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## Order CICONIIFORMES

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

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## Family ARDEIDAE bitterns, herons

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

Body, slim; neck, long with kink at sixth vertebra. Male larger than female. Wings, long and broad. Flight strong with regular wing-beats, neck retracted. Eleven primaries: p7-p10 longest, p11 minute. Fifteen to twenty secondaries; diastataxic. Tail, short, square or slightly rounded; 8-12 feathers. Under tail-coverts, nearly as long as tail-feathers. Bill, long, straight and sharply pointed, except in *Cochlearius*; often serrated with notch near tip. Nostrils, long slits. Lores, bare. Legs, long; lower part of tibia, bare. Toes, long; small web between middle and outer. Hind and inner toes, broadened at base; claw of middle, pectinate. Stance upright, neck retracted when at rest; gait striding. Perch in trees adeptly (herons) and climb about expertly in reeds (bitterns). Oil-gland small, often with short tuft (longer in night herons *Nycticorax*). Aftershaft well developed. Plumage, loose; feather tracts, narrow; down confined to apteria. Two to four pairs of powder-down patches; down soft and friable, producing fine particles used in care of plumage. Ornamental plumes on head, back or chest in many species; usually more highly developed in breeding season. Bare parts, yellow, brown or black; usually more colourful in season of display and pair-formation. Seasonal differences in plumage, small. Moults, poorly known; mostly two per cycle, but pre-breeding moult often restricted. Moult 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 minuta* Linnaeus, 1766, *Syst. Nat.*, ed. 12, 1: 240 — 'Helvetia, Aleppo'; restricted to Switzerland by Vaurie, 1965, *Birds pal. Fauna, Non-Pass.*: 57.

The generic name is compounded of the Greek ἰξός (mistletoe, also probably reed) and βρύχειν (to roar) = the roarer of the reeds; the specific name is for its small size.

OTHER ENGLISH NAMES Leech or Minute Bittern.

POLYTYPIC Nominate *minutus*, Europe, Mediterranean, w. Siberia, Middle East to Kashmir; *payesii* (Hartlaub, 1850), Africa, S of Sahara; *podiceps* (Bonaparte, 1855), Madagascar; *dubius* (Mathews, 1912), Aust., s. New Guinea.

**FIELD IDENTIFICATION** Length 25–36 cm; wing-span 41–49 cm; weight c. 85 g. Small bittern, very similar to Yellow Bittern *Ixobrychus sinensis* in size and structure but with slightly shorter bill. In flight, show dark remiges contrasting with buff wing-patch. Sexes differ, mostly in colour of upperparts. Probably no seasonal plumage changes. Juveniles separable, like adult female.

**DESCRIPTION** Subspecies *dubius*. **ADULT MALE.** Crown, black with narrow chestnut margin; face and sides of neck, buff to rufous; hindneck, chestnut; mantle, back and tail, glossy black. Remiges, dull black or dark grey-brown contrasting with buff wing-patch (upper wing-coverts); may have small buff or rufous tips, usually on outermost secondaries. Throat and foreneck, buff with central double stripe of dark brown, often with broad buff marginal stripes; long feathers of foreneck, grey, overhanging upperbreast. Breast and flanks, buff appearing streaked dark brown (dark-centred feathers at tip of foreneck feathers); abdomen and undertail, white. Bill, yellow to yellow-green with black culmen; lores, yellow; base of bill flushed red and lores flushed rufous-red at times during breeding season. Iris, yellow. Legs and feet, green. **ADULT FEMALE.** Crown, black with rufous on forehead; face and sides of neck, buff; hindneck, chestnut; back, dark brown or red-brown usually with buff streaks; tail, black. Primaries, dark grey-brown (paler than adult male), innermost tipped pale rufous; secondaries, grey-brown, outermost tipped pale rufous; coverts, buff. Underparts, similar to adult male, possibly whiter and some with central tawny and brown stripes except on vent and under tail-coverts (these may be subadults; R.P. Jaensch). Bare parts, like male. **JUVENILE.** Crown, black heavily streaked rufous; hindneck, rufous-brown streaked brown; probably looks uneven rufous-brown in field; back, dark brown heavily streaked buff; tail, black; remiges, pale grey-brown with prominent rufous tips; underparts, white, prominently streaked with buff (streaked feathers with fine dark central streak). Bill, buff; lores, yellow; iris, yellow; legs and feet, green.

