

## 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 ibis* Linnaeus, 1758, *Syst. Nat.*, ed. 10, 1: 144; based on *Ardea (Ibis)* of Hasselquist, 1757, *Iter Palestin.*: 248 — Egypt.

OTHER ENGLISH NAME Buff-backed Heron.

**Cattle** has prevailed over **Buff-backed** as an excellent descriptive epithet of the species' feeding association with stock, cattle in particular.

POLYTYPIC Nominate *ibis* extralimital in Africa, sw. Asia, s. Europe, North and South America; *coromanda* (Boddaert, 1783), Asia E from Baluchistan to Aust. and NZ.

**FIELD IDENTIFICATION** Length 70 cm (body 36% of total); wingspan: male 91 cm, female 88 cm; weight: male 390 g, female 340 g. Small stocky, mostly white, egret with short neck, stout yellow to red bill and heavy jowl; orange to buff on crown, neck, breast and mantle during courtship and breeding. Sexes similar but males heavier. Marked seasonal changes in plumage and bare parts. Juveniles (first-year) indistinguishable from non-breeding adults; however, before end of first year, many develop some colouration during breeding season, showing range of plumages, from mostly white (like juvenile and non-breeding adult) to full adult breeding coloration (then indistinguishable from breeding adults).

**DESCRIPTION ADULT BREEDING.** Density and extent of buff on head, neck, scapulars and breast, and number and conspicuousness of plumes, vary much. Head: white with buff crown, or wholly buff or orange; neck, breast and mantle, white, pale buff or bright orange, with no plumes, or with poorly developed to conspicuous plumes. Back, tail, wings and abdomen, white. Colours of bare parts change through breeding season. Before and during courtship: bill, bright magenta-red with yellow tip; lores, magenta; iris, red; legs, red or orange brown. After courting and pair-formation, quickly lose magenta flush: bill, at first dull red with pronounced yellow tip, fading until bill wholly yellow 2–7 days after pair-formation; lores, yellow; iris yellow; legs, yellow, then returning to dark grey-green during incubation (some sooner). Birds (males and females) can breed in their first or second years; in first year, breed in all plumage variations. Birds breeding in second season and older, show orange and conspicuous plumes (McKilligan 1985; Maddock 1989a). **ADULT NON-BREEDING.** All white with inconspicuous buff patch on crown. No plumes. Bill and lores, yellow. Iris, cream or yellow. Legs and feet, dark green-grey to black. **NESTLING.**

Down, wholly white. Bill: at first, yellow with black tip and margins; later, grey-black with yellow tip; at fledging, yellow. Lores, like bill. Iris, white or pale grey becoming yellow by 8 days old. Legs and feet, flesh-coloured, then yellow; grey-green and grey-black at fledging. **FIRST-YEAR.** At first, like non-breeding adult. Bill and lores change through dark grey, grey-yellow, yellow to orange-yellow with increasing maturity; iris, pale yellow to cream; legs and feet, dark grey to black. Before end of first year (during breeding season), can develop full adult breeding colour, paler buff version of adult breeding plumage, have only trace of buff or remain in white plumage; can breed in any of these plumages before end of first year. Breeding birds have adult bare-part colours.

**SIMILAR SPECIES** When breeding, buff plumage diagnostic. Outside breeding season, only likely to be confused with other white egrets, especially **Intermediate Egret** *A. intermedia*, which differs by longer-necked, less stocky jizz; neck of Intermediate about same length as body (shorter in Cattle Egret); bill similarly proportioned but lacks slight downcurved appearance of Cattle. Easily confused with Cattle Egrets when feeding with stock and seen from a distance. **Great Egret** *A. alba*: obviously larger, with longer legs and much longer neck (c. 1.5 times length of body), slimmer profile and noticeably flattened crown. **Little Egret** *A. garzetta*: similar size but always with black, very slender bill, and longer-necked, more slender jizz. **Eastern Reef Egret** *A. sacra* (white morph): larger, no buff crown, much heavier, horn-coloured bill; solitary and coastal habits. **Nestlings** identified from those of Little, Intermediate and Great Egrets by slightly downcurved bill with bill-length:depth of 3.00 and distinct gape that extends to back of, but not behind, eye. This feature also found in Intermediate Egrets, which have ratio of bill-length:depth of 3.11 (Maddock 1989b).

Gregarious; in small parties to flocks of hundreds, occasionally single birds, foraging among grazing stock, in flooded pastures or floodplains, resting in pastures, on margins of swamps or billabongs, or roosting in trees. In NZ, very shy and wary and not allowing close approach, even in car. When foraging, walk slowly, peering at ground, with quick dashes after prey; also take parasites and other insects from backs and bellies of cattle. Walk with marked back and forward movements of head. At rest, appear hunched and deep-jowled. Flight swift with wingbeats more rapid than other egrets; legs do not protrude far beyond tail. Generally silent but variety of croaks heard at colonies.

**HABITAT** Tropical and temperate grasslands, wooded lands and terrestrial wetlands; uncommon in arid and semi-arid regions. Regularly forage away from water on low-lying grasslands, improved pastures and croplands (Chalmers 1972). Density high on moist, low-lying, poorly drained pasture, especially near hollows and ditches and where tussocks of long grass present; avoid short-cropped dry pasture (Heather 1982; McKilligan 1984). Also observed on earthen dam walls, edges of ploughed fields (McKilligan 1984); enter woodlands and forests in tropical NT (Morton *et al.* 1989). Associate with grazing animals, particularly cattle; but also other domestic stock (pigs, goats, sheep, donkeys, horses, deer), poultry (fowls, geese), feral Water Buffalo, Magpie Geese *Anseranas semipalmatus*, pet kangaroos (Jenkins & Ford 1960; Crawford 1972; Heather 1982; Morton *et al.* 1989); follow earth-moving machinery (Cooper 1979) and forage at garbage tips (Hobbs 1986); also feed independently. Wetlands used are mainly shallow, open and fresh; they include meadows, swamps with low emergent vegetation and abundant aquatic flora, and shallow open water in deep swamps; occasionally use swamps with tall emergent vegetation (e.g. *Eleocharis*, *Typha*) or wooded swamps (Corrick & Norman 1980; Gosper 1981; Corrick 1982). Recorded from edges of estuaries in NZ, but use of saline habitats rare (Heather 1982). Seasonal variation of use of habitat in NT: in floodplains in dry season; in wood-

lands and forests in wet season (Morton *et al.* 1989). In Gippsland, Vic., prefer shallow wetlands, Apr.–May; low-lying grasslands, June–Sept.; improved pasture, lucerne plantings and cropland on higher ground, Oct. (Chalmers 1972).

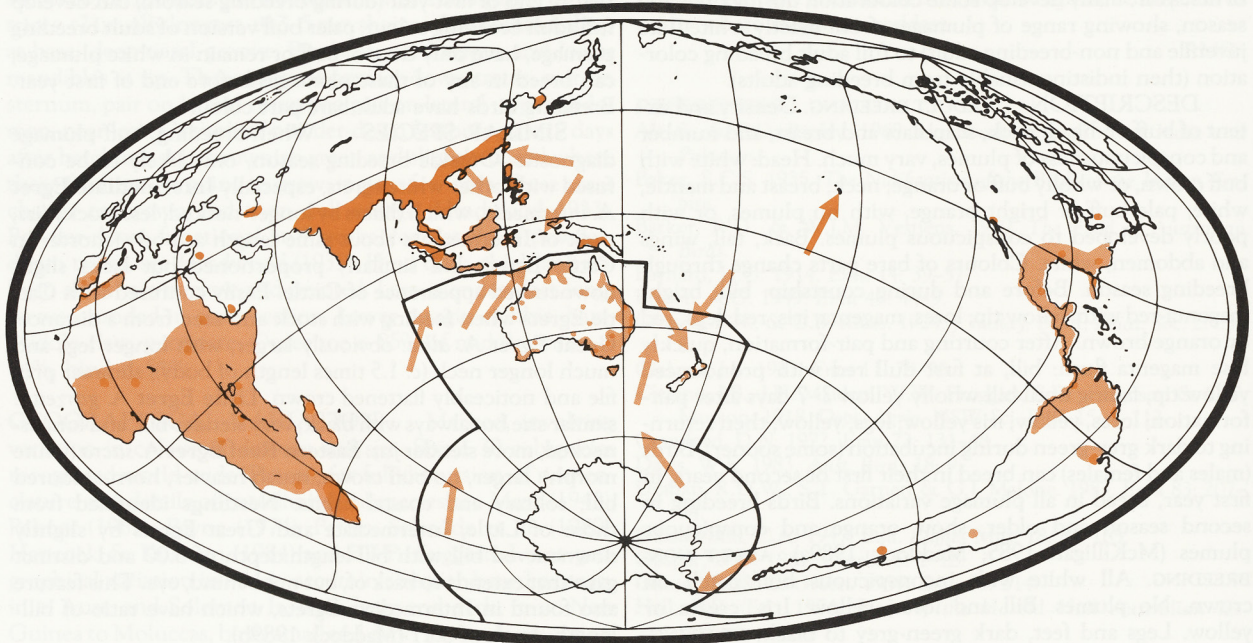
Nest in dense woodland in or beside swamps, rivers or pools (Goddard 1955; Morris 1979; McKilligan 1985); close to settlement and industrial areas in Murwillumbah, NSW (Pratt 1979).

