucos*, one Cattle Egret) from recognized Great Egret sites by newly arrived Great Egret observed twice. Both sexes take part in incubating, brooding and care of young.

BREEDING DISPERSION Nesting colonies may contain up to several hundred nests. Although recorded as 'closely packed' (Sharland 1957), nest densities or distances not measured in Aust. At L. Kyle, Zimbabwe, territorialism ensures nests well spaced: mean distance between nests, 2.38 m (Tomlinson 1976).

ROOSTING Roost in trees at night (Serventy 1959).

SOCIAL BEHAVIOUR Based on observations by M.N. Maddock at Shortland, NSW.

AGONISTIC BEHAVIOUR **THREAT.** Crest and neck feathers are raised and beak stabbed in direction of opponent one or more times. Other species on branches too close to established nest-territory are ejected by displacement: Great Egret flies onto branch with feathers of head and neck raised and beak agape. **APPEASING** actions, indicative of fear, contain 'facing away' as a common gesture. Individuals exhibiting fear may flatten crest and curve neck back with beak above horizontal (Tomlinson 1976).

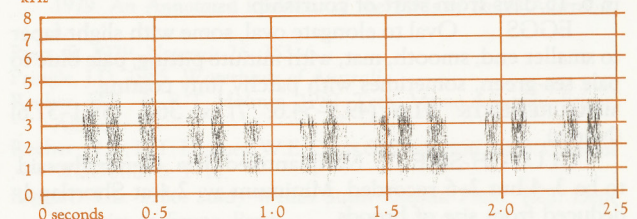
SEXUAL BEHAVIOUR Following displays, observed by M.N. Maddock at Shortland, NSW, are similar to those noted in Africa by Tomlinson (1976). **ADVERTISING DISPLAYS:** **Stretch.** Conspicuous. Solitary males take up position at old nest (or identified Great Egret nest-site) and stand at site with neck in hunched position. On sighting another bird, turn away and extend neck and beak skywards, with aigrettes slightly fanned. Suddenly retract neck with bill still pointing upwards. Body may be raised to meet back of head. May be repeated several times in succession. **Twig Shake.** Birds reach out or down to twig attached to tree, grasp it with bill, and shake it vigorously with jerky trembling motions. Neck remains semi-retracted and aigrettes fanned out over back. May crouch by flexing legs. **Wing Preen.** With head turned to one side, run slightly opened bill along leading edge of wing as it is raised outwards. **Circle Flight:** displaying male flies in wide circle with slow wing-beats and neck extended, returning to launch point. Snap and Bow behaviour, observed by Tomlin-

son (1976) in Africa, not reported in Aust. When another Egret joins advertising individual, **COURTING** behaviour begins. Tomlinson (1976) in s. Africa, Wiese (1976; USA) and Mock (1978; USA) report that pairing activities involve significant aggression between individuals, and Mock refers to 'fragile pair-bond', c. 10–20% of which dissolve before laying. At Shortland, almost no aggression noted between individuals, even when more than one nest in same tree. Pair-bonds probably quickly established and stable. Both birds participate in nest-building, with one remaining at site while other collects sticks. Nest-sticks passed to builder, which uses tremble-shove movements (Tomlinson 1976) to place into position. Vocal greetings used during transfer of stick, and plumes are elevated. Stretching may follow; preening may intervene between building periods. Courting to completion of building took 1–6 days (five nests) and 15 days (one nest). **GREETING DISPLAYS.** Occur when birds change-over during incubation and brooding. Bird approaching nest flies with neck extended and crest erect, uttering Arrival Calls (see Voice). Involve elevation of plumes, and Stretch may be performed one or more times by both individuals. Other Greeting Displays observed in Aust. include **Back Biting:** each partner runs partly open, quivering mandibles over scapulars and back feathers of mate. Apparently reinforces pair-bond, relieving distrust by using maximum stimuli: tactile, visual and auditory. **Bill Grasping** occasionally invoked. Mates face each other with necks raised in 'S' shape and aigrettes raised, and gently open and shut beaks in contact. Heads may be raised and lowered in unison. **COPULATION.** Observed after elaborate waiting period with Back Biting and plume-displays. One male observed flying directly to nest and mounting without preliminaries.