**SIMILAR SPECIES** Small size distinctive; likely to be confused only with vagrant **Yellow Bittern** in our area. **Adult male** Little, unmistakable: glossy black upperparts contrasting with pale wing-patch, distinctive (adult male Yellow Bittern has pale-red to yellow-brown back and rump contrasting with black remiges and olive-buff coverts of innerwing). **Adult female** is same size as, and with similar upperparts to, adult female Yellow Bittern but (1) bill about same length as head (longer, more slender and distinctly longer than head in Yellow); (2) remiges, darkish grey-brown with chestnut-brown tips (black in Yellow); in flight, does not show so much contrast between back, remiges and coverts as Yellow Bittern, which appears buff and black, almost pied; (3) obvious dark double-line down centre of throat and foreneck (adult male Yellow Bittern has no dark marking on throat and foreneck; most female Yellow Bitterns have alternating stripes of pale cinnamon and white down foreneck); (4) no small dark mark on malar area (Yellow shows dark malar mark from base of bill to below eye). **Juvenile** Little Bittern similar to juvenile Yellow; as with adults, lengths of bills differ and juvenile Little usually has no dark malar mark. Other distinctions: (1) streaking on throat fine and predominantly buff with thicker blackish central streak (streaking coarse and predominantly rufous on Yellow and feathers also have narrow dark-brown shafts); (2) remiges, pale grey-brown with rufous tips and p10 has light-rufous outer-web (remiges black and p10 has creamy outer-edge in Yellow); (3) under wing-coverts buff (white in Yellow). Little Bittern could be confused with **Striated Heron** *Ardea striata* but Striated Heron has no pale shoulder-patches, is larger and mainly found in estuarine and marine habitats. **New Zealand Little Bittern**, assumed to be extinct, much larger and darker overall (*q.v.*).

Secretive and rarely seen; skulk in thick reed beds, flooded shrubland, other dense vegetation in swamps or marshes or at edges of wetlands, or other still fresh waters and occasionally slow-moving rivers. Generally considered nocturnal but, when breeding, seen flying over reed beds during



day and extraliminally said to be diurnal (Langley 1983). Walk in crouched, rail-like fashion with rapid steps and head inclined forward. Rarely traverse open ground, preferring to move through vegetation, with only evidence of presence being movement of tops of reeds; if flushed from nest, return through vegetation. When alarmed, stand still with head and neck extended vertically in typical bittern-fashion, often with legs grasping vegetation but held at awkward angle to body; turn slowly to keep breast towards passing intruder until legs become wrapped round each other and bird forced to move or to fly. Stalk slowly after prey at water's edge or perch on emergent vegetation. When flushed, rise awkwardly with neck extended and legs dangling. Fly with legs extended, head drawn back and rapid shallow flaps of rounded wings, skimming low over water or vegetation, sometimes gliding before alighting. Mostly silent but give scolding *quock quock* near nest; males give low grunting or croaking *kohr-kohr-kohr* . . . advertising call in breeding season and may give sharp barking call when alarmed.