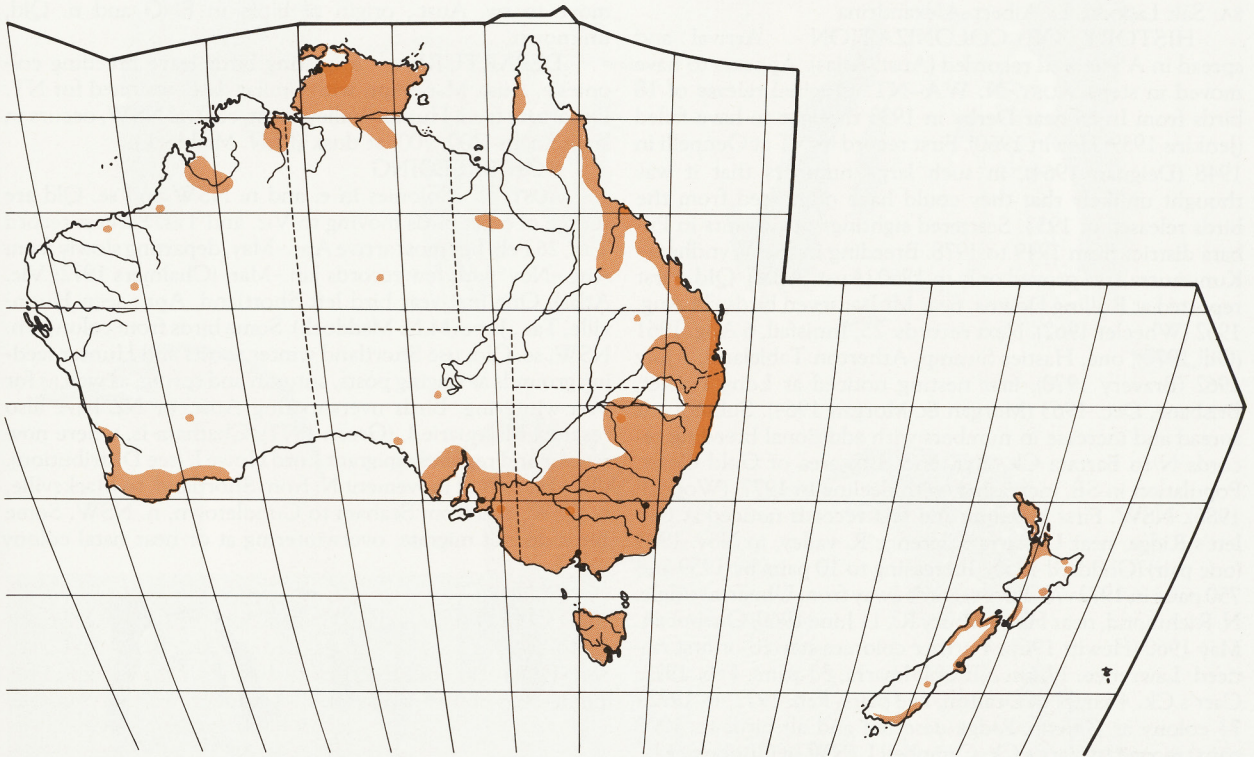
Roost in trees or among ground vegetation in or near lakes and swamps (Chalmers 1972; Corrick 1981; Thomas & Wheeler 1983; Jaensch *et al.* 1988).

Recent world-wide expansion of range favoured by clearing of wooded lands and conversion to pasture, especially in high-rainfall areas; but main stimulus in areas with low densities of native grass-eating herbivores seems to be intense stocking with domestic grazing animals, particularly cattle. Spread into drier parts (s. Africa, Aust.) may be assisted by construction of artificial waterbodies and irrigation schemes (Blaker 1971). Valued by graziers as consumers of pasture pests, and infestation by cattle ticks may be reduced where density of Egrets high (McKilligan 1984).

**DISTRIBUTION AND POPULATION** Originally Africa and sw. Europe, and Asia from Pakistan S to Sri Lanka, N to Himalayas, and E to Korea, Japan, s. Malaysia and Philippines; has now expanded to all continents except Antarctica and many island regions. Aust. birds of Asian origin.

**AUST.** Widespread and even common, according to migrations, movements and breeding localities, in two regions: ne. WA and Top End, NT, from Wyndham to Arnhem Land; se. Aust. S and SE of line roughly from Bundaberg, Qld, inland to Roma, Thargominda, Inverell, Walgett, Nyngan, Cobar, Ivanhoe, Balranald, Swan Hill, Pinnaroo and Pt Augusta, including Tas. Occurs less regularly or commonly: in Broome-Derby area, WA; mainly coastal S from parts of C. York Pen. and Cairns to Bundaberg; coastally round Eyre Pen. from Pt Augusta to Ceduna, SA; and in sw. WA, SW of line from Perth to Esperance (Aust. Atlas). Otherwise, records





of vagrants in Aust. Atlas in area of Mt Isa and Cloncurry, Qld; Alice Springs; S of L. Eyre; the Pilbara area and Kalgoorlie, WA.

**NZ** Regular migrant from Aust. (history of colonization given below); arrive mainly Apr.–May on w. coast; by midwinter, birds have congregated into widely spaced flocks at about 30 traditional sites on both NI and SI; depart mainly Oct.–Nov. Single birds landed on oil-rig working SE of Stewart I. in 1977 and 1978 (Heather 1982); rig left after 1978. A few stay over summer most years but seldom in same district in successive years. Has not bred (Heather 1978, 1982, 1986; NZ Atlas; B.D. Heather). Annual national counts listed below (from Heather 1982; B.D. Heather).

YEAR	NI	SI	TOTAL
1977	196	97	293
1978	152	114	266
1979	381	243	624
1980	404	367	771
1981–83	fewer than 1980 figures at most places		
1984	1126	405	1531
1986	2288	964+	3252+
1987	1755+	495+	2250+
1988	816	326	1142

**NORFOLK I.** Considered vagrant (Schodde *et al.* 1983) but apparently now recorded annually, Feb.–June (Hermes *et al.* 1986).

**LORD HOWE I.** Considered vagrant (P.J. Fullagar) but now recorded annually, passing through Apr.–June and Nov.–Dec.; in 1983, two on 25 Apr., 10 on 4 May, 16+ on 9 May, 9 on 26 May (I. Hutton; G. Fraser; NSW Bird Reps).

**COCOS-KEELING IS** Accidental, Jan. 1982 (Stokes *et al.* 1984).

**SUBANTARCTIC ISLANDS** Accidental. **Macquarie I.:** remains of one bird collected 1975 (Green 1977); **South Shetland Is:** four dead specimens, summer 1984–85 and 1985–86 (Trivelpiece *et al.* 1987). **Prince Edward Is:** 20 birds recorded to 1987. Eight birds, 29 Mar. 1948 (Crawford 1952); one, 14 Jan. 1980 with six previous sightings of nine birds (Berruti & Schramm 1981); one, 1 May 1982 (Newton *et al.* 1983); one, 20 Apr. 1986; three, 13 May 1986; singles: 25 May 1986; 1 June 1986; 5 June 1986; 20 Mar. 1987 (Gartshore 1987).

**BREEDING** Strongholds are: Wyndham–Darwin area in n. Aust; se. Qld and ne. NSW from Bundaberg to Newcastle and in the Macquarie Marshes. Also isolated colonies near Ayr, ne. Qld, S to Rockhampton. Permanent or temporary colonies known at:

- WA: Wyndham–Kununurra
- NT: Oenpelli
- Adelaide R.
- Mary R.
- East Alligator R.
- QLD: Bald Hill
- Barrata Creek, Ayr
- Palmwoods
- Brisbane (including Doboy heronry)
- Gatton
- NSW: Murwillumbah
- Lawrence
- Ulmarra, Clarence R. valley
- Grafton
- swamps between Urunga and Bellingen
- Macksville
- Boambee
- Macquarie Marshes
- Seaham Swamp, Newcastle
- Shortland, Newcastle
- VIC.: Gunbower I., Murray R.

