

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).

REFERENCES

Ligon, J.D. 1967. *Occas. Pap. Mus. Zool. Univ. Mich.* 651.

Meyerriecks, A.J. 1966. *Auk* 83: 683-4.

Sibley, C.G., & J.E. Ahlquist. 1972. *Bull. Peabody Mus. nat. Hist.* 39.

van Tets, G.F. 1965. *AOU orn. Monogr.* 2.

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.

REFERENCES

- Bock, W.J. 1956. *Am. Mus. Novit.* 1779.
 Curry-Lindahl, K. 1971. *Ostrich* 9 (Suppl.): 53–70.
 Daanje, A. 1950. *Behaviour* 3: 48–99.
 Fullagar, P., & C.C. Davey. 1983. Pp. 39–42. In: Haigh 1983.
 Haigh, C. 1983. *Parks and Wildlife: Wetlands*. NSW NPWS.
 Hancock, J., & H. Elliott. 1978. *The Herons of the World*.
 Meyerriecks, A.J. 1960. *Publs Nuttall orn. Club* 2.
 Mock, D. 1977. *Bird-Banding* 48: 81–4.
 Payne, R.B., & C.J. Risley. 1976. *Univ. Mich. Mus. Zool. Misc.*
 Publ. 150.
 van Tets, G.F. 1977. *Emu* 77: 156–7.

Ardea sacra Gmelin, 1789, *Syst. Nat.* 1: 640; based on *Sacred Heron* of Latham, 1785, *Gen. Syn. Birds* 3: 92 — Tahiti.

The specific name follows Latham's designation, given because 'the early Polynesians considered them holy birds' (Holyoak 1973, *Ibis* 115: 419).

OTHER ENGLISH NAMES Blue, Reef, Blue Reef Heron, Sacred, Pacific or White or White Reef Heron.

POLYTYPIC Nominate *sacra* occurs throughout the range of the species except New Caledonia and the Loyalty Is where *albolineata* G.R. Gray, 1859, occurs.

FIELD IDENTIFICATION Length 60–65 cm (about half, neck; half, body); wingspan 90–100 cm; weight 330–450 g. Medium-sized dimorphic heron with long heavy grey-brown or yellow bill and dull grey-yellow legs; plumage either sooty grey or pure white. Upper- and under-wings of dark morph, uniform grey lacking contrast between remiges and wing coverts. Sexes similar; seasonal changes in colour of bare parts and development of plumes. Immatures pale smoky grey or white. Proportions of white and dark morphs varies with latitude and possibly with habitat (see *Habitat & Distribution*).

DESCRIPTION ADULT BREEDING. Dark morph. Uniform slaty or sooty grey to grey-brown; inconspicuous patch of dull-white feathers on chin and sometimes as streak on lower throat. Grey lanceolate plumes on nape (forming small nuchal crest) and on back and lower foreneck. Shade of plumage varies between individuals and with light conditions;

in fresh plumage, pale grey bloom gives light appearance; worn plumage tends to be browner. Bill, yellowish brown to yellow; tip, horn-coloured. Lores, yellow-green. Iris, yellow to orange-red and red. Legs and feet, grey-yellow or greenish yellow; soles, yellow. **White morph.** Wholly white; lanceolate plumes on back and lower foreneck and small nuchal crest, white. Upper mandible, horn-brown; lower, yellow-grey but varies. Lores, green-yellow. Iris, yellow. Legs and feet, yellow-green to grey. **ADULT NON-BREEDING.** Both morphs similar to breeding but lanceolate plumes on back, lower neck and nape reduced or absent. **Dark morph.** Bill, grey or greyish brown. Lores, possibly without yellow tinge. Legs, grey with dull yellow wash. **White morph.** No change in colour of bare parts definitely known but possibly as grey morph. **JUVENILE, IMMATURE. Dark morph.** Uniform pale smoke-grey, browner and duller than adult and without plumes. Bill, dark brown. Lores, grey. Legs and feet, yellow. **White morph.** Wholly white.

SIMILAR SPECIES Usually distinguished from other herons by strictly coastal maritime habitat. **Dark morph** distinguished from other grey herons in Aust. and NZ by absence of any obvious white in plumage. In flight, uniform grey upper- and under-wings distinguish it from other grey herons, which have contrasting dark remiges and paler upper and under wing-coverts, particularly from **White-faced Heron** *A. novaehollandiae*, which also has white on face and throat, is more slender, with more upright, less hunched stance. Not likely to be confused with **Pacific** *A. pacifica*, **Pied** *A. picata* or **Great-billed** *A. sumatrana* Herons, which are larger or have striking white necks or both. **White morph** may be confused with other all-white herons. **Great Egret** *A. alba* is larger, more slender with black legs, obviously longer neck and all-yellow or black bill. **Intermediate Egret** *A. intermedia* has bill, pure yellow to orange-red, and black legs. **Little Egret** *A. garzetta* has light build with black bill and legs, and yellow feet. **Swinhoe's Egret** *A. eulophotes* in non-breeding plumage is probably indistinguishable in the field from white morph Eastern Reef Egret (see Hancock & Elliott 1978; Hancock & Kushlan 1984) but has not yet occurred in our region. **Cattle Egret** *A. ibis* is smaller, with stockier hunched silhouette, shorter bill and is usually gregarious, feeding in parties with cattle.

Occur singly, in pairs or small family groups; mostly on rocky marine shores, intertidal mudflats and muddy estuarine waterways; in NZ and Pacific islands also occasionally at freshwater lakes and marshes. Flight direct, with more rapid wing-beats than most egrets and herons, with head drawn back and feet trailing slightly beyond tail; usually close to ground or water but up to 40–50 m high. Take-off laboured with legs dangling and neck sometimes partly extended. Longer flights often end with glides. Roost and nest in loose colonies or solitarily; prefer roosts on rocky outcrops near feeding sites. Forage in shallow water, mostly at low tide, using variety of techniques: low-stalking, upright-stalking, crouching, foot-stirring and aerial feeding. Typical stance more crouched and horizontal than most other herons and egrets. Harsh, guttural calls, mostly during breeding periods.