**HABITAT** Terrestrial wetlands and, occasionally, estuarine and littoral habitats. Mainly in dense emergent vegetation in freshwater swamps, lakes and watercourses, where forage in shallow water or from supporting emergent or aquatic vegetation over deep water (Smith 1966; Glover 1976). Particularly in beds or patches of tall sedge, reeds or rush (e.g. *Scirpus*, *Phragmites*, *Baumea*, *Typha*, *Juncus*), often > 1.5 m in height, with collapsed or dead material within (Carter 1966; Smith 1966; Corrick & Norman 1980; Gosper 1981; Jaensch 1983); may avoid beds of *Phragmites* that are very thickly choked with dead matter (R.P. Jaensch). Also occur in inundated shrub thickets (e.g. *Muehlenbeckia*, *Melaleuca*) or dense woodland, either alone or interspersed with reeds or rush; occasionally in seasonal swamps with short emergent vegetation (Sutton 1934; Vestjens 1977; Gosper 1981). Tolerate brackish-saline waters in mangrove swamps, *Juncus*-dominated saltmarsh, and wooded margins of coastal lagoons (Parker 1970; Gosper 1981). Records from cereal crops, veg-

etable gardens (Hobbs 1961; Parker *et al.* 1979). Occasionally remain in open or perch in trees after being disturbed (Carter 1966; Glover 1976).

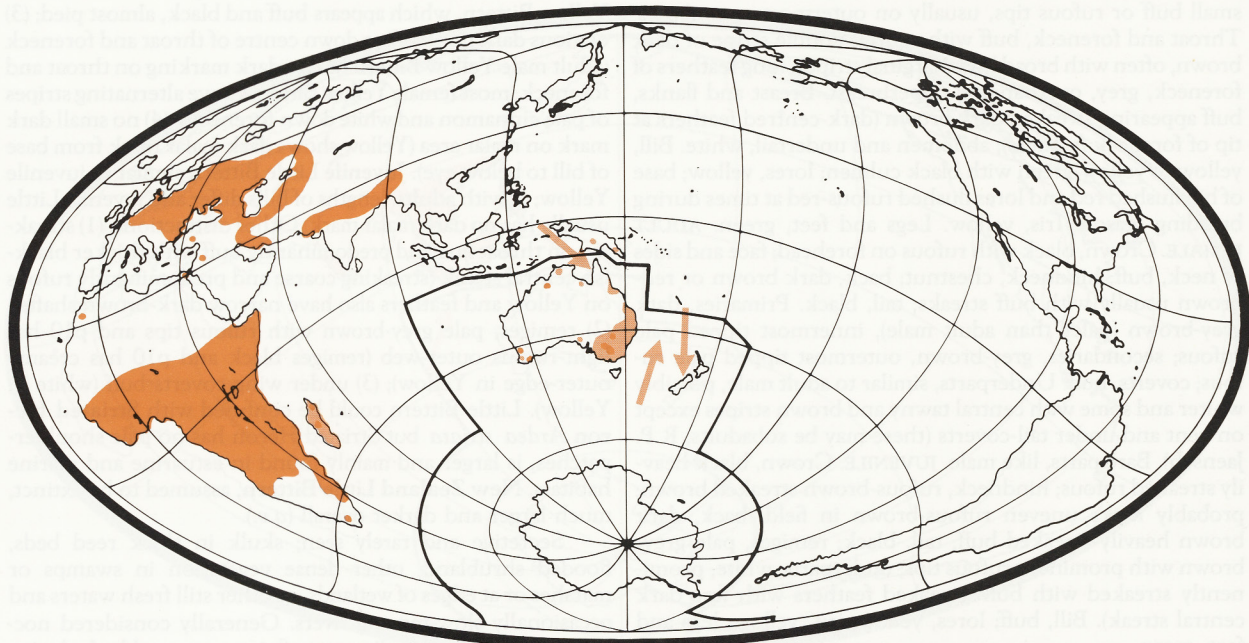
Breed mainly S of 29°S in Aust.; inland breeding in E and coastal breeding in W (Aust. Atlas). Nest in densely vegetated freshwater wetlands; invariably over water; in sedge, reeds or rush, either in pure stands or interspersed in wooded thickets (Sandland & Orton 1922; Hood 1934; Disher 1962; Jaensch 1984a, 1988, 1989).

Fly reluctantly, usually low over reeds or water (Jaensch 1984a).