SA: Salt Lagoon, Ls Albert–Alexandrina

**HISTORY OF COLONIZATION** Arrival and spread in A'asia well recorded (Aust. Atlas). Appears to have moved in steps. AUST. N. WA–NT. Original release of 18 birds from India near Derby in 1933 thought to have failed (Jenkins 1959; Hewitt 1960). First record in NT at Oenpelli in 1948 (Deignan 1964), in such large numbers that it was thought unlikely that they could have originated from the birds released in 1933. Scattered sightings of vagrants in Pilbara district from 1949 to 1978. Breeding in the Wyndham–Kununurra area proved only in 1980 (Aust. Atlas). Qld. First reported at Rolling Downs, near Mt Isa, seven birds, 24 Aug. 1952 (Wheeler 1962). Next records: 25, Innisfail, 6 Aug. 1961 (Gill 1970); one, Hastings Swamp, Atherton Tableland, 2 July 1962 (Bravery 1970); first nesting noticed at Long Pocket, Brisbane, Dec. 1963 (Morgan & Morgan 1964). Subsequent spread and increase in numbers with additional breeding records N to Barrata Ck, Ayr, and S to area of Gold Coast. Population in SE, increasing (with decline in 1977) (Woodall 1986). NSW. First breeding and first records noticed at Gillett's Ridge, near Ulmarra, Clarence R. valley, in Nov. 1954 (one pair) (Goddard 1955), increasing to 10 pairs by 1959 and 750 pairs in 1972–73. First records away from Ulmarra: single, N. Richmond, near Hawkesbury R., 11 June 1960; Ourimbah, May 1960 (Hewitt 1961). Further colonies started or first noticed: Lawrence, 17 km NE of Ulmarra, 35 pairs, Feb. 1972; Carr's Ck, 4 km N of Grafton, five pairs, Feb. 1972; in 1972–73 colony at Gillett's Ridge deserted and all birds (c. 1000 pairs) moved to Carr's Ck; Campbell I. (NW of Gunbower I.), Murray R., four pairs, Dec. 1974 but no nesting in later years; S of Murwillumbah, 60+ pairs, Mar. 1976, increasing to 700–800 pairs, Dec. 1977; 2 km S of Macksville on Nambucca R., Jan. 1977–79; Macquarie Marshes, near Quambone, 17+ nests, Nov. 1978; Seaham Swamp, 20 km NE of Maitland, Hunter Valley, 25+ pairs, Jan. 1979; swamps between Urunga and Bellingen, 50+ pairs, 1983. Increase in NSW population to c. 2300 pairs in 20 years (Morris 1979) and further increases since then (NSW Bird Reps). Vic. First record, Cororooke, L. Colac, 18 Jan. 1949 (Brown 1949) with increasingly frequent sightings till widely and regularly reported by 1987 with breeding record at Gunbower I., Murray R. (Vic. Atlas). SA. First report: single, West Beach airport, Adelaide, 13–16 Dec. 1948 (Lendon 1951). Next records: Ceduna, Eyre Pen., and Lakes district, 1962–63 and then fairly regularly reported. Only breeding record: two nests, Salt Lagoon, Ls Albert–Alexandria, 14 Nov. 1971 (Parker *et al.* 1979). Has not bred in sw. Aust. (Jenkins 1959).

NZ. First record, near Christchurch, May–Sept. 1963 (Turbott *et al.* 1963), but possibly visited NZ as early as 1956 (Brown 1980); after 1963, further records of stragglers reported annually (including Stewart I., 1967) until early 1970s then becoming widely reported on both main islands. By 1973, regular annual visitor from Aust. to many parts of NI and SI and Chatham Is, with numbers increasing, although some later fluctuations: increased to a peak in 1980, fell then rose to further peaks in 1984 (Heather 1986) and 1986 and has declined again to 1989 (see table above; Jackson & Olsen 1988; B.D. Heather). Has not bred.

**MOVEMENTS** Partial migrant; birds in non-breeding part of range sometimes staying to breed, extending range (for history in Aust. and NZ, see Distribution). At present most birds wintering se. Aust. and NZ apparently originate from breeding colonies in se. Qld and ne. NSW; some NT birds

move to sw. Aust.; origin of birds in PNG and n. Qld, unknown.

**DEPARTURE** Migrating birds leave breeding colonies e. Aust. Mar.–Apr. with similar dates assumed for NT. Departure from Hunter Valley roost, central NSW, occurs in large flocks (200, 700) at dusk (M.N. Maddock).

**NON-BREEDING**

AUST. Colonies in e. and n. NSW and se. Qld are source of most birds moving to Vic. and Tas. Earliest record Tas., 26 Feb. but most arrive Apr.–May, departing slowly from Aug.–Nov. with few records Jan.–Mar. (Chalmers 1972; Vic. Atlas). One first-year bird left Shortland, Apr.; seen Huonville, Tas., June (M.N. Maddock). Some birds from colonies n. NSW, se. Qld, use Shortland winter roosts and Hunter feeding grounds as staging posts, autumn and spring, as well as for over-wintering. Birds overshooting Aust. or NZ have also reached Macquarie I. (Green 1977); Chatham Is, where now regular and regularly migrant Lord Howe I. (see Distribution). Only records of movement N: from Shortland, to Macksville, n. NSW, and from Seaham to Cundletown, n. NSW. Some birds do not migrate, overwintering at or near natal colony

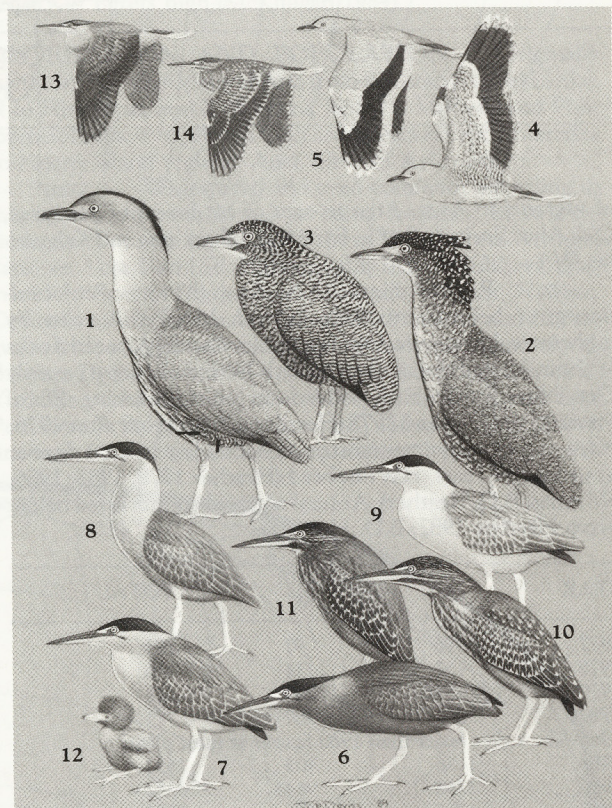


Plate 73

Malay Night Heron *Nycticorax melanolophus*

1. Adult
2. Immature
3. Juvenile
4. Adult
5. Adult

Striated Heron *Ardea striata*

6. Adult, subspecies *macrorhyncha*, grey form
7. Adult, subspecies

8. Adult, subspecies *stagnatilis*, grey morph
9. Adult, subspecies *stagnatilis*, rufous morph
10. Juvenile, subspecies *macrorhyncha*, grey form
11. Immature, subspecies *macrorhyncha*, grey form
12. Downy young, subspecies *macrorhyncha*
13. Adult, subspecies *stagnatilis*, grey morph
14. Juvenile

even in first year; at Seaham, one bird left Apr.-Aug. in first year but remained for next two and another has remained continuously for two years (M.N. Maddock). In n. and w. Aust., movement less well understood. Recorded all months in NT although less abundant Feb.-May immediately after breeding (Crawford 1972). Birds reaching sw. WA, which arrive Apr., depart Sept.-Oct. probably from NT. Unlike e. Aust., wave of arrivals in SW, in 1959, failed to establish breeding population (Jenkins & Ford 1960; Aust. Atlas). Considered a dry season visitor to PNG (Finch 1982) from Aust. but exact source not known. Most records from ne. Qld also during dry season, implying regular movement E from NT or N from se. Qld.

**NZ** Migration to NZ studied by Heather (1978, 1982, 1986). Recorded following ships across Tasman as early as 1 Mar. (Jenkins 1981) but most birds arrive early Apr.-May, many making landfall on w. coast where they may remain several weeks before proceeding to favoured farms where they repeatedly overwinter. Departure occurs from Oct. on, with most leaving Nov. Small numbers may remain in NZ over summer but none has attempted to breed. Banding recoveries

or observations of wing-tagged birds indicate that birds in NZ come from colonies in e. and n. NSW and se. Qld.

N-S migration similar to that in A'asia is also followed by American and Eurasian populations. Vagrants from these populations have overshot to S. Shetland Is (Rootes 1988), Weddell Sea (Trivelpiece *et al.* 1987) and subantarctic islands of Indian Ocean (Jouanin & Paulian 1954; Burger *et al.* 1980; Stahl *et al.* 1984).

**RETURN** To e. Aust. breeding sites July onwards with most of population arriving Oct.-Nov. One bird, recorded Sale, Vic., in Oct. returned to Shortland in Dec.