HABITAT Widely distributed in maritime littoral and estuarine habitats of mainland, islands and atolls. Prefer rocky shorelines and reefs of mainland; coral cays and reefs in tropical Aust. Also on intertidal areas of estuarine mudflats, mangrove-lined shores, tidal reaches of rivers and creeks, and beaches of gravel or mud. Sandy beaches used in sheltered harbours, but avoided on exposed coasts unless broken by rocky promontories (Crawford 1972; Recher & Recher 1972; Edgar 1978). On Cocos-Keeling Is, mudflats in atoll used (Stokes *et al.* 1984). In places, on fields, grasslands, saltfields and freshwater lakes near coast (Hopkins 1948; CSN 19; Rix 1978; Stokes *et al.* 1984); but few inland records, from lakes, floodwaters and rivers (McKenzie & McKenzie 1961; Edgar 1978; CSN 19; Jaensch *et al.* 1988). In NZ, tolerate pedestrians and traffic along urban shorelines, and occur at garbage tips (Edgar 1978). In littoral and estuarine habitats, feed mainly at low tide in shallow water; in pools and channels in rock platforms, mudflats and river beds. On coral reefs forage in clear shallow water over reef-crests and edges, in living coral and coral rubble (Recher & Recher 1972). May fish in deeper water in flight ('tarning') when sallying from rocks or other perches (Recher & Recher 1972; Edgar 1978). Even enter forest on coral cays to scavenge (Recher & Recher 1972). On Pacific islands, occur inland along rivers, in freshwater

swamps and in wet fields, up to 600 m asl (Hadley & Parker 1965; Gorman 1975; Holyoak 1979). Apparent correlation of light and dark morphs with light and dark habitats needs further study; ratio of 1:1 on rocky beaches and reefs; of 1 white:10 dark on muddy creeks and rivers (Gill 1970). Holyoak (1973), in e. Polynesia, found correlation between occurrences of white morphs and light coral habitat but Recher (1972b) did not in Qld.

Breed on islands, rocky islets and coral cays, near intertidal habitat suitable for feeding and with sheltered sites among rocks or vegetation for nesting; most nests placed on ground, but at some locations regularly nest in shrubs or trees (Cooper 1948; Edgar 1978; Abbott 1982; Gill 1985; King *et al.* 1985).

Fly over water c. 1 m above surface, but on long-distance flights may reach 40–50 m (Edgar 1978). Roost near water on dead or living trees, sand spits and banks, rocks and artificial structures, such as wharves, breakwaters, jetties, boats and posts; roosting determined by tidal cycle.

Artificial structures (wharves, jetties, hulks) regularly used for roosting and occasionally for nesting (Edgar 1978). Population decline in NZ attributed to dismantling of wooden wharves used for roosting and nesting, reclamation of tidal land, deepening of channels and disturbance by power-boats (Edgar 1978). Tolerate long-standing human disturbance in urban areas in NZ or near tourist centres of Great Barrier Reef (Cooper 1948; Edgar 1978), but establishment of research station on One Tree I. led to desertion of nests within 50–70 m of camp (Domm & Recher 1973).

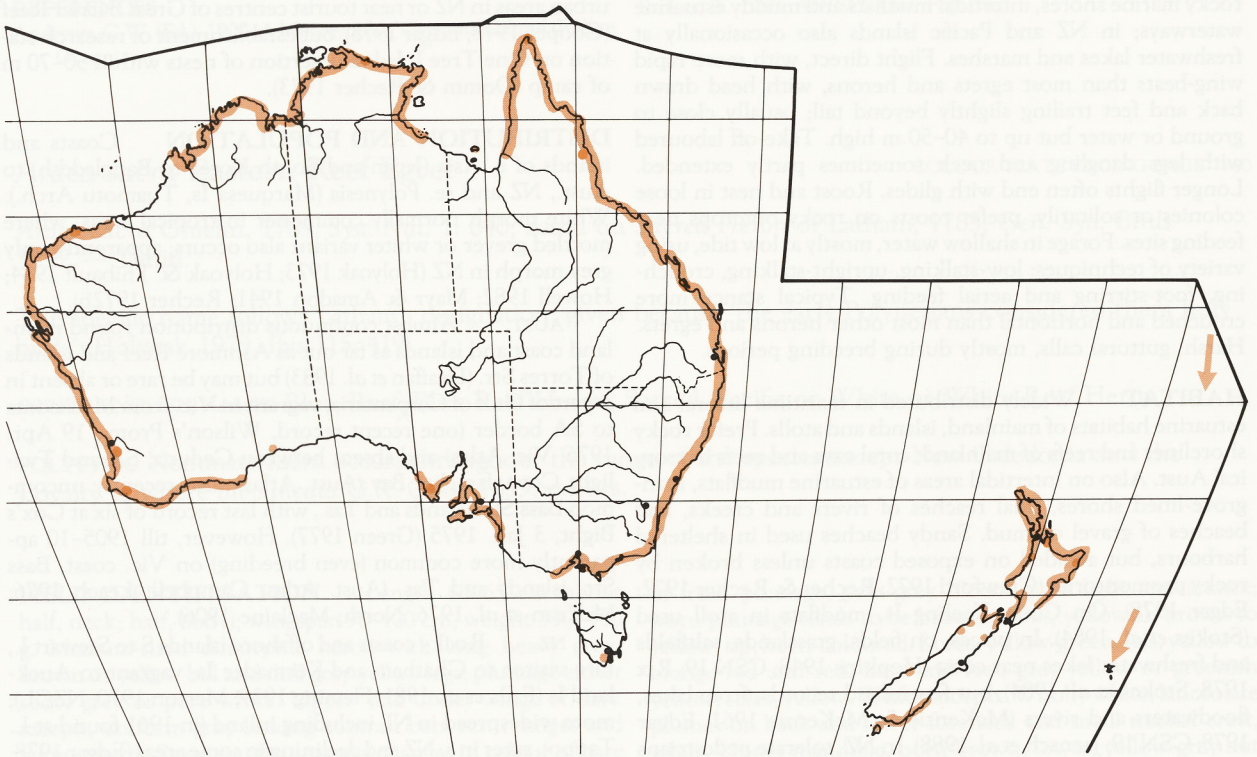
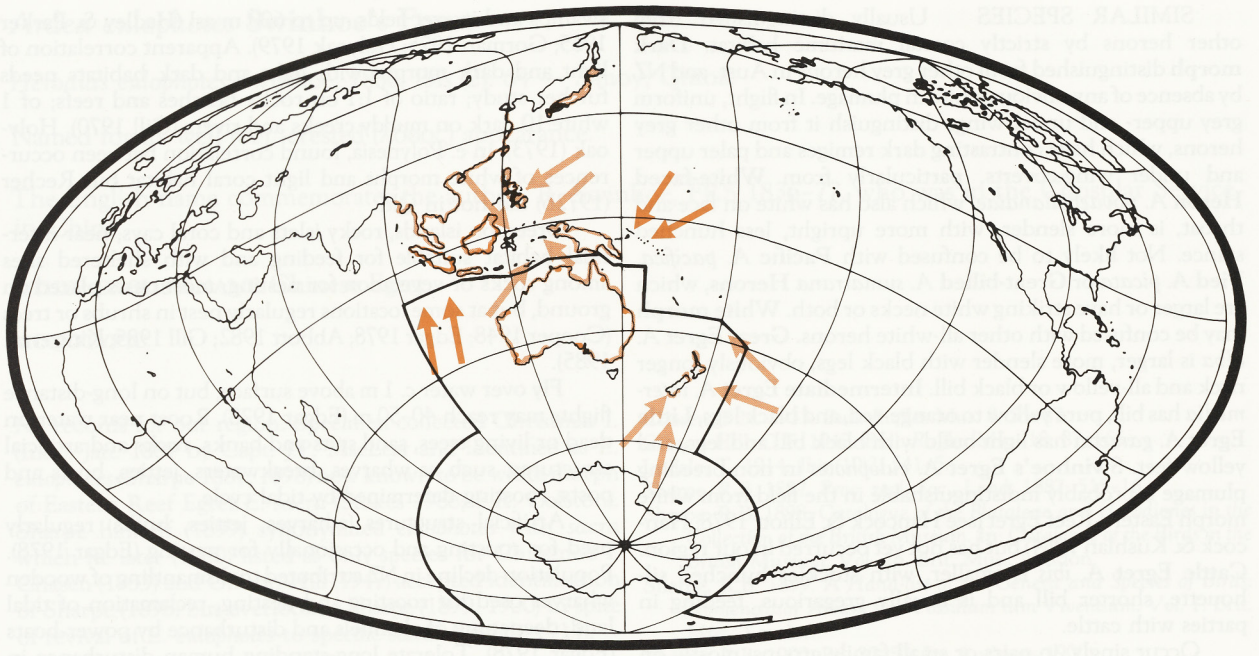
DISTRIBUTION AND POPULATION Coasts and islands of e. Asia (Japan and South Korea to Bangladesh) to Aust., NZ and se. Polynesia (Marquesa Is, Tuamotu Arch.). White morph normally commoner in tropical areas, where mottled greyer or whiter variant also occurs; apparently only grey morph in NZ (Holyoak 1973; Holyoak & Thibault 1984; Howell 1982; Mayr & Amadon 1941; Recher 1972b).