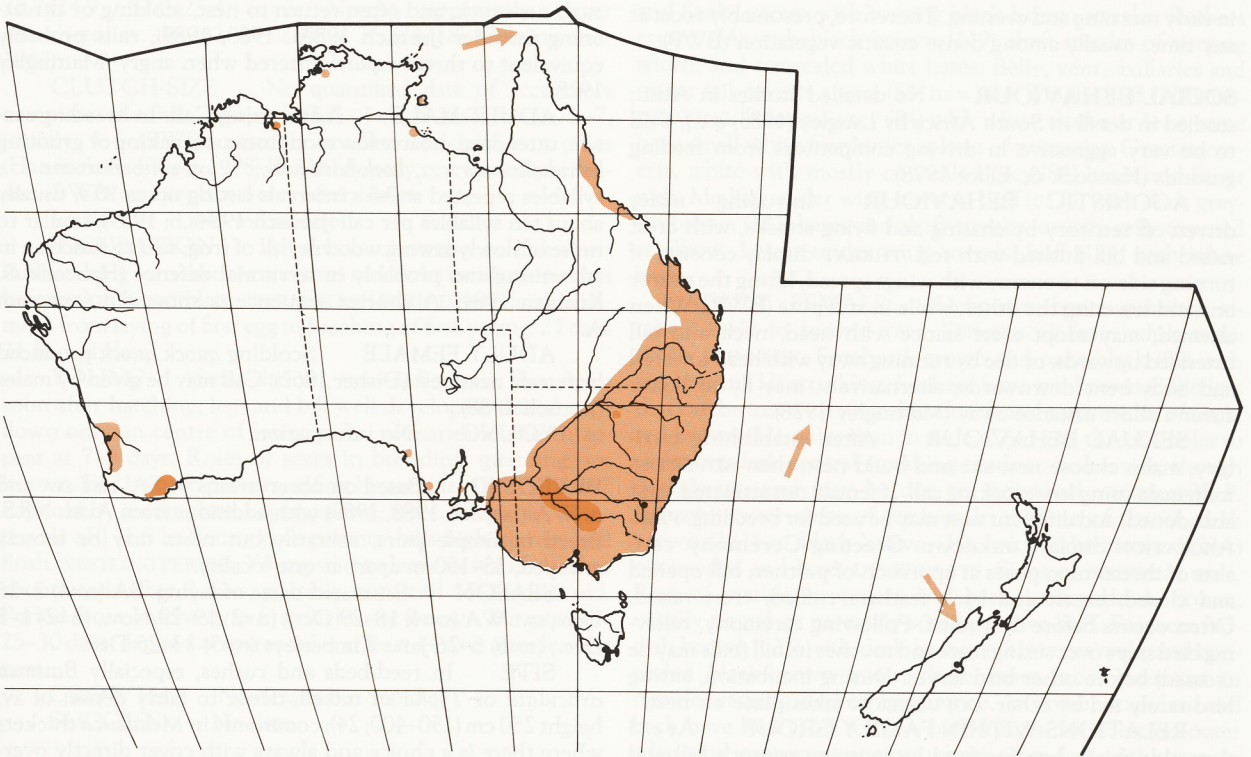
Breeding recorded only recently in nw. WA, since completion of Ord R. Diversion Dam increased area of permanently flooded rushland (Jaensch 1988). Dense vegetation needed for nesting may not develop if wetlands are grazed or burnt excessively (Hood 1935; Jaensch 1984a). If suitable habitat available, occur in city parks (McGill 1959; Wheeler 1959); breed in swamps in Perth metropolitan area, using artificial islands at L. Monger (R.P. Jaensch).

**DISTRIBUTION AND POPULATION** Aust.; vagrant to NZ. Extraliminally: few records s. New Guinea, probably breeding Fly R.; Eurasia through n. Pakistan and India; Africa S of Sahara; Madagascar.