RELATIONS WITHIN FAMILY GROUP Both sexes take part in building, brooding and care of young. Feeding of young in Aust.: nestlings grasp parent's beak to stimulate regurgitation, and do so until they are able to make feeding excursions. Regurgitation incomplete when chicks large, but Tomlinson (1976) reported as complete in Africa for first 10 days. Communications between adults and young undescribed in Aust. Interaction of siblings, dominance within brood, recognition of young by parents and brooding and shading behaviour of adults may be as described for African birds (Tomlinson 1976). Ejection of youngest sibling by older siblings observed in dry year at Shortland (M.N. Maddock).

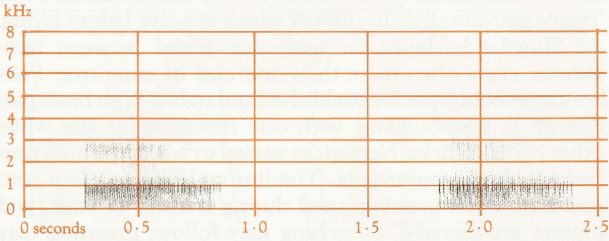
VOICE No detailed studies in A'asia; limited information from Shortland, NSW (M.N. Maddock). Generally silent away from nest, alarm calls reported; quiet at colony. Calls consist of range of harsh and guttural croaks but not well described. No information on sexual or individual differences or geographical variation. No non-vocal sounds reported.

ADULT Alarm Call. When disturbed at nest, utter consistent repeated guttural *glock-glock-glock*; see sonagram A



A K. & J. Bigwood; Okarito, NZ; P102

for calls at a colony. Away from colony, when flushed, low rasping staccato *ar-ar-ar-ar-ar . . . aaarr*, each note rapidly repeated; continued in flight (sonagram B) (M.J. Hewish; J.M. Peter). **Arrival/Greeting Call.** Usually, noisy series of slow



B P.J. Fullagar; Rotamah I., Vic., Aug. 1981; B878

croaks *gorork-gorork-gorork . . .*, repeated varying number of times, followed by rapid croaks *. . . grock-grock-grock*; given when approaching nest during nest-building, at change-overs and during feeding of young. **Copulation Call:** series of low squeaky grunts; sex of calling bird not known.

YOUNG When begging for food, a rapid chattering *kek-kek-kek . . .*; continues after being fed (M.N. Maddock).

BREEDING Based on study at Shortland, Newcastle, NSW (M.N. Maddock); some information from Aust. NRS. Breed in simple pairs, colonially, associated with other herons, ibises, spoonbills, cormorants. Proportions of Great Egrets' nests in mixed colonies: from c. 60% in small colony (50) with Rufous Night Heron *Nycticorax caledonicus* (Aust. NRS) to 13% in medium colony (566) at Shortland and c. 15% in large (3000+) colony in NT (Aust. NRS). Said to nest solitarily sometimes (Campbell).

SEASON At Shortland: Nov.-early May, depending on nature of season, with peak of laying before early Dec. In 1990, major flood followed long dry period, and breeding began again in late Feb. after fledging of young (G. Baxter). Elsewhere no detailed knowledge but active breeding recorded (NRS): NSW, Sept.; Vic., Nov.-Jan.; SA, Nov.; WA, Nov.; NT, Mar.-Apr.

SITE In forks in tops or upper parts of trees standing in water: *Melaleuca* (NSW, WA); mangroves *Avicennia* (NSW, NT); eucalypt, casuarinas (Vic., NSW, WA). At Shortland, in topmost sites of trees above nests of other species. Nests used regularly from year to year but site fidelity of individuals not proved. 7-15 m above ground.

NEST, MATERIALS Shallow platform of loosely woven sticks. Both sexes build; one bird (?female) remains at nest, partner collects sticks from ground, water nearby or pillages other nests; builder fixes material in position with tremble-shove movements (Tomlinson 1976). Intermittent building into nestling period but building mostly completed in 6-15 days from start of courtship.