AUST. Almost continuous distribution round mainland coast and islands as far out as Ashmore Reef and islands of Torres Str. (Draffan *et al.* 1983) but may be rare or absent in s. part of Gulf of Carpentaria; vagrant in Vic. from Mallacoota to SA border (one recent record, Wilson's Prom., 19 Apr. 1976; Vic. Atlas) and absent between Ceduna, SA and Twilight Cove-Israelite Bay (Aust. Atlas); also recently uncommon Bass Str. islands and Tas., with last record of six at Cox's Bight, 3 Jan. 1975 (Green 1977). However, till 1905–10 apparently more common (even breeding) on Vic. coast, Bass Str. islands and Tas. (Aust. Atlas; Campbell; Leach 1976; McKean *et al.* 1976; North; Maclaine 1906).

NZ. Rocky coasts and offshore islands S to Stewart I., rare visitor to Chatham and Kermadec Is, vagrant to Auckland Is (Falla *et al.* 1981; Fleming 1939; Merton 1970; NZCL); more widespread in NI, including inland (in 1961 found at L. Taupo), rarer in s. NZ and declining in some areas (Edgar 1978; Hancock & Kushlan 1984; McKenzie & McKenzie 1961; NZ Atlas). Only grey morphs recorded, but possible white morph once, Kermadec Is (Merton 1970).

CHRISTMAS I. (IND.). Small, resident population, especially n. and e. areas (Gibson-Hill 1947; van Tets 1983). Record of Swinhoe's Egret, based on specimen collected in Jan. 1887 (Sharpe 1887, 1898, 1900), later confirmed as Eastern Reef Egret (P.R. Colston; see Swinhoe's Egret).

COCOS-KEELING IS. Widespread resident (Stokes *et al.* 1984).



INCIDENCE OF MORPHS Proportion of white and dark morphs varies regionally. In NZ, Edgar (1978) mentions dark morphs only, despite rare records of white morphs (Mayr & Amadon 1941; Wodzicki & Eyles 1945). No mottled adults in Aust. or NZ. At Cocos-Keeling Is, of 40–50 breeding pairs, 60–65% white phase; remainder dark, with light and dark birds interbreeding ($n=3$) (Gibson-Hill 1949, 1950). Also at Cocos-Keeling, Stokes *et al.* (1984) report white morph commoner. On Double I., off Barrow I., WA (21°S), dark

morph commoner than white, 13:3 (Serventy & Marshall 1964). Abbott (1982) lists morphs observed on 22 islands off WA; at Browse I., of 34 birds, 28 white; at Adele I., of 188 birds, 47 white. Abbott (1982) states that the difference in representation of white morphs between Browse I. and Adele I. is inexplicable. In Qld, Lady Elliot I. (24°S), eight white morphs, one dark (Walker 1986). Similarly at Heron I. (23°S), white morph predominates (Kikkawa 1970). Generally, white morphs found in tropical regions (Mayr & Amadon 1941).

Dark morphs only (or white very rare) in s. Aust. (NSW to SA) (Aust. Atlas; Leach 1976; McKean *et al.* 1976).

BREEDING Aust. Surprisingly few recent records (22 Aust. NRS cards from Qld, NSW, SA, WA to 1982) but assumed to breed throughout range. NZ. Also probably breed throughout range or at least did so until 1977 (Edgar 1978) but not many records away from a few traditional breeding sites.

MOVEMENTS Almost unknown. Some evidence for post-breeding dispersal of isolated s. Aust. population (Parker *et al.* 1979) and birds banded Capricorn Is, Qld, have been recovered Qld coast. Long distance movements also recorded NZ where post-breeding congregations of 10–11 birds noted, sometimes occurring as late as June (Edgar 1978). No evidence of any large scale seasonal movement (Aust. Atlas).