**AUST.** Locally distributed and recorded only sporadically. Recorded in coastal areas of Cairns-Townsville district, Qld, and fairly widely reported E and SE of line roughly from Mackay through Roma and St George, Qld, and SW along line of Darling River to mouth of Murray; in sw. WA, SW of line from 100 km N of Perth to about Hopetoun and near Esperance. Outside these limits, reported on islands of Torres Str. (Draffan *et al.* 1983); near Adelaide and on Yorke and Eyre Pens, SA (Parker *et al.* 1979); Kununurra, ne. WA (Jaensch 1988); Groote Eylandt and MacArthur R., and once at Darwin, NT. No records Tas. Information based on Aust. Atlas. Assumed to breed widely within main range but most records from Murray-Darling Basin (Aust. Atlas; Aust. NRS). Recently found breeding at Kununurra (Jaensch 1988).







**NZ** Single record: juvenile, Westport, 5 Feb. 1987 (O'Donnell & Dilks 1988).

**LORD HOWE I.** Vagrant: male specimen (AM 0.39841), 1 Oct. 1960 (Hindwood 1961).

**MOVEMENTS** Probably migratory. Most reported sightings throughout continent Aug.–Apr. although outside breeding season birds hard to find.

**DEPARTURE** Leave sw. Aust. (Curry 1981; Jaensch 1984a) and inland NSW (Mattingley 1928) after wetlands dry out during summer, latest records for Riverina (Hobbs 1961) being Mar. Most also leave se. SA by Mar. (Parker *et al.* 1979) but last record 11 May (Glover 1976). In Vic., latest record Apr. (Vic. Atlas).

**NON-BREEDING** Movement from inland may explain arrival of large numbers in coastal NSW (Sefton 1958; McGill 1959) during dry years although one recorded Lord Howe I., Oct. 1960 (Hindwood 1961) and another NZ in Feb. 1987 (O'Donnell & Dilks 1988), both moderately wet years. Movement through n. Aust. may occur from mid-summer: recorded Booby I., Torres Str. on nights of low cloud in Feb.–Apr. (Draffan *et al.* 1983; Ingram *et al.* 1986). Regarded as winter visitor to s. PNG (H.L. Bell), though Rand & Gilliard (1967) give only single record from middle Fly R., of bird ready to lay in Sept.

**RETURN** SA (Glover 1976) and Riverina, NSW (Hobbs 1961), late Aug.; sw. Aust., Sept. (Sandland & Orton 1922). In n. Aust. part of population may be resident. Reported all year round at Groote Eylandt (Aust. Atlas) and may also be resident at L. Kununurra (Jaensch 1988; Thomas 1989). Records from s. PNG in Sept. (Rand & Gilliard 1967) and near Port Moresby (Anon. 1981) suggest sedentary population there as well (Jaensch 1988).

**FOOD** Mainly small aquatic invertebrates. **BEHAVIOUR.**

Food may be taken by standing and waiting at edge of water or perched on emergent vegetation, occasionally jabbing bill at water (Glover 1976) or by stealthy stalking. When food observed, neck slowly extended to full length then bill stabbed into water before rapid withdrawal (Smith 1966). Sometimes squeeze prey with bill before swallowing (Mattingley 1928). Said to raid nests of reed-dwelling birds (Hancock & Elliott 1978) but no information from Aust. Mainly crepuscular and nocturnal, usually foraging alone. Sharp bill very slightly hooked, for grasping slippery prey.

**ADULT** Recorded taking crustaceans, shrimps (Barker & Vestjens 1989), prawns, freshwater crayfish (Mattingley 1928); insects (North) incl. dragonfly larvae (Barker & Vestjens 1989), water-boatmen, waterbugs; fish (North; Mattingley 1928) incl. *Gambusia affinis* (one stomach; Vestjens 1977); frogs (Mattingley 1928).

**NESTLING** Freshwater crayfish (Thomas 1967) and tadpoles (Disher 1962; Thomas 1967; Jaensch 1984a) only food recorded.