EGGS Oval to elongate oval, some with slight taper to smaller end; smooth, mat, with minute pitting; pale blue to pale sea-green, sometimes with patchy limy coating.

MEASUREMENTS: 51.6 (49.5-54.6; 7) x 36.2 (35.1-37.6) (North).

CLUTCH-SIZE No quantified data. Generally said to be 3-4 but 2-6 recorded. Minimum av. 2.4 at Shortland, deduced from size of broods.

LAYING No information.

INCUBATION By both sexes. No further information.

YOUNG Semi-altricial, nidicolous. Both parents brood and feed young; no further information. Feeding by regurgitation; not known whether incomplete throughout nesting period but certainly so when chicks are large; grasping adult bill to stimulate regurgitation. Young start to scramble out of nest at 34 days old (25-37; 12). **NESTLING PERIOD.** Hatching to first flight not established (42 days; BWP) but flights from nesting tree occur for c. 10 days (3-16; 8) before final departure; during that time, young return to nest to be fed after adult has arrived at nest; not noted to be fed away from nest. Hatching to final departure: 64 days (55-88; 16).

GROWTH No detailed knowledge. Bare facial skin yellow at early age, turns greenish, extends well behind eye.

SUCCESS Of 90 nests at Shortland, 81 (91%) fledged some young. Size of broods definitely recorded: 11x1, 33x2, 17x3; giving av. 2.1 ± 0.68 chicks reared per successful breeding pair (in dry year, average 1.78 from 32 nests; in wet, 2.45 from 29).

PLUMAGES *A.a. modesta*.

ADULT BREEDING Age of first breeding unknown. Entirely white. Long aigrettes among scapulars, extending up to 100 mm beyond tip of tail; aigrettes not recurved at tips, no elongate breast plumes.

ADULT NON-BREEDING, JUVENILE Similar to adult breeding but no aigrettes; juveniles indistinguishable, other than by size.

NESTLING Down short, cream (54) with pale-yellow shade; down erect on crown.

BARE PARTS Based on Hindwood *et al.* (1969) and photos in Pringle (1985) and Slater (1987), except where stated.

ADULT BREEDING Colours of bare parts change through breeding period. Iris, reddish during courtship; becomes yellow after pair-formation. Bill, grey-black (82), occasionally yellow, sometimes with yellow or green-grey base; or yellow with black tip. Loral skin, grey-olive (43); bright pale olive-green; or blue-green. Tibia, pink (3). Legs and feet, black with red or red-brown wash on upper leg; or grey-black (82) with greyish-green shade.

ADULT NON-BREEDING Iris, yellow. Loral skin, yellow to yellow-green. Bill, orange-yellow with grey-black (82) tip to mandibles. Legs and feet, grey-black (82); soles paler.

NESTLING Iris, cream or yellow. Bill, black, tipped yellow; rictus, black. Tongue, black or grey, pink or yellow becoming black near fledging. Palate, black; yellow or pink becoming black near fledging. Loral skin, greenish yellow. Tarsus, dusky; soles, pale grey. Skin colour of nestling, greyish green (Maddock 1988, 1989).

JUVENILE Similar to adult non-breeding.

MOULTS Breeding season protracted in Aust.; no definite moult period can be ascribed. Based on skins at MV and NMNZ.

ADULT POST-BREEDING Complete; primaries irregularly; in NZ, Feb.-May; beginning with loss of aigrettes.

ADULT PRE-BREEDING Aigrettes appear July-Aug.

POST-JUVENILE Partial; body feathers moult Feb.-May.

MEASUREMENTS (1) Aust. and NZ, adults, skins (MV, AM, NMNZ, SAM). (2) Shortland Wetlands Centre, NSW, juveniles, live (M.N. Maddock).