BANDING
23S151E 11 P U 9 535 314 ABBBS
23S152E 04 1+ U 90 142 286 ABBBS
41S174E 12 P U 08 764 203 NZNBS
41S174E 12 P U 19 238 270 NZNBS

FOOD Mainly fish, some crustaceans and molluscs. **BEHAVIOUR.** Prey caught by mixture of stealth and surprise. Approach prey by slow stalking with neck and head retracted and body held low (low stalk; Fig. 1), by walking slightly faster in upright position with head held well above body (upright stalk) or with body pressed almost to substrate (crouch; Fig. 2). Individuals alternate methods: low stalk to take small prey, particularly at water's edge; upright stalk to catch fish in intertidal pools; crouch often follows short flights to exposed reef. When food sighted, stab rapidly, sometimes repeatedly, with bill, lunging up to 2 m from perch in pouncing dive. Almost always feed actively, flying from rock to rock or walking slowly along water's edge. Rarely stand and wait or pursue prey (Recher & Recher 1972). Wings sometimes flicked when stabbing at fish or may be partly spread, birds feeding within the shadow (Edgar 1978). Also seen to hop (Recher *et al.* 1983), hover while stabbing at water from air (Loyn 1985, 1987), pick fish from surface, stir silty or weedy substrate with feet, clamber and scavenge in trees among nesting noddies, steal fish from Crested Terns *Sterna bergii* and recover fish

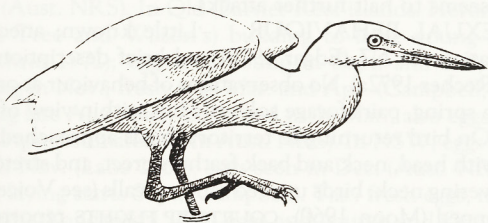


Fig. 1 Low stalk

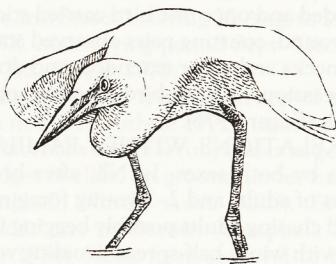


Fig. 2 Crouch

regurgitated by terns (Recher & Recher 1972). Fish <8.5 cm swallowed immediately, larger fish carried to water's edge and manipulated on ground before being swallowed head first (Edgar 1978). Foraging success s. Great Barrier Reef 47.8% (2268 attempts). Bill shorter and stouter than most herons, apparently adapted for catching slower prey. Usually feed alone, sometimes defend foraging territories (Recher 1972a), from shortly after full tide to shortly before, including at night, particularly by moonlight (Recher & Recher 1972).

ADULT At Heron and One Tree Is, s. Great Barrier Reef (273 regurgitated items; Recher & Recher 1972), crustaceans 0.7% no. (*Rhinchocinetes* 0.4), fish 99.3 (*Pseudochromis purpurascens* 0.7, *P. tapeinosoma* 0.4, *Acanthochromis polyacanthus* 2.6, *Pomacentrus tripunctatus* 0.7, *P. spp* 4.0, *Cheilinus* 0.4, *Cirrhilabrus fenniki* 1.1, *Hemigymnus melapterus* 0.4, *Atrosalarius fuscus* 1.1, *Enchelyurus* 1.1, *Istiblennius edentulus* 4.4, *I. lineatus* 0.4, *Neqoscrates sinuosus* 0.7, *Omobranchius* 0.7, *Salarias fasciatus* 4.0, *Vauclusella* 0.4, *Asterropteryx semipunctatus* 0.7, *Bathygobius fuscus* 1.8, *Eviota viridis* 62.3, *E. spp* 4.8, *Acanthurus mata* 0.4). Size of prey summarized in Table 1.

Table 1. Size of prey taken by Eastern Reef Egret (from Recher & Recher 1972).

Size range (cm)	% wt.	% no.
0–2.5	12.9	80.0
2.5–5.0	15.7	12.0
5.0–7.5	26.4	4.5
7.5–10.0	25.0	3.0
10.0–12.5	13.1	0.6
12.5–15.0	6.8	—
n	1168	1054

Other records: Aust.: fish: Hemiramphidae (Barker & Vestjens 1989), *Atherinomorus capricornensis*, *Majarra* (Recher & Recher 1972), *Mugil* (Barker & Vestjens 1989); birds: chicks of Black Noddy *Anous minutus* (Recher & Recher 1972), Common Noddy *A. stolidus* (K. Hulsman). In NZ recorded taking molluscs, crustaceans, fish (McKenzie & McKenzie 1961) incl. eels, grayling (Oliver), flounder ≤ 12.5 cm (McKenzie 1972; Edgar 1978), herrings (Edgar 1978); gecko, lizards (Mander 1972) and food brought to tern chicks.

NESTLING In NZ young fed mainly small flat-fish (Oliver; Edgar 1978).

INTAKE Heron and One Tree Is, 0.33 g/min (1509 min; Recher & Recher 1972).

SOCIAL ORGANIZATION Little known; account based on limited studies in NZ (Edgar 1978) and Aust. (Recher 1972a). During breeding season gregarious or in pairs; singly, in pairs or family groups at other times; in NZ, solitary during non-breeding periods. Feed alone, isolated or in scattered groups spaced along shore, each individual maintaining feeding territory.

BONDS Probably monogamous but few data. No information on duration of pair-bonds nor age at first breeding. Both parents incubate and tend young.

BREEDING DISPERSION Singly or colonially, in groups up to 200–300 birds (North; Guthrie 1972; Aust. NRS).

ROOSTING Influenced by tides; during day and at

night; at One Tree and Heron Is, n. Qld, birds forage at night; more on moonlit nights and especially if little time available for foraging during day (Recher 1972a). Usually roost at high-tide, though occasionally birds continue to forage. In NZ, on rock platforms or other rocky substrate near feeding sites; if rocks not available, on sandbanks, boats, jetties, posts and dead and living trees, including mangroves; in built-up areas, wharves and sea-walls (Edgar 1978). Nocturnal roosts not described. In NZ, congregations of 10–11 birds form at high-tide roosts after breeding and sometimes in winter (Edgar 1978).