**SOCIAL ORGANIZATION** Usually solitary; occasionally in pairs. Forage alone at fringe of, or within, dense cover.

**BONDS** Monogamous; pair-bonds last for at least one season. Both parents tend young until fledging or soon after.

**BREEDING DISPERSION** Male establishes territory of varying size at start of breeding season. Density of nests depends on continuity and age of stands of nesting cover, with old continuous vegetation having greatest density although fundamentally solitary nesting. At Bool Lagoon, SA, recently active nests ranged from 35–470 m apart (Jaensch 1989); in WA, nests as close as 5 m but usually 30–100+ m apart (Jaensch 1988).

**ROOSTING** Active both day and night, especially



in early morning and evening. Therefore, presumably roost at any time, usually among dense aquatic vegetation (BWP).

**SOCIAL BEHAVIOUR** No detailed studies in Aust.; studied in detail in South Africa by Langley (1983; *q.v.*) Said to be very aggressive in driving competitors from feeding grounds (Hancock & Elliot 1978).

**AGONISTIC BEHAVIOUR** Intruding males driven off territory by chasing and flying attacks, with crest raised and bill flushed with red. **THREAT** display consists of turning side-on to enemy with wings spread, lifting the nearer one and lowering the other, while in stiff pose (BWP). When alarmed, may adopt erect stance with head, neck and bill extended upwards, or flee by running away with head lowered and body bent downwards; alternatively, may fly to better cover a short distance away (Mattingley 1928).

**SEXUAL BEHAVIOUR** After establishing territory, males choose nest-site and build nest; then **ADVERTISE** for female using low croaking call. If female not attracted, nest abandoned, and different nest may be used for breeding. **PAIR-FORMATION** displays unknown. **Greeting Ceremony**: consists of threatening poses at approach of partner; bill opened and closed, breast and back feathers ruffled, crest raised. Often occurs before nest-relief. Following ceremony, relieving bird steps over sitting mate and touches its bill (bills may be crossed) before other bird leaves. During incubation, sitting bird rarely fed by other. **COPULATION** takes place on nest.

**RELATIONS WITHIN FAMILY GROUP** At c. 3 days old, chicks beg for food by grasping parent's bill and tugging it downwards. May stay near nest throughout whole fledging period if undisturbed, but occasionally explore immediate surrounds when still quite young (BWP). Nestlings known to leave nest at 8 days and may use nest less often each day thereafter (Jaensch 1988, 1989).

**VOICE** Poorly known; no detailed studies in Aust. Based on Jaensch (1984a,b,c, 1988, 1989). Adults and young usually silent; during breeding season, utter small range of low croaking or grunting calls though Advertising Call may carry to at least 100 m on still evenings. Usually, most calling between half an hour before and half an hour after sunset; sometimes later in windy weather. In WA, earliest calls heard 6–7 Sept. 1984. Call at 0.5-s intervals; rate consistent nw., sw. and se. Aust. (Jaensch 1989; R.P. Jaensch), but apparently interval longer (1 s in South Africa, 2 s in Europe) extralimitally (Hancock & Kushlan 1984; Langley 1983; BWP). Some birds give fewer syllables per call but this may vary with weather or stage of breeding or may be sexual difference. Bill-clapping reported in Europe (Hancock & Kushlan 1984).

**ADULT** Advertising Call (below) said to be given only by male. Sexual differences in other calls not known. **Alarm Call**. If flushed from nest, adults utter repeated sharp *cuck-cuck-cuck-cuck*, *kuk-kuk*, *kak-kak*, *khot* or *cra-a-a-k*,

*cuck-cuck-cuck*, and often return to nest, scolding or threatening intruder (Jaensch 1984a, 1988, 1989); calls probably equivalent to throaty *quark* uttered when angry (Mattingley 1928).