	MALES	FEMALES
WING	(1) 375.8 (7.09; 365-387; 11)	353.3 (3.94; 346-359; 6) *
8TH P	(1) 239.2 (9.90; 227-267; 11)	230.1 (8.00; 220-240; 6)
TAIL	(1) 135.4 (6.15; 127-146; 10)	126.5 (5.40; 120-132; 5) *
BILL	(1) 112.2 (2.62; 109.1-116.5; 11)	102.7 (4.85; 95.7-108.7; 6) *
TARSUS	(1) 156.8 (7.23; 145.1-167.7; 11)	141.6 (6.38; 129.3-148.8; 6) *
TOE	(1) 105.7 (2.43; 101.6-110; 11)	99.0 (3.10; 94.1-103; 5) *
UNSEXED		
WING	(2) 320, 330	
BILL	(2) 82.5, 84.5	
BILL D	(2) 16.5, 18.5	
TARSUS	(2) 130, 135	

Further measurements in Gallagher (1974).

WEIGHTS Aust. and NZ, adults, skins (MV, AM, NMNZ, SAM): males: 969.2 (473.14; 353-1970; 7); females: 761.3 (111.92; 605-861; 3). Shortland Wetlands Centre, NSW, unsexed juveniles, live: 735, 835 (M.N. Maddock). No data on seasonal changes.

STRUCTURE Wing, long and broad. Eleven primaries: p8 usually longest, p10 3-13 mm shorter, p9 0-8, p7 0-8, p6 13-27, p5 28-51, p4 50-73, p3 69-92, p2 85-108, p1 101-121, p11 minute. P10-8 emarginated on inner web, p9-8 slight on outer. Ten secondaries and four tertials. Tail, square: 12 rectrices, t1 longest, t6 c. 5 mm shorter. Bill, long and tapering; deep at base. Lower half of tibia, bare. Middle claw, pectinate. Outer toe c. 84% of middle, inner c. 77%, hind c. 44%.

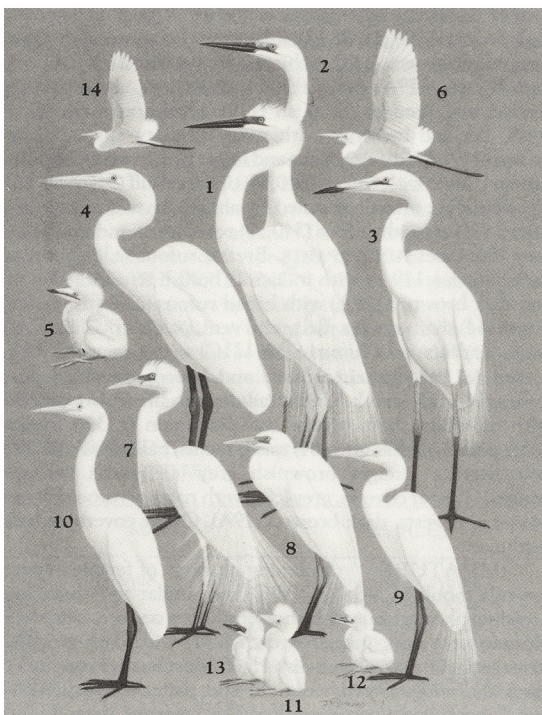
RECOGNITION Confusion possible with other species of egret (see Hindwood *et al.* 1969; Cox 1973; Field Identification). Confusion also possible with other nestling egrets. In nestlings, post-gape loreal notch behind back of eye, and long robust bill is slender in proportion to length; forehead flat (Maddock 1988, 1989).

GEOGRAPHICAL VARIATION Subspecies based on size and colour of bare parts. Nominate *alba* largest (average wing-length of males, 438-451 mm); subspecies *melanorhynchus* and *egretta* (average wing-length of males, 383 mm) smaller; *modesta* also smaller but populations of *modesta* in Aust. and NZ larger than those in India and China (average wing-length of males, 376 v. 361.5). Populations of Japan and nearby areas may be intermediate in size between *alba* and *modesta* (Amadon & Woolfenden 1952). In *melanorhynchus* and *egretta*, tibia, black; in *egretta*, bill of breeding adult, orange-yellow, not black. NZ populations have been placed separately in subspecies *maoriana* (Mathews & Iredale 1913).

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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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