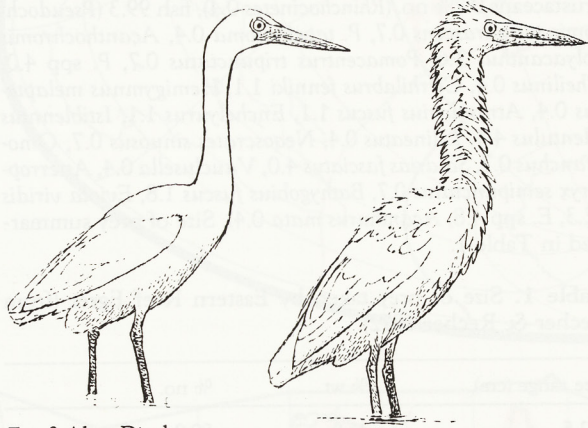


Fig. 3 Alert Display

Fig. 4a Forward Display

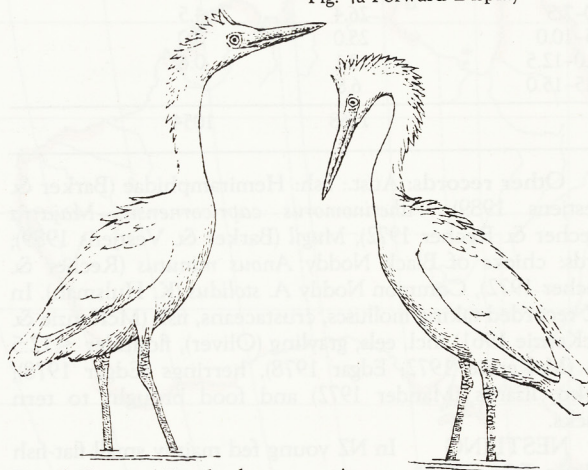


Fig. 4b Forward Display between pair

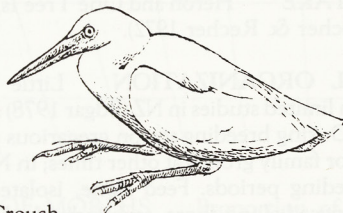


Fig. 5 Withdrawn Crouch

SOCIAL BEHAVIOUR Poorly known. Based mainly on Recher (1972a) at One Tree and Heron Is, Qld, and Edgar (1978) in NZ. Mostly forage at low tide; in Qld, as tide begins to fall, birds leave loafing areas and congregate along shore, some moving to edge of water while others remain in vegetation along fringe of shore; birds disperse over reef progressively as tide falls (Recher 1972a). Descriptions of agonistic and terri-

torial behaviour refer only to foraging. Courtship and breeding behaviour little known.

AGONISTIC BEHAVIOUR Displays between foraging and loafing birds simple and brief. At least some birds defend feeding territories against most other egrets; most forage in definite areas of the reef (Recher 1972a). Alert and Withdrawn Crouch are main agonistic displays. **Alert Display** (Fig. 3): bird stands in upright posture with head held up, neck fully extended, feathers on head, neck and body sleeked and bill held horizontal; often shown when observer approaches bird, and usually precedes flight, or when raptor flies past; also elicited by approach of another Reef Egret, leading to flight or Forward Display. **Forward Display** (Fig. 4); complex range of movements always directed at another Egret and often causing opponent to retreat; functions to increase distance between individuals. Display varies from simple supplanting movements through Threat displays to attack and chase coupled with territorial disputes. Supplanting movements involve physical displacement of one bird by another, but may lead to chases or fight. **THREAT**. May occur at any time of year (Edgar 1978). Body of supplanting bird low and head withdrawn, or may be in stiff-legged erect posture; body- and head-feathers sleeked. As intensity of display increases, bird moves more rapidly and feathers on head, neck and body raised; wings may be used for balancing in rapid running movement, or attacker may fly at opponent. If **FIGHTING** occurs, birds fly at each other and flutter up into air and nearly all feathers on body raised, most markedly on crown, back of neck and along back. Forward Display occurs during territorial boundary disputes and early in pair-formation. When another Egret approaches, birds shift from Alert to Forward Display; intruders to territory are threatened with Forward Display; territory holder will then attack and pursue intruder out of territory. Neighbouring territory holders threaten each other with Forward Display, which results in fight or retreat without pursuit. Forward Display may also occur between members of pair when bird approaches mate. In NZ, Forward Display also directed towards Little Egrets, White-faced Herons and other birds. **SUBMISSIVE DISPLAY**. Threatened birds usually retreat, but on occasions may display submissive **Withdrawn Crouch Display** (Fig. 5) in which body lowered, head withdrawn and feathers sleeked; bird may remain stationary or may slowly back away from opponent, which seems to halt further attacks.

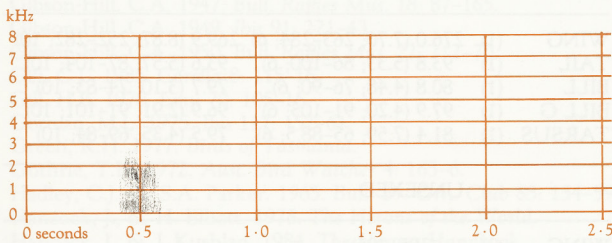
SEXUAL BEHAVIOUR Little known; anecdotal information for NZ (Edgar 1978) and brief descriptions for Aust. (Recher 1972a). No observations of behaviour at or near nest. In spring, pairs forage solitarily but within view of each other. On bird returning to territory, birds approached each other with head, neck and back feathers erect, and stretching and lowering neck; birds uttered raucous calls (see Voice) and bill-snapped (Moon 1960). **COURTSHIP FLIGHTS** reported in NZ; flights, swooping, banking and chasing, quite different from normal flight; occasionally pursuer may fly with neck extended and once one bird carried stick in bill (Edgar 1978). On ground, courting pairs observed stalking round together, with necks arched or extended, and dorsal plumes raised; on two occasions, a third bird present, apparently in submissive crouch (Edgar 1978).

RELATIONS WITHIN FAMILY GROUP Incubation by both sexes. In NZ, after breeding seen in family groups of adults and 2–3 young foraging together; young observed chasing adults possibly begging for food; adults moved away with wings half-spread avoiding young; these young for-

aged independently. Post-breeding congregations of 10–11 birds at high-tide roosts (Edgar 1978). No further information.

VOICE Badly known; no detailed studies. Limited information from Edgar (1978) and Hancock & Kushlan (1984). Generally quiet, especially when breeding. Limited range of guttural croaks and cawing groans during breeding season and when alarmed throughout year. Non-vocal sounds: Bill-snapping reported during breeding season. No information on sexual differences, individual or geographical variation.