**BREEDING** Population in ne. NSW highly concentrated, although travel at least 29.3 km from Gattton heronry to forage (McKilligan 1984). Even in nearby Richmond R. and Hunter R. valleys, species was considered scarce Nov.-Feb. (Gosper 1981), 57.5% of annual variation in numbers being attributable to season (Gosper *et al.* 1983). Now common in Hunter Valley floodplain areas throughout year (M.N. Maddock).

**BANDING** Returns (all ABBBS) from se. Qld summarized Fig. 1, from Shortland, central e. NSW Fig. 2.

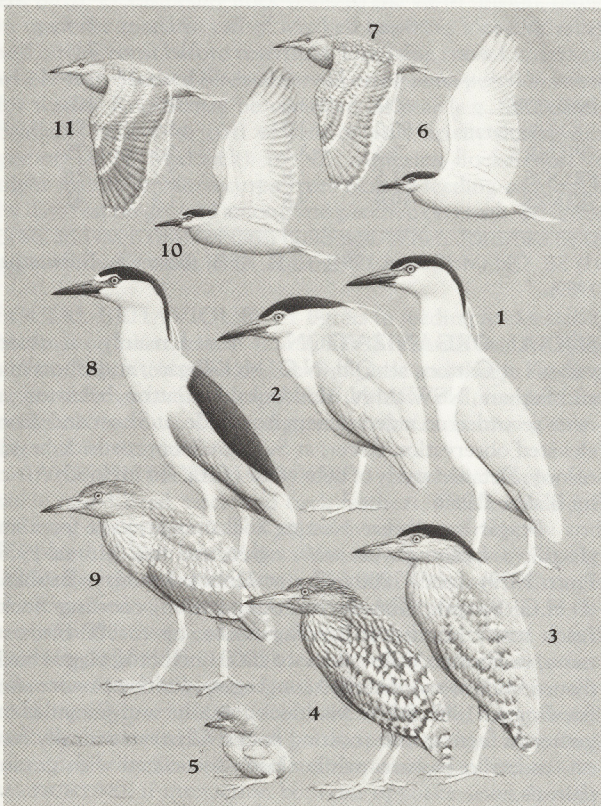


Plate 74

Rufous Night Heron *Nycticorax caledonicus*

1. Adult with courtship flush
2. Adult
3. Immature
4. Juvenile
5. Downy young
6. Adult
7. Juvenile

Black-crowned Night Heron *Nycticorax nycticorax*

8. Adult
9. Juvenile
10. Adult
11. Juvenile

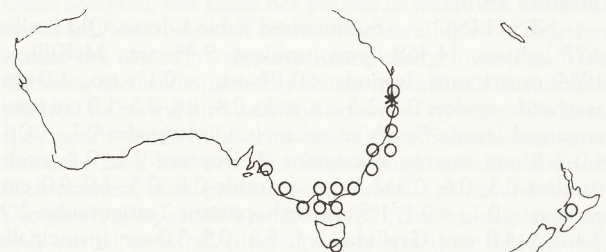


Fig. 1. 28S 153E 2X2 ABBBS

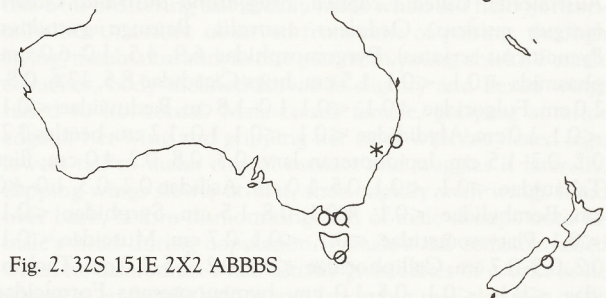


Fig. 2. 32S 151E 2X2 ABBBS

**FOOD** Mostly grasshoppers in breeding season with smaller numbers of other insects, particularly cicadas, centipedes, spiders, cattle ticks, frogs, including cane-toads, lizards (principally skinks), and a few small mammals. In winter may take more earthworms and they are main food in NZ (B.D. Heather). **BEHAVIOUR.** Usually follow cattle, horses, sheep, goats or other large animals, snapping up disturbed insects (Jenkins & Ford 1960; McKilligan 1984) or worms forced to surface by trampling of cows (Heather 1982; Jackson & Olsen 1988). Occasionally follow earthmoving machinery (Cooper 1979) or the plough (Heather 1982). Also use cattle as vantage point from which to sally after insects, sometimes catching them on the wing, sometimes snatching them from grass. Take ectoparasites of cattle. On ground, search for prey with neck stretched either vertically or horizontally. Sometimes also sway necks from side to side before lunging at prey. Insects picked from grass heads (Jackson & Olsen 1988). Suggested that cattle may be selected on length of hair (Heather 1978). Not all egrets associated with stock in se. Qld where 4-26% noted feeding independently; association more general

among egrets in dry years. When feeding independently of cattle, flocks have been observed moving forward on a front, the birds at the back continually flying over the top of those feeding in front; one flock of 400 was observed to cover c. 1 km across pasture using this method and flying back to starting point and repeating procedure several times (Newton 1986; Jackson & Olsen 1988; M.N. Maddock). Most of daylight spent feeding (56.4–78.4% of observations, 22 transects; McKilligan 1984).

**ADULT** At heronry in se. Qld (6 male, 15 female stomachs, 2317 items; McKilligan 1984) about 30% food unidentifiable; rest spiders 1.7% wt., 3.1% no., 47.6% freq., ticks 1.0, 4.5, 14.3; orthopterans 75.8, 56.3 (Gryllidae 11.8, 5.4, 61.9, Tettigoniidae 7.4, 12.7, 61.9, Acrididae 48.6, 33.3, 90.5, Pyrgomorphidae 8.0, 4.9, 85.7), bugs *Parkalla muelleri* 11.4, 15.4, 19.0, flies *Lucilia sericata* 4.1, 17.6, 42.9, other insects 1.3, 2.1, 57.1; frogs 3.6, 1.0, 33.3; skinks 0.3, 0.1, 9.5. No difference detected between males and females.

Other records: Aust.: flies (Hobbs 1986); NZ: worms; insect larv. (Harrison & Howell 1975), water boatmen, crickets (Heather 1978), flies (Jackson & Olsen 1988); mice (Heather 1978).

**NESTLING** Summarized Table 1. In se. Qld similar (677 boluses, 14 468 items, unident. 9.3% wt.; McKilligan 1984) crustaceans, isopods <0.1% wt., <0.1% no., 1.0 cm; arachnids, spiders 0.2–2.5 cm, ticks 0.4, 1.6, 0.5–1.0 cm (incl. engorged female *Boophilus microplus*); centipedes 0.1, <0.1, 4.0–6.5 cm; insects: odonatanans Anisoptera 0.1, 0.1; cockroaches 0.3, 0.6, 0.5–2.5 cm; mantids 0.8, 0.5, 1.0–9.0 cm; earwigs <0.1, <0.1, 1.5 cm; orthopterans Tettigoniidae 2.9, 7.4, 0.8–4.0 cm, Gryllidae 5.4, 5.5, 0.5–3.0 cm (principally *Teleogryllus commodus*), Acrididae 34.8, 51.5, 0.5–5.5 cm (incl. *Austroicetes*, *Caledia captiva*, *Froggattina australia*, *Gastri-margus musicus*, *Oedaleus australis*, *Patanga guttulosa*, *Pycnostictus seriatus*), Pyrgomorphidae 6.9, 4.5, 1.0–6.0 cm; phasmids <0.1, <0.1, 1.5 cm; bugs Cicadidae 8.5, 17.6, 0.8–2.0 cm, Fulgoridae <0.1, <0.1, 1.0–1.8 cm, Reduviidae <0.1, <0.1, 1.0 cm, Alydididae <0.1, <0.1, 1.0–1.2 cm; beetles 0.2, 0.2, 0.3–1.5 cm; lepidopteran larv. 0.3, 0.8, 0.2–4.0 cm; flies Tabanidae <0.1, <0.1, 0.5–1.0 cm, Asilidae 0.2, 0.3, 1.0–4.0 cm, Bombyliidae <0.1, <0.1, 0.8–1.5 cm, Syrphidae <0.1, <0.1, Platystomatidae <0.1, <0.1, 0.7 cm, Muscidae <0.1, 0.2, 0.5–0.7 cm, Calliphoridae <0.1, 0.2, 0.5–1.0 cm, Tachinidae <0.1, <0.1, 0.5–1.0 cm; hymenopterans Formicidae <0.1, <0.1, 0.6–1.5 cm; frogs 1.0–6.0 cm (incl. *Limnodynastes dumerilii* <0.1% no., *L. tasmaniensis* <0.1, *Litoria albobuttata* <0.1, *Litoria caerulea* <0.1, *L. fallax* 0.7, *Bufo marinus* 1.0); lizards 2.0–35.0 cm (incl. *Delma plebeia* 0.1, *Lialis burtonis* <0.1, *Amphibolurus muricatus* <0.1, *Carlia foliorum* <0.1, *C. mundivensis* <0.1, *C. pectoralis* and *C. vivax* 0.2, *C. schmeltzii* <0.1, *Ctenotus robustus* 0.1, *Egernia modesta* 0.1, *Eremiascincus richardsonii* <0.1, *Lampropholis delicata* 0.2, *Morethia boulengeri* <0.1); mammals 1.1, <0.1, 12.0 cm (Yellow-footed Antechinus *Antechinus flavipes* <0.1, House Mouse *Mus musculus* <0.1). Proportions of prey differed between years with toads being taken in only one season and proportions of orthopteran families varying. Average weight of prey also varied, being 96% heavier 1981–82 than 1979–80 or 1980–81; feeding dispersion from colony was also less in 1981–82. Boluses collected in the afternoon similar in composition to those collected in morning.