**ADULT MALE** **Advertising Call**. In breeding season, utter deep, hoarse low monotonous croaking or grunting *kohr-kohr-kohr* . . . , *hork-hork-hork* . . . or *cor-orr-orr-orr* . . . ; syllables repeated at 0.5 s intervals lasting up to 10 s; usually about ten syllables per call (Jaensch 1984a,b; 1989); similar to noise of slowly sawing wood or call of frog; said to function in advertising and probably in territorial defence (Hancock & Kushlan 1984). A shorter sequence is shown in sonagram A.

**ADULT FEMALE** Scolding *quock quock* produced by female near nest (Disher 1962). Call may be given by males (Jaensch 1988).

**YOUNG** No information.

**BREEDING** Based on observations in SA, and sw. and n. WA (Jaensch 1988, 1989) with additions from Aust. NRS. Breed in simple pairs, solitarily but nests may be loosely grouped, 35–150 m apart at one locality.

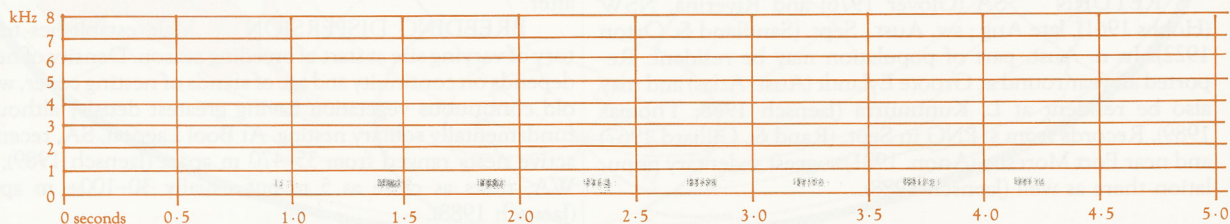
**SEASON** Estimated dates of laying: SA (n=4) 2–25 Dec.; sw. WA (n=4) 18–29 Oct., (n=2) 19–29 Nov., (n=2) 1–5 Dec., (n=6) 5–26 Jan.; Kimberleys (n=3) 13–25 Dec.

**SITE** In reed-beds and rushes, especially *Baumea articulata* or *Typha* or mixed, dense to fairly dense, of av. height 250 cm (150–400; 24); commonly in *Melaleuca* thickets where there is a choice and always with cover directly overhead. At average height of 62 cm (5–210; 25) above water of average depth 34 cm (10–70; 24), but varying, deepening or shallowing during nesting cycle; 0.3–8.0 m from edge of reed-bed and open water (av. 2.4; 19) except three at 10, 15, 20 m from edge; usually > 5 m from shore. Previous year's nests near occupied ones suggest some fidelity to site.

**NEST, MATERIALS** Flimsy platform of seed-heads, short live and dead segments of stems (5–8 mm diameter) of *B. articulata* or *Typha*, fine twigs and grass, tea-tree bark, green leaves or reeds, fine sedges and rushes. Three nests at Kunamurra, NT, all had woven canopies above nests, possibly made by Purple Swamphens *Porphyrio porphyrio* when using site as roost before Bittern built. Usually a flat platform but sometimes slightly concave or dish-like or like spokes of inverted umbrella. Always supported by strong vertical stems of reeds; no ramp leading up to nest beyond a few convenient stems. Dimensions: 15–20 cm across (somewhat less in thick cover), c. 10 cm thick. Building practice not known but said to be by male overseas (BWP).

**EGGS** Regularly ovate, blunt ended or slightly tapered at one end; mat, not glossy, finely pitted, especially at larger end; pure chalky white.

**MEASUREMENTS:** 33.4 (1.4; 30.9–35.1; 10) x 25.4 (0.6; 24.3–26.4; 13) (MV);





28.7x24.9, 32.0x25.4 (n=2; North); apparently larger elsewhere: av. 36 (32–39; 250) x 26 (24–28) (Schönwetter 1967).

**CLUTCH-SIZE** No quantified data of acceptably complete clutches except 1xC/3, 1xC/5. Said to be 2–7, usually 4–6 (BWP); possibly smaller clutches in tropics (Hancock & Elliott 1978). Probably only one brood per season (BWP) and replacements after losses.