ADULT (1) Varying harsh guttural *croak*; given during courtship displays. During non-breeding periods, low *croak* given when bird joins another. (2) **ALARM CALL.** Harsh guttural *crrow*; given when alarmed or flushed throughout year; also described as harsh *squawk* (Hancock & Kushlan 1984). (sonagram A) (3) Reported *mewing* like kittens as birds



A R. Swaby; Green I., Qld, June 1971; P26

hovered overhead when nest threatened (Buller 1888). **NON-VOCAL SOUNDS:** **Bill-snap.** Mandibles snapped shut; reported during breeding season.

YOUNG No information.

BREEDING Poorly known. No detailed studies. Information from M.N. Maddock. Breed colonially or solitarily. Colonies of 20–70 pairs and 200–300 birds (North; Guthrie 1972; Aust. NRS) are perhaps mostly in n. Aust. where species common; S of c. 30°S only solitary nesting known (Lane 1965; Aust. NRS). On coastal islands, reefs, atolls and sea-cliffs.

SEASON **Aust.** In NT (Port Essington) breeding reported Aug. (North), in Torres Str. (Tuesday I.) eggs seen 22 Jan. (Aust. NRS). In Qld (Barrier Reef islands: Heron, Hope, One Tree and Wilson's) building to large young in Nov. (Guthrie 1972); eggs and young in Sept. and fully fledged young in Nov.; fresh eggs Mar. and Apr. (Campbell; North); laying late Aug.–early Sept. and early Mar., also eggs seen in mid Apr. (estimated from Aust. NRS). In NSW, eggs laid first week Nov. (Lane 1965); eggs seen in Dec. (Aust. NRS). Bass Str., laying starts Sept. (Campbell). Tas.: fresh eggs, mid-Oct. (North). Kangaroo I., SA, eggs and young, end Oct. (Campbell; North); Brothers and Goat Is, laying late Sept.–early Oct., and young 21 Nov. (estimated from Aust. NRS). In WA (Pt Cloates, NW Cape and Fraser I.) laying 25 Aug. to 25 Sept. (Campbell; North). NZ. Main laying period Sept.–Dec., peak Oct., some laying in Jan. (Edgar 1978).

SITE In forks of *Pisonia* trees or on top of tangled *Pandanus* to about 6 m high (Guthrie 1972); in low scrubby trees to 3 m high; on flat rocks under scrub, under large rocks, in crevices and on ledges of cliffs, on ground under tussocks, in small caves (Campbell; North; Aust. NRS). Even on wrecked ships or under pier in Darwin (Campbell; North; Hancock & Kushlan 1984). Nests from sea-level to highest

point of islands. Nests often not easy to see, even in colonies (Guthrie 1972), or generally well concealed (North). In NZ, preferred sites are caves, crevices, rock-shelves under overhang; recorded in open among rushes, among roots of trees and on artificial structures. Height above high water-mark, 1–11 m (Edgar 1978).

NEST, MATERIALS Large flattish pile or platform of sticks and dead stalks to c. 8 mm in diameter and 60 cm long, and coarse herbage, seaweed; unlined (Heron I.) or lined with finer material, seaweed (Campbell; North; Guthrie 1972). Rusty wire used as material on wrecked ship far from supply of natural material (Campbell). Overall diameter c. 40 cm; a few centimetres thick but once recorded as 1 m in height, which suggests persistent use of same nest (Campbell; North).

EGGS Elliptical to oval: fairly close-grained or somewhat coarse texture; not glossy, sometimes with limy excrescences; pale bluish white, light green inside shell.

MEASUREMENTS:

46.3 (44.5–48.0; 10) x 35.2 (34.3–39.6) (North); 46.0 (45.0–47.2; 4) x 34.0 (33.5–34.3) (Campbell).

CLUTCH-SIZE Said to be 2–3, occasionally four, rarely five (Campbell; North). In NZ, 2–3 (with ratio of 3:4 but probably more in favour of C/3) (Edgar 1978). No accurately quantified data.

LAYING Guthrie (1972) claimed that second egg laid about one week after first. Edgar (1978) stated an interval of up to 2 days. No information on replacement laying or second broods.

INCUBATION By both sexes. **INCUBATION PERIOD:** estimated as 25–28 days (Falla *et al.* 1981; Edgar 1978) but no definite determinations. No further information.

YOUNG Altricial, nidicolous. Hatched with dark-grey down; bill, flesh-coloured with black tip to upper mandible; legs, flesh-coloured (information from Indonesia; Hancock & Kushlan 1984). Brooded for first few days but gradually left alone in nest during day (Moon 1960). Fed by incomplete regurgitation; chicks grab parent's bill crosswise. After about 3 weeks wander away from nest and may hide in crevices. **NESTLING PERIOD** said to be 5.5 weeks in NZ (Falla *et al.* 1981). Closely attended by parents on fledging but soon capable of independence; young fledged in Nov. still closely associating with parents in Feb. (Edgar 1978). No further information.

SUCCESS No information. At Heron I., most nests had C/2 but only one brood of two recorded; otherwise only one chick reared per nest (Guthrie 1972).

PLUMAGES Nominate *sacra*. Plumage dimorphic: dark and white morphs.

ADULT BREEDING **Dark morph:** **HEAD AND NECK.** Feathers on crown to hindneck, long and grey (84). Nape, black-brown (119). Chin, light grey-brown (119C) with scattered white feathers and extending as long white stripe from chin, tapering to lower throat; stripe c. 80 mm in length; length varying, unknown if correlated with sex and age (Edgar 1978). Lower throat to lower foreneck, black-brown (119). **UPPERPARTS,** dark brown (121), darker on back, where dark brown (219) with grey (84) shade; concealed bases of feathers, light grey-brown (119C) and exposed when disarranged. Lanceolate plumes on back 140–165 mm long, grey (84); basal rami, light grey-brown (119C). Rump and upper tail-coverts, dark brown (219). **TAIL,** grey (84). **UPPERWING.** Tertiaries, long and broad, grey (84). All remiges, grey (84); dark-grey (83)

fringes on greater and median coverts. Marginal and lesser coverts, grey-black (82). **UNDERPARTS.** Breast to under tail-coverts, including flanks, brown (28). Breast plumes 70–79 mm long, lanceolate and grey (84). Under tail-coverts end 3–7 mm short of tip of tail. Axillaries short, brown (28). **UNDERWING.** Marginal coverts, brown (28) with brown-grey (79) fringes. Greater coverts, light grey (85); rami, plumulaceous basally, brown-grey (80). Median and lesser coverts, grey (84) with brown-grey (79) shade. Marginal coverts, almost grey-black (82). **White morph.** Plumage, entirely white; occasional scattered, but few dark-brown (119A) feathers on body; also has ornamental plumes.