At Shortland Wetland Centre and Seaham Swamp, e. NSW, (61 boluses; Baxter & Fairweather 1989) animals 97.7% bolus wt., 100% freq.: spiders 3.3% bolus wt., 0.44 cm cepha-

lothorax (mostly *Lycosa godeffroyi*), insects 71.6, 1.79 cm incl. odonatanans <0.1% live wt., 0.2% bolus wt., 8% freq., 2.90 cm, mantids <0.1, 2.9, 43, orthopterans 66.2% bolus wt., 1.85 cm less terminalia (Tettigoniidae 14.6% live wt., 6.4% bolus wt., 72% freq., 1.32 cm, Gryllidae 15.9, 19.6, 85, 2.09 cm, Acrididae 36.3, 34.5, 93, 2.02 cm, Pyrgomorphidae 16.1, 5.7, 61), bugs Belostomatidae <0.1, 0.3, 8, 1.48 cm, beetles <0.1, 0.3, 16, lepidopterans <0.1, 0.6, 28, flies adults <0.1, 0.7, 41, hymenopterans <0.1, <0.1, 28, other insects <0.1, 0.3, 16, fish 1.3, 9.3, 3, 5.77 cm, frogs 3.0% bolus wt., 2.32 cm snout-vent length (*Litoria fallax*, *Limnodynastes tasmaniensis*, *L. peroni*), lizards 9.7% bolus wt., 3.36 cm snout-vent length (mostly *Lampropholis delicata*), birds <0.1% live wt., 0.1% bolus wt., 2% freq., mammals <0.1, 0.7, 2 (House Mouse *Mus musculus*); plants 2.3% bolus wt., 57% freq. (*Melaleuca*, Poaceae leaves). Fish probably scavenged from heronry floor. Preliminary observations at same site (Maddock 1986) had noted grasshoppers, crickets and lizards *Lampropholis delicata*, *L. mustellina*.

**Table 1.** Diet of nestling Cattle Egrets.

	% wt.		% no.		% freq.	
	1	2	1	2	1	2
INSECTS	60.4	83.0	89.5	100		
Orthopterans	50.0	83.0	68.9	98		
SPIDERS	2.3	3.1	5.1	75		
FROGS	1.5	2.8	2.2	26		
SKINKS	19.9	9.8	1.4	41		

(1) SE. Qld (McKilligan 1984); (2) E. NSW (Baxter & Fairweather 1989).

**SOCIAL ORGANIZATION** Based mainly on observations at Gatton, se. Qld (N.G. McKilligan), and Shortland and Seaham, NSW (M.N. Maddock). At Gatton, behaviour at nests recorded on video camera from hide; at Shortland, from elevated observation tower; at Seaham, from roadside beside colony. Detailed study of behaviour of *A. i. ibis* in South Africa by Blaker (1969).

Gregarious all year. Nesting flocks range in size from single pair associating with other egrets and ibis (Morris 1979; Pratt 1979), to c. 7000 pairs at Doboy heronry, Brisbane (D.H.C. Seton). Outside breeding season, roosting flocks reach many hundreds. Feeding flocks, up to 300 birds or more; in Hunter Valley, flock of 2000 (including tagged birds from several areas) observed congregating in one pasture after flooding in 1981 (M.N. Maddock). Adults and juveniles together in feeding and roosting flocks. Characteristically feed on insects in pastures while closely associated with grazing animals.

**BONDS** Monogamous; at least for one breeding season at Gatton; at Shortland, of 21 marked birds (1988–89), 14 nested only once, six acquired new mates in second nesting attempt, one uncertain. Some promiscuity observed at female's nest-site when mate absent; some promiscuous females were building nests, others laying or incubating; male concerned was usually near-neighbour, but some from farther afield. Female generally showed aggression on approach and departure of intruding male, but adopted normal copulatory posture and by raising tail after dismount, suggested that cloacal contact made. Female mate of intruder, if present, showed no interest in his behaviour. Promiscuous mating excited



other males, which flew to the couple, alighting directly onto them and attempting to mate with female also (N.G. McKilligan). At Gatton, sex ratio 1:1. Age at pair-formation, 11 months. One-year-olds breed successfully. About 25% of first-year nesters at Gatton retain white juvenile plumage or only partly acquire orange plumes of adult breeding birds (McKilligan 1985). Both parents incubate and tend young until after fledging.

**BREEDING DISPERSION** Colonial. Inter-nest distances at Gatton measured from centre of nests: 62 cm (39–110; 166). Nests throughout canopy, except in lowest branches.

**ROOSTING** At nest during breeding season. Usually nocturnal roosting; some stop foraging to rest and drink at edge of pond or lagoon during day, most notably during hot weather and when food abundant. Arrive at roosting grounds *en masse* in early evening, first landing 10–200 m from roost; later arrivals tend to fly straight to trees. Movement to final roost usually at twilight. Birds settle quickly, most perching with some preening evident. Some display agonistic behaviour, stabbing and counter-stabbing at adjacent birds. Occasionally flock takes to the air in unison, often in response to alarm call of Masked Lapwing *Vanellus miles* and circles roost before resettling. Use same roost for days or whole year. Marked birds observed using same perch in roost for weeks. Roosts may be occupied all year (e.g. Shortland, Seaham), others for part of year or only briefly during migration (M.N. Maddock). In NZ, wintering flocks roost at night mainly in *Macrocarpa* trees next to feeding paddocks; by day, rest on ground among and perched on stock, on fence posts and even roofs of farm buildings. When disturbed fly to tops of nearby trees (B.D. Heather).

**SOCIAL BEHAVIOUR** Egrets in feeding flocks stand, or squat on tarsi and rest among herds of cattle that are lying or standing; often stand on backs of cattle and sheep. Feeding egrets defend favourable position by cow and compete for conspicuous items of prey. Aggression common among roosting and nesting birds.

**AGONISTIC BEHAVIOUR** Agonistic displays involve raised head, neck and back feathers, vocalizations and stabbing at opponent. The aggressive Forward Display and Supplanting Run and Alert Posture, described by Blaker (1969) also observed at Gatton; Blaker's Withdrawn Crouch not identified with certainty. **Forward Display:** varies in intensity and is most common threat in defence of site; at full intensity, bill held horizontal, feathers of crest, neck and other plumes erected, bill opened and slightly lowered, bird usually stabs rapidly towards opponent while uttering *raa* call and making downward sweep of partly spread wings. May then run along branches or fly and supplant rival. Can lead to **AERIAL FIGHTING**, if interaction between opposite sexes in early stages of pair-formation. **Supplanting Run:** run at opponent with stiff-legged strides, observed mostly at feeding grounds; if threatened bird does not retreat, both usually fly at one another and clash briefly, giving low-intensity calls. **Alert Posture:** neck and head held erect, neck straight and bill pointed slightly upwards; usually adopted when threatened with Forward Display. Overt fighting involves stabbing with bill, mostly at opponent's head and, less frequently, locking bills to wrestle or have tug-of-war. Victor often raises its plumes fully.