**LAYING** No information.

**INCUBATION** All details uncertain or unknown but hatching asynchronous and thus no doubt incubation starts before clutch complete. **INCUBATION PERIOD:** one fair assessment from laying of first egg to hatching of first young: 21 days  $21 \text{ h} \pm 1 \text{ day}$ .

**YOUNG** Semi-altricial, semi-nidicolous. Eyes open soon after hatching; legs and bill well developed; naked with down only on centre of lower parts; primaries in sheath appear at 7–9 days. Roles of sexes in brooding, guarding not known. Fed by both parents, at first by complete, and after c. 7 days old by incomplete, regurgitation; after 7 days old, at intervals of 1–1.5 h. Young grab parents' bills high up near red flush. **NESTLING PERIOD.** Young start to leave nest and clamber about reeds after 9 days, possibly not until 13–14 days old. Period from hatching to first flight not known but possibly 25–30 days; depend on parents for at least 14 days after leaving nest.

**GROWTH** No details but rapid.

**SUCCESS** No data.

**PLUMAGES** *Subspecies dubius.*

**ADULT MALE** Definitive basic; attained early in second year. **HEAD AND NECK.** Forehead, crown and nape black (89), with slight green iridescence in strong direct light; nape feathers rather long, running about one-quarter distance down hindneck. Narrow supercilium, and feathers bordering bare facial skin, rufous-brown (c340) to chestnut-brown (c132A); hindneck and upper sides of neck chestnut-brown (132A). Ear-coverts and lower sides of neck olive-buff. Chin and throat, white, grading to buff (124) foreneck, with light-brown (123A) central line varying mottled dark brown; sometimes faint broad olive stripes on sides of neck either side of midline (R.P. Jaensch). Feathers of midline of throat have white inner webs, which can be exposed in some postures; outer webs light brown (123A) with varying amount of dark brown (121) to black-brown (19) at tips, and with concealed white bases. Foreneck feathers long, covering much of upper breast. **UPPERPARTS,** glossy black (89); some feathers, especially scapulars, show faint green iridescence in some lights. Feathers at sides of mantle have cream (54) outer edges; those at extreme sides also have cream (54) inner edges. **TAIL,** glossy black (89). **UPPERWING.** Tertiaries, tertial coverts and inner web of innermost secondary covert, glossy black (89). Lesser, median, most secondary greater coverts and most marginal coverts, olive-buff; innermost marginal coverts and marginal coverts near carpal joint, chestnut-brown (132A). Carpal covert and outermost secondary coverts, rufous-brown (240). Alula, primary coverts and remiges (excluding tertiaries), grey-black (82) becoming dark brown (c121) with wear; primary coverts, alula and outer secondaries have rufous-brown (c340) tips; outer web of p10 pale rufous (c340) with dark greyish-brown (c121) base and tips. **UNDERPARTS.** Sides of upper breast, black-brown, streaked cream; feathers black-brown (119) with cream (54) fringes. Centre of upper breast similar, but usually concealed by long foreneck feathers. Lower breast

and flanks cream with varying black-brown streaks; feathers cream (54) with black-brown (119) shaft-streaks of varying width, and concealed white bases. Belly, vent, axillaries and under tail-coverts cream (54) to white. Thighs buff (124). **UNDERWING.** Remiges grey (84) with white shafts; at least some have small white filoplumes at base of primaries. Greater coverts, white with mostly concealed grey (84) bases and inner web. Median under wing-coverts, buff (c124) with dark greyish brown (121) bases and shaft-streaks, usually only exposed at elbow. Lesser under wing-coverts, buff (124) with white bases.

**ADULT FEMALE** Definitive basic; possibly attained early in second year. Differences from adult male: **HEAD AND NECK.** Forehead, crown and nape black (89) with red-brown (32) streaking; feathers have red-brown (32) edges that can be lost with wear. Hindneck and upper sides of neck, red-brown (32), paler than in male. Chin and