ADULT NON-BREEDING Similar to adult breeding in both morphs; largely lacks very long back, nape and breast plumes, but, if present, short.

NESTLING Down, dark grey in dark morph; white in white morph; sparse and erect on crown.

JUVENILE **Dark morph.** Paler than adult. **HEAD AND NECK.** Crown and lower neck, black-brown (119), crown-feathers narrowly fringed white. Chin, light grey-brown (119C). White stripe on throat, duller and shorter; not prominent as in adult; in one male, 70 mm long and in three females 60, 87, 88 mm (Edgar 1978). Cheeks, black-brown (119). **UPPERPARTS,** dark brown (119A); no plumes on back. **TAIL,** similar to adult. **UPPERWING.** All coverts, fringed light grey-brown (119C). **UNDERPARTS.** Breast, light grey-brown (119C), flanks brown (119B); under tail-coverts similar in colour to breast. Feathers on breast, long and loose; no plumes. **UNDERWING,** similar to adult. **White morph.** Entirely white or varying streaked with dark brown (119A) on head and neck, body, tail and upper wing-coverts.

IMMATURE In both morphs, similar to juvenile; may show partial adult characteristics, particularly short back plumes.

BARE PARTS Based on photos in Moon (1979), Pringle (1985) and Aust. RD, except where stated.

ADULT BREEDING No sexual differences recorded. Iris, orange (17), orange-yellow (18). Bill, orange-buff (118); upper mandible, except middle portion, and tip of lower, black-brown (119). Loral skin, dark grey (83) in dark morph; varies from bluish green to yellowish green and more yellow before laying (Edgar 1978). Loral skin, orange-buff (153) in white morph. Legs and feet, pale green (162D) to pale green (161); scutes on front of tarsus and toes, grey-black (82); varying (Edgar 1978). For Cocos-Keeling Is see Gibson-Hill (1950).

ADULT NON-BREEDING In dark and white morphs, iris, pale yellow (157). Bill, loral skin and legs and feet, similar to adult breeding. Further descriptions of bare parts based on field observations of dark morphs in NZ (Edgar 1978). McKean *et al.* (1976) state that greenish grey bill appears common in white morphs.

NESTLING **Dark morph.** No data. **White morph.** Iris, pale yellow (157). Bill, orange-buff (118) or buff (124); base and tip of upper mandible, and tip of lower, and lores, dark brown (121). Legs and feet, yellow-olive (52).

JUVENILE, IMMATURE **Dark morph.** Iris, straw-yellow (56). Bill, similar to adult, but browner (Edgar 1978). Legs and feet, buff (53); scutes on front of tarsus and toes, dark olive-green (49). **White morph.** No data.

MOULTS Timing and duration unknown in Aust.; further study required.

ADULT POST-BREEDING Complete; primaries irregular; secondaries irregular (based on skins at MV, SAM, NMNZ). In NZ, about Feb.; involves reduction but not total loss of back plumes.

ADULT PRE-BREEDING Unknown, probably in Sept. or Oct.; involves acquisition of ornamental plumes.

POST-JUVENILE Begins about Mar.–Apr. Based on skins, sequence: head, neck and upper back; wing and rectrices last, after most or part of body plumage replaced; primaries centrifugal (Mayr & Amadon 1941).

MEASUREMENTS (1) Cocos-Keeling and Christmas (Ind.) Is; BILL G = bill to gape (Gibson-Hill 1950). (2) NZ; methods unknown (Oliver). (3) One Tree I., Qld; BILL G = culmen and gape, other methods unknown (Recher & Recher 1972).

		MALES	FEMALES
WING	(1)	276.0 (7.70; 263–284; 6)	269.9 (8.87; 252–282; 10)
TAIL	(1)	93.8 (5.33; 86–100; 6)	93.6 (5.57; 87–104; 10)
BILL	(1)	80.8 (4.48; 76–90; 6)	79.7 (3.10; 74–83; 10)
BILL G	(1)	97.9 (4.20; 91–105; 6)	96.9 (2.91; 91–101; 10)
TARSUS	(1)	81.4 (7.59; 65–88.5; 6)	79.5 (4.35; 69–84; 10)
UNSEXED			
WING	(2)	— (285–295)	
BILL	(2)	— (80–92)	
BILL G	(3)	83.0 (5.0; 23)	
TARSUS	(2)	— (76–90)	
	(3)	80.0 (10.0; 23)	
TOE	(2)	— (65–70)	
TAIL	(2)	— (100–108)	

WEIGHTS Few data. Label data on skins at NMNZ: adult female 332.0, immature male 371.0. Skin at SAM: immature male 463.0. No data on sexual or seasonal variation.

STRUCTURE Wing, broad. Eleven primaries: p8 usually longest, p10 4–6 mm shorter, p9 0–3, p7 0–5, p6 10–11, p5 24–27, p4 39–45, p3 52–57, p2 70–75, p1 83–85, p11 minute. P10–9 emarginated on inner webs; slight on outer of p9. Very slight emargination on outer and inner webs of p8. Fifteen secondaries; three of tertial form. Twelve rectrices: t1 usually longest, t6 c. 2–3 mm shorter. Tail, short, square. Bill, pointed; high at base; robust. Pair of powder-down patches at sternum. Lower half of tibia, bare. Legs and feet, slender. Claw of middle toe, pectinate. Outer toe c. 88% of middle, inner c. 75%, hind c. 55%.

AGEING Juvenile plumage retained for about 1 year. In mottled juveniles of white morph, entire or part of plumage all white at first adult plumage; pure white thereafter, following subsequent moults (Mayr & Amadon 1941).