**SEXUAL BEHAVIOUR** **ADVERTISING.** males give Flap-flight, Twig-shake, Wing-touch, Stretch, and Wing-

spread displays described by Blaker (1969). **Flap-flight:** bird launches itself from site with deep exaggerated wing-beats that produce loud thudding noise; occasionally performed by birds with eggs and chicks as well as red-billed males. **Wing-touch:** downward stroke along wing with point of bill. In contrast to nominate *ibis*, inside of wing, rather than edge, is stroked; performed often when female nearby. **Stretch-display:** stretch body and hold neck up so that bill pointed towards sky. Body then lowered by bending of legs and head inclined backwards while head and bill remain in initial posture; swelling of top of upstretched neck observed in *coromanda*, but not in nominate *ibis*. **Twig-shake-display:** very common; male extends neck and grasps leaf or twig in bill, shaking it for 1–3 s, sometimes giving chattering call. Head-flick Display described by Blaker (1969) not reported for *coromanda*. The red-billed female searching for mate generally has sleeked plumage and frequently elongates neck to peer in direction of displaying male. To gain male's acceptance, female flies repeatedly at male, landing on his back. At first he drives female off, but may eventually accept her. When not harassing male thus, female stands a few metres away with slightly raised plumes. Once accepted, she raises her plumes to match his and both preen and back-bite each other while standing close together at nest-site. **GREETING** displays during change-over (Fig. 3) are elaborate and accompanied by chattering calls and elevation of plumes. Relieving bird calls and answered by mate. On nest, they gently fence bills, cross necks, give Stretch-display or mutually Back-bite or both. **Back-biting:** mandibulation of back-feathers, often probing feathers of the rump, and female also gently grasps male's neck with bill. Stretch-display often only partial with bill tilted upwards and then body slowly lowered and raised, but quite often stretching of neck omitted. Soft chattering call usually made when bill held horizontally. **COPULATION:** observed from time of pairing, through laying, incubation and, in one pair, with young chicks. Female crouches, body inclined forwards slightly and flexed wings raised to horizontal. Male treads female, grasping anterior edge of her wing and gripping her sides with his flexed legs; lowers tail to make cloacal contact and waggles it laterally, flapping wings slowly at first, then rapidly with wings lifted over back, before dismounting. Bill of male droops onto female's head during copulation. Female's tail remains raised when he dismounts. Male usually gives series of croaks as he advances on female before copulation but may also step or fly onto her back without obvious ceremony.

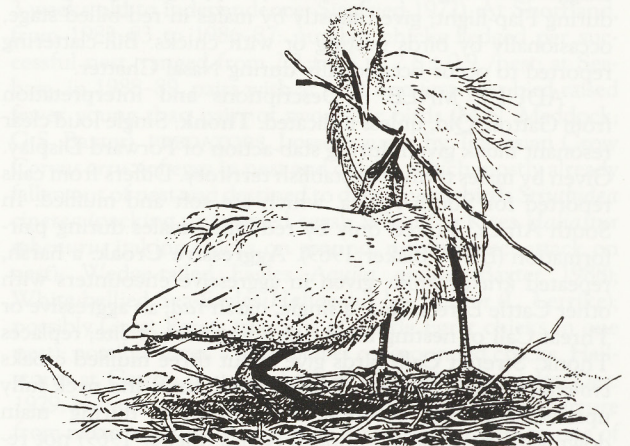


Fig. 3 Change-over at nest

**RELATIONS WITHIN FAMILY GROUP** Male does most collecting of sticks for nest. Initially, both sexes build, while competing for right to place sticks, but female does most of building. Parents share incubation, each sitting c. 24 h; nest-relief mostly between 07:00 and 10:00 h. Both parents feed chicks. When begging for food, chicks hold wings out, and head bobbed rapidly and thrust forward. Older chicks flap wings vigorously and flop about nest, pecking up at parent's bill or attempting to hold it until parent regurgitates. Fledgelings pursue parent for food among branches near nest. Thermoregulation assisted by gular fluttering and standing with wings held up and partially extended; latter posture also used to shade chicks. Chicks often peck siblings, especially while feeding; smaller chicks cower in nest when attacked. Response of chicks to inspection changes with age: initially, they make begging sounds and motions; by 4 days old, they cower in nest and, at 8 days, become aggressive, stabbing at intruder; from 10 days on, they generally flee nest.

**VOICE** Reasonably well known from studies in S. Africa by Blaker (1969) and information from about 200 h observations at Gatton, Qld (N.G. McKilligan) but no detailed studies of voice. For extralimital information see Blaker (1969) and BWP. Phonetic renderings and nomenclature follow Blaker (1969) where appropriate but direct comparisons difficult because no sonagrams and no studies of individual or geographical variation. Generally silent, particularly away from colonies; most calls heard at colonies and roosts. At roosts, most calling on arrival in evenings; little or no calling before departure in mornings. At colonies, a range of croaking calls, usually repeated. Apparent sexual differences in vocabulary and differences develop in Greeting Call as breeding progresses (N.G. McKilligan). At Gatton, distinct individual differences noted for Greeting Calls; in South Africa, individual differences reported for several calls; suggested that differences allow individual recognition (Blaker 1969). Some indication of geographical variation of calls; at Gatton, calls appear broadly similar to those described by Blaker (1969), however, following differences noted: Thonk loud and clear, not soft and muffled; croaks preceding nasal chatter not mentioned by Blaker; single syllable *kru* or *krok* (Greeting Croak) replace two-syllable Rick-rack Call; sexual differences in Greeting Croak not mentioned by Blaker; nor does he mention distinctive Triumph Call but this may be equivalent to his harsh chatter. **NON-VOCAL SOUNDS:** loud thuds made by deep exaggerated wing-beats (but not by clapping wings together) during Flap-flight; given mostly by males in red-billed stage, occasionally by birds nesting or with chicks. Bill-clattering reported to occur occasionally during Nasal Chatter.

**ADULT MALE** Descriptions and interpretation from Gatton, Qld, unless indicated. **Thonk.** Single loud clear resonant *thonk* given during stab-action of Forward Display. Given by males trying to establish territory. Differs from calls reported for South Africa, which are soft and muffled. In South Africa, uttered only by red-billed males during pair-formation (BWP; Blaker 1969). **Aggressive Croak:** a harsh, repeated *kru* or *krow*; given in aggressive encounters with other Cattle Egrets. **Raa:** a single, harsh *raa*; an aggressive or Threat Call of nesting birds defending nest or site; replaces Thonk. **Stretch Call:** birds give about three muffled croaks *cro-cro-cro* during Stretch Display when head and neck fully upstretched; soft crooning call reported during main downward movement in South Africa (Blaker 1969) not reported at Gatton or Shortland. Given by males establishing

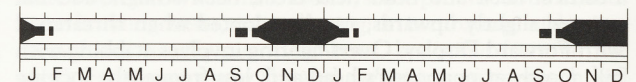
territory and, after pairing, by both birds at nest, though not usually at full intensity and sometimes silently or giving only Soft Chatter (N.G. McKilligan). **Nasal Chatter:** series of low, distinct croaks followed by about 10 rapidly delivered notes *crok-crok-crok*. . . *he-he-he-he*. . ., producing chattering or low whinnying. In South Africa, low introductory croaks not mentioned (Blaker 1969); in Aust., may be given without introductory croaks. Call accompanied by small movements of mandibles that are usually inaudible but rarely produces **Bill-clattering:** given by male returning to territory, often after aggressive encounter; in South Africa, given only by male and suggested that call functions in advertising (Blaker 1969). **Soft Chatter:** similar to Nasal Chatter in structure but quieter; given as part of Greeting Display. **Triumph Call.** Rapid series of clipped notes *ka-ka-ka-ka-ka*. . .; at Gatton, given in circumstances of Triumph Call by bird returning to mate after chasing another bird. Appears similar to Harsh Chatter of Blaker (1969); Triumph Call not reported by him. **Greeting Croak:** repeated, croaking single-syllable *kru* or *krok*, similar to, but less harsh than, Aggressive Croaks; calls of males and females initially the same, but female calls change (see below). Recognizable individual differences in these calls. Greeting Croak replaces Rick-rack Call of Blaker (1969) and used in same circumstances. Similar call given before copulation and extra-pair copulation. **ALARM CALLS:** **Kok.** Low, slowly repeated *kok* (with o as in 'got'); usually several seconds between notes. Given by birds alarmed by other Egrets or by presence of intruders. **Wail:** two-syllable *kreow* (e as in 'meet', ow as in 'owl') with second syllable drawn out into wail. Given by group of nesting birds in response to predators (e.g. ravens). Call described as *kaak* by Blaker (1969).

**ADULT FEMALE** As for male except for Greeting Croak. Initially, calls of males and females alike, but by incubation, call of female develops to a high-pitched *kri-kri-kri*. . . (i as in 'bit'; N.G. McKilligan).

**YOUNG** **Begging.** Young chicks (less than 2-3 weeks old) beg for food with repeated sharp two-syllable *chi-chi*. Older chicks beg with louder and deeper, repeated *ke-ke*. **Alarm Call:** chicks older than about 9 days old, give harsh prolonged *raaa*. . . when approached by man and threaten intruder or stab with bill.

**BREEDING** Based on studies at Gatton, Qld, by N.G. McKilligan and at Shortland and Seaham, NSW, by M.N. Maddock. Breed colonially in simple pairs; associated usually with other egrets, ibises and other waterbirds. At Gatton and at two other localities (Morris 1979) Cattle Egrets founded colony and other species joined them. At Shortland, proportion of Cattle Egrets' nests in mixed colony varied from 31% of 348 nests to 68% of 606.

**SEASON** At Gatton: laying usually starts Oct. and last young independent early Mar.; in one year exceptionally early start in Sept., followed by abandonment of colony and re-start in Nov. with young birds into Apr. At Shortland: start laying late Oct.-early Nov., and no laying after early Feb.; in 1988-89, laying started late Sept.