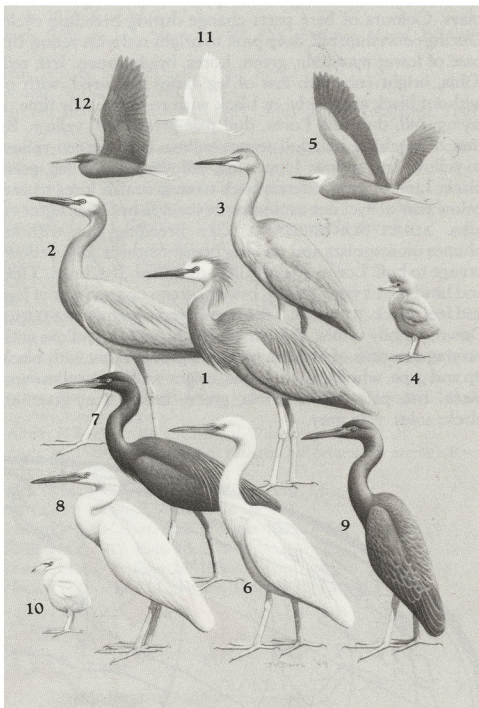
GEOGRAPHICAL VARIATION Polymorphic; dimorphic in A'asia. Two subspecies: nominate *sacra*, from s. Asia, e. Polynesia, Aust. and NZ; *albolineata* from New Caledonia and Loyalty Is differs in having larger wing (Mayr & Amadon 1941). Proportion of white and dark morphs varies (for details see Distribution). For further discussion of proportions of morphs and genetic basis see Mayr & Amadon (1941). For discussion of ecological basis of polymorphism in

herons, see Murton (1971), Recher (1972b) and Holyoak (1973).

RMO

REFERENCES

- Abbott, I. 1982. *Corella* 6: 119-22.
- Andrews, C.W. (Ed.) 1900. *A Monograph of Christmas Island (Indian Ocean)*.
- Barker, R.D., & W.J.M. Vestjens. 1989. *The Food of Australian Birds*. 1.
- Buller, W.L. 1888. *A History of the Birds of New Zealand*.
- Cooper, R.P. 1948. *Emu* 48: 107-26.
- Crawford, D.N. 1972. *Emu* 72: 131-48.
- Domm, S., & H.F. Recher. 1973. *Sunbird* 4: 63-77.
- Draffan, R.D.W., S.T. Garnett & G.J. Malone. 1983. *Emu* 83: 207-34.
- Edgar, A.T. 1978. *Notornis* 25: 25-58.
- Falla, R.A., R.B. Sibson & E.G. Turbott. 1981. *The New Guide to the Birds of New Zealand*.
- Fleming, C.A. 1939. *Emu* 38: 380-413, 492-509.
- Gibson-Hill, C.A. 1947. *Bull. Raffles Mus.* 18: 87-165.
- Gibson-Hill, C.A. 1949. *Ibis* 91: 221-43.
- Gibson-Hill, C.A. 1950. *Bull. Raffles Mus.* 22: 212-70.
- Gill, C.L. 1985. *Corella* 8: 115-16.
- Gill, H.B. 1970. *Emu* 70: 105-16.
- Gorman, M.L. 1975. *Ibis* 117: 152-61.
- Green, R.H. 1977. *Birds of Tasmania*.
- Guthrie, T.H. 1972. *Aust. Bird Watcher* 4: 165-6.
- Hadley, C.J., & S.A. Parker. 1965. *Bull. Br. Orn. Club* 85: 154-59.
- Hancock, J., & H. Elliott. 1978. *The Herons of the World*.
- Hancock, J., & J. Kushlan. 1984. *The Herons Handbook*.
- Holyoak, D.T. 1973. *Ibis* 115: 419-20.
- Holyoak, D.T. 1979. *Emu* 79: 7-18.
- Holyoak, D.T., & J.-C. Thibault 1984. *Mem. Mus. Nat. Hist. nouv. Ser. A.* 127: 1-209.
- Hopkins, N. 1948. *Emu* 47: 331-47.
- Howell, L. 1982. *PNG Bird Soc. Newsl.* 193/194: 30.
- Jaensch, R.P., R.M. Vervest & M.J. Hewish. 1988. *RAOU Rep.* 30.
- Kikkawa, J. 1970. *Sunbird* 1: 34-48.
- King, B.R., R.C. Buckley & C.J. Limpus. 1985. *Corella* 9: 78-80.
- Lane, S.G. 1965. *Emu* 64: 317-19.
- Leach, G.J. 1976. *Sunbird* 7: 112.
- Loyn, R.H. 1985. *Aust. Bird Watcher* 11: 133-5.
- Loyn, R.H. 1987. *Aust. Bird Watcher* 12: 68.
- Maclaine, D. 1906. *Emu* 5: 208-209.
- Mander, R. 1972. *Notornis* 19: 27.
- Mayr, E., & D. Amadon. 1941. *Am. Mus. Novit.* 1144.
- McKean, J.L., H.B. Gill & J.H. Lewis. 1976. *Sunbird* 7: 20-1.
- McKenzie, H.R. 1972. *Notornis* 19: 26.
- McKenzie, H.R., & H.M. McKenzie. 1961. *Notornis* 9: 200.
- Merton, D.V. 1970. *Notornis* 17: 147-99.
- Moon, G. 1960. *Focus on New Zealand Birds*.
- Moon, G. 1979. *The Birds Around Us*.
- Murton, R.K. 1971. *Ibis* 113: 97-9.
- Parker, S.A., H.J. Eckert, G.B. Ragless, J.B. Cox & N.C.H. Reid. 1979. *An Annotated Checklist of the Birds of South Australia*. 1.
- Pringle, J.D. 1985. *Waterbirds of Australia*.
- Recher, H.F. 1972a. *Emu* 72: 126-30.
- Recher, H.F. 1972b. *Ibis* 114: 552-5.
- Recher, H.F., & J.A. Recher. 1972. *Emu* 72: 85-90.
- Recher, H.F., R.T. Holmes, W.E. Davis & S. Morton. 1983. *Colonial Waterbirds* 6: 1-10.
- Rix, C.E. 1978. *Companion to Cooper's Birds of a Salt-field*.
- Serventy, D.L., & A.J. Marshall. 1964. *Tech. Pap. Div. Wild. Res. CSIRO Aust.* 6.
- Sharpe, R.B. 1887. *Proc. zool. Soc. Lond.* 1887: 515-16.
- Sharpe, R.B. 1898. *Catalogue of the Birds of the British Museum*. 26.
- Sharpe, R.B. 1900. *In: Andrews* 1900.
- Stokes, T., W. Sheils & K. Dunn. 1984. *Emu* 84: 23-8.
- van Tets, G.F. 1983. *In: The Preservation of Abbott's Booby on Christmas Island*. Rep. Senate Stand. Comm. Sci., Tech. Env.
- Walker, T. 1986. *Sunbird* 16: 73-82.
- Wodzicki, K.A., & J.R. Eyles. 1945. *Emu* 44: 181-2.



Volume 1 (Part B), 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

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