(se. Aust.)

**SITE** In live and dead trees (*Eucalyptus*, *Melaleuca*, *Casuarina* spp), in bushes, bamboos (D.H.C. Seton). At Gat-

ton, generally 2.5–7.4 m from ground, at top of highest available tree and in all parts of tree except lowest branches. At Shortland, 3–15 m from ground; 10.5 m high (Goddard 1955). At Gatton, centres of nests 62 cm (39–110; 166) apart.

**NEST, MATERIALS** Shallow platform woven mostly of dead twigs and small branches from previous year's nests or collected from up to 400 m away; unlined but some fresh leafy *Melaleuca* sprays usually in cup. Some nests almost entirely of fresh *Melaleuca* sprays. Both sexes collect material and build, but male does most collecting, female most building, with tremble-shove movements. Singly or together, male and female may tug at leafy twigs near nest and add material if efforts successful. At Seaham, built new nests at different sites for second attempts. Long sticks (<1 m) often laid as foundation and nest usually solidly constructed by time of laying (*contra* Blaker 1969). Material collected throughout day but forays for distant material only 07.30–10.30 approximately. Material added during incubation and even as late as 3 weeks into nestling period. Unattended nests pillaged by neighbours unless firmly cemented with faeces. Dimensions: c. 35 cm across, 13 cm thick with central depression 3–4 cm deep; old reused nests to 40 cm thick.

**EGGS** Oval, slightly pointed at one end; smooth but finely pitted on close inspection; very pale greenish white (25A2 in Kornerup & Wanscher 1967) but some distinctly green (26A2).

**MEASUREMENTS.**: Gatton: 45.4 (40.4–52.3; 122) x 33.3 (30.4–34.8); one miniature also, 24.8 x 20.9 mm.

**CLUTCH-SIZE** At Gatton: 3.6 (2–7 + 2xC/9). Overseas: South Africa, 3 (Siegfried 1972); Florida, 3.5 (Jenni 1969); France, 4.8 (Hafner 1978). At Shortland, estimated from visible broods 66xC/2, 112xC/3, 11xC/4 (n=183; M.N. Maddock): minimum av. 2.7 excluding one brood of five. In South Africa, similar estimate av. 2.8 (n=155; Blaker 1969) (broods of one ignored throughout). Lost clutches replaced occasionally, and then laying of clutch took more than 7 days. Replacement laying, after loss of whole brood 3.8%, started c. 7 days after loss of last chick. Usually only one brood per season for successful pairs; one record of re-laying after fledging of first brood but eggs failed to hatch; lateness of hatching and fledging of some young suggests possible successful second nesting.

**LAYING** At intervals of 1–2 days (av. 1.6). Clutch usually completed in 7 days after start; twice an additional egg laid 20 and 25 days after start. Time of day not recorded.

**INCUBATION** By both sexes, starting with laying of first egg. Shift estimated at 24 h; males and females share roughly equally; at Shortland, percentage share of shifts of each partner 48.6% (5.2; 42–58; 14 pairs). One wing-tagged first-year bird and untagged mate observed over 25 days of incubation before nest failure: of 38 observations, tagged bird brooding on 23 occasions, mate on 15 (M.N. Maddock). Pipping to emergence usually less than 24 h; twice, 24–48 h. Hatching asynchronous. **INCUBATION PERIOD.**: at Gatton: 24.2 days (0.613; 23–26; 26); no difference between first four eggs of a clutch. At Shortland: 24.4 days (21–30; 9).

**YOUNG** Semi-altricial, nidicolous. Brooded roughly equally by both parents for about first 2 weeks; percentage share of shifts of each partner 48.4% (4.9; 42–59; 14 pairs). Fed by both parents by complete regurgitation for 7–8 days, parents eating what young do not finish; later by incomplete regurgitation, chicks seizing bill of adults. Adults defend nest-site against other egrets, crows, without mobbing but do not defend chicks that have strayed. Adults leave nest and fly

about if raptor enters colony. Chicks defaecate over side of nest. To age of 7 days, chicks cower in nest when inspected, later peck at intruder with harsh calls and, when old enough, leave nest, often to be attacked viciously by neighbouring adults or chicks. **NESTLING PERIOD.** Hatching to first flight probably 6+ weeks but at 2–3 weeks (even at 10 days old if frightened), may spend much of day in branches near nest, returning at times to rest on tarsi and peer over edge.

**GROWTH** At hatching, eyes open, skin greenish becoming yellow, very sparse down. Can lift head only weakly; pin-feathers appear at 4 days; whole body spiny by 8 days; pins burst 10–11+ days; by 21 days, well feathered; powder-down tracks appear at about 3 weeks old. At hatching, iris white or pale grey, distinctly yellow by 8 days; bill, yellowish with black tip and edges, becoming grey black with yellow tip about 10 days old to yellow-grey and all yellow at fledging but some fledge with dark bills; lores, grey or black to match bill colour, changing to yellow as bill colour changes. Legs green, becoming mostly grey-black at c. 4 weeks old. **WEIGHT.** At hatching average 18 g; 4 days, 40.5 g; 7 days, 62 g; 11 days, 134 g; 14 days, 207g. Average weight of recently fledged young, aviary-reared from c. 3 weeks of age, 322.2 g (285–347; 5) or 91% of mean adult weight.

**FLEDGING TO MATURITY** After first flight, roam to nearby trees or ground below nest, where they forage for dropped food; then wander farther to wet pastures or lagoons to feed and loaf; return to nest to be fed by parents. Chicks do not pursue adults away from nest (M.N. Maddock). Plumage entirely white from acquisition but at c. 5 weeks tips of feathers on forehead become buff, which colour persists; nominate race in South Africa said to acquire buff forehead only when 5 months old (Siegfried 1971). Post-fledging dependence of 2 weeks (Siegfried 1971).

**SUCCESS** At Gatton, based on 711 nests, 2401 eggs laid, during three seasons: about 6% of nests abandoned, disappeared within few days of discovery without receiving eggs, mostly early in the season; only 0.4% built after mid-Dec. did not receive eggs. Of 2401 eggs laid: hatched, 2168 (90.3%); young reared to 7 days, 2053 (85.5%); to 11 days, 1933 (80.5%). Mean brood size: at hatching, 2.9; at 7 days, 2.8; at 11 days, 2.6. Five of 18 replacement clutches reared chicks to 11 days. Mean brood size at 4–6 weeks, 2.3 (1–4; 317). Estimated 1.5–1.8 chicks fledged per pair; lower estimate from total nest success (66%) x mean brood size at 4–6 weeks; upper assumes no losses after 11 days, and probably better because older chicks apparently survive well (McKilligan 1985) (3% loss after 3 weeks old to independence; Siegfried 1972). At Shortland, from 1982–83 to 1986–87: number chicks fledged per successful nest, ranged from 2.3 ± 0.8 to 2.8 ± 0.9 /nest; at Seaham, in 1988–89, pairs with at least one first-year bird raised fewer young than pairs of two older birds (M.N. Maddock; G.S. Baxter). **PREDATORS.** Losses caused by Torresian Crow *Corvus orru*, (of eggs in nest and chicks, which mostly already fallen out of nest and destined to die); Apostlebirds *Struthidea cinerea* (pecking unguarded eggs); Whistling Kites *Haliastur sphenurus* (taking chicks on ground, not by direct attack on nest); Wedge-tailed Eagles *Aquila audax* (Baxter 1988); White-bellied Sea-Eagles *Haliaeetus leucogaster* (L. Lerrike); possibly Great Egrets (remains of Cattle Egret chicks in one nest); possibly foxes *Vulpes vulpes* on grounded chicks. Hailstorm at Gatton destroyed 5% of all eggs and chicks, Dec. 1979. Human interference caused panic, premature departure from nests, inability to return and eventually taken by one of above predators. Five to 13% of eggs failed to hatch: of 196

failed eggs, 44% had no development, 37% with dead embryo 14+ days old, 19% decomposed (McKilligan 1987). The tick *Argas robertsi* transmits Lake Clarendon virus to chicks; heavily infected chicks usually died (10–12%; McKilligan 1987) but not known whether by arbovirus, loss of blood or by toxic effect of tick (D. Kemp).

**PLUMAGES** Subspecies *coromanda*. Breed successfully in first year, some nesting when 10 months old; at Shortland, estimated 23% of marked first year birds observed at colonies bred. Birds breeding in first year do so in any of four plumage categories (listed below under First year) varying between full adult breeding and adult non-breeding colours; all possible combinations of pairings occur (Maddock 1989a). McKilligan (1985) also observed first-year birds breeding in varying plumages. All second-year birds, and older, show adult breeding plumage during breeding season (Maddock 1989a) and non-breeding plumage for rest of year (when indistinguishable from juveniles). No sexual differences in plumages.

**ADULT BREEDING** (Second year and older).

**HEAD AND NECK.** Entire head, orange-rufous (132D), except for narrow strip of pink-buff (121D) feathers surrounding bare loral area, encircling gape to chin. Sides of neck, hind-neck and base of foreneck, orange-rufous (132D). Rest of foreneck, white. **UPPERPARTS.** From centre of mantle, long, hair-like, dull-pink (5) plumes extend beyond tip of tail. **UNDERPARTS.** Upper breast-feathers, long, loose, orange-rufous (132D). Rest of plumage white.

**ADULT NON-BREEDING** White; orange-buff (118) on crown always present but small (see Moults). In field, no observable difference between adult non-breeding and juvenile (Heather 1982).

**NESTLING** At hatching, down white; hairy and erect on crown. Pin feathers appear at 4 or 5 days, first on humeral tract; all feather tracts covered by 7 days. Sheaths start to burst at 10 or 11 days, most by 14 days. Feathers on forehead acquire orange-buff tinge at c. 5 weeks (N.G. McKilligan; M.N. Maddock).

**FIRST YEAR** First basic. Can begin development of adult breeding colour when 8 months old, though some do not develop adult breeding colour till second year. Maddock (1989a) classified first-year birds returning to Shortland, NSW, into four categories (though variation probably continuous): 'full coloured' (= adult breeding), 'full pale', 'pale' and 'white' (= adult non-breeding); small patch of orange-buff (118) on crown not used in classifying birds. **Full coloured:** indistinguishable from adult breeding. **Full pale:** extent of colour like full-coloured birds but colour distinctly pale buff; feathers on mantle and upper breast short. **Pale:** some colour on neck, back or breast but extent much less than full coloured and less intense. **White:** indistinguishable from adult non-breeding.

#### BARE PARTS

**ADULT BREEDING** Iris, red (12) during courtship; orange-buff (153) during rest of breeding season, change at 2–7 days after pair-formation. Bill: red (11) at courtship, tipped yellow; red (11) often persists in some adults until feeding chicks but usually fades 2–5 days after copulation; in most adults, bill becomes orange-yellow (18) during chick-rearing. Loral skin, red or magenta (2) at courtship; orange-buff (118) later in breeding season. Tibia, dull orange (94) from onset of courtship until just before laying. Tarsus and feet, black (Hindwood *et al.* 1969).

**ADULT NON-BREEDING** Iris, cream (54), or buff (123D). Bill, orange-buff (118). Loral skin, buff (53).

**NESTLING** Iris, white or pale grey at hatching, yellow at c. 7 days. Bill, initially yellow with black tip and margins, progressively darkening to grey-black with yellow tip at c. 11 days; close to fledging, gradual change to yellow with c. 90% (n=80) fledging with yellow bill. Tongue, pink; in some grey, or combination of black and pink; black rare. Palate, black or grey; pink or yellow, becoming black near fledging. Loral skin, as bill. At hatching: tarsus and feet, flesh coloured, becoming yellow at c. 4 days; grey-green at 7 days, darkening to grey-black at fledging (Maddock 1988, 1989b).

**FIRST YEAR** Like adult non-breeding but bill, grey or yellow-grey, observed on independent young feeding with adults away from colony. Birds breeding in first year develop colours as adult breeding (Maddock 1989a).

**MOULTS** Few data for *coromanda*. Wide variation in moult schedule (and colour changes) within single colonies in any one season; e.g. in Hunter Valley in 1988, first full-coloured birds July; in Oct. when nesting, well advanced, 10% of birds arriving at night roost still in neck-moult and without colour; first post-breeding moult, late Jan., but some birds still moulting late Mar. (M.N. Maddock).

**ADULT POST-BREEDING** Complete; in NZ, Jan. onwards, but duration uncertain (B.D. Heather). In Aust., duration of body-moult in two caged birds, c. 6 weeks (N.G. McKilligan); often birds in moult while feeding young late in season (possibly second nesting); one record of female moulting while incubating second clutch after fledging young. Sequence of primary moult unknown.

**ADULT PRE-BREEDING** Partial; Aug.–Nov.; mantle, breast and head plumes appear. Field observation suggests breast moults before back and head (Heather 1982); two marked birds began moult (late Aug., early Oct.) with feathers of neck; attained full breeding colour in 27 and 26 days (M.N. Maddock).

**POST-JUVENILE** Complete; in Aust., starts at 9 months old, in Aug. or Sept. About 25% (n=24) (resightings of marked individuals), only acquire pale (poorly developed) orange-buff plumage (N.G. McKilligan). For full details of moult in nominate *ibis*, see Stresemann & Stresemann (1966), Siegfried (1971) and BWP.

**MEASUREMENTS** (1) Full-coloured birds, skins (SAM). (2) Methods unknown (Vaurie 1963) (3) Gatton, Qld,

		MALES	FEMALES
WING	(1)	253.3 (5.58; 241–257; 6)	-
	(2)	253.8 (243–260; 20)	246.4 (230–256; 20)
	(3)	262.0 (3.3; 8)	245.3 (6.5; 16) *
8TH P TAIL	(1)	173.2 (4.06; 167–178; 5)	-
	(2)	86.8 (2.79; 84–92; 6)	-
	(3)	85.6 (76–98; 20)	83.7 (76–92; 20)
BILL	(1)	91.9 (1.9; 8)	88.4 (3.0; 16) *
	(2)	58.3 (2.26; 54.3–61.3; 6)	-
	(3)	71.1 (66–77; 20)	68.5 (62–73; 20)
TARSUS	(1)	60.0 (1.3; 8)	59.5 (2.2; 16)
	(2)	79.7 (3.58; 79.7–90.2; 6)	-
	(3)	85.0 (80–91; 20)	82.3 (78–87; 20)
TOE LMP	(1)	96.6 (6.3; 8)	85.9 (4.4; 16) *
	(2)	79.4 (4.88; 70.4–85.4; 6)	-
	(3)	154.6 (28.2; 8)	135.1 (16.9; 16)

recently dead, Jan. 1982; LMP = longest mantle plume (N.G. McKilligan).

Shortland and Seaham, NSW, unsexed birds (M.N. Maddock): (4) Live and recently dead adults. (5) Live juvenile.

	MALES
FEMALES	
WING	(4) 252 (7.40; 243-265; 6) (5) 226
BILL	(4) 58.4 (3.31; 53.5-62.1; 7) (5) 50.0
BILL D	(4) 14.0 (0.86; 13.0-15.5; 7) (5) 15.0
TARSUS	(4) 86.2 (6.91; 78.2-98.0; 7) (5) 70.5

**WEIGHTS** Recently dead birds collected at Gatton, Qld, late Jan.; weights with stomach emptied, birds had little fat: males 389.9 (10.9; 8); females 336.4 (24.2; 16); males significantly heavier ( $P < 0.05$ ). Weights probably also affected by sample being taken at end of breeding season (N.G. McKilligan). At Shortland and Seaham (as [4], [5] above): live and freshly dead adults 342 g (26.6; 305-371; 6); one juvenile 330 g (M.N. Maddock).

**STRUCTURE** Wings, broad. Eleven primaries: p8 longest, p10 2-6 mm shorter, p9 0-2, p7 1-5, p6 12-17, p5 26-34, p4 40-48, p3 53-59, p2 66-69, p1 73-80, p11 minute. P10-9 emarginated on inner web; slight on p9-8 on outer web. Fifteen secondaries including three tertials. Tail, square; webs rounded; 12 rectrices: t6 longest, t1 c.1-2 mm shorter; under tail-coverts reach tip of tail. Five patches of powder-down, one on breast, one on each side of rump and inner thighs. Bill, robust, short and pointed, with deep nasal groove. Legs, slender; lower half of tibia, bare; toes, long. Middle claw, pectinate. Middle toe, longest, outer c. 86% of middle, inner c. 74%, hind c. 48%.

**RECOGNITION** Nestling Cattle Egrets distinguished by post-gape loreal notch below back of eye; bill robust with slight downward curve; forehead sloping (Maddock 1988, 1989b; see illustration there).

**GEOGRAPHICAL VARIATION** Two subspecies, *coromanda* and *ibis*, separated on size and colour of breeding plumage: bill and tarsus of *ibis* average shorter, with less of tibia bare; breeding plumage of *ibis* paler buff and less extensive, confined to plumes of crown, breast and mantle; further, in *ibis*, non-breeding plumage of males and females differs; in *coromanda*, no plumage differences between sexes (Vaurie 1963; Payne & Risley 1976; Heather 1982; Peters; BWP). Suggested that *coromanda* distinguished from *ibis* on structural differences (Tucker 1985, 1986), but Hancock (1986) suggests no difference. Payne & Risley (1976) suggest *ibis* and *coromanda* may be specifically distinct, forming superspecies.

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**Volume 1 (Part B), Plate 72**

- 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

- Little Egret *Ardea garzetta*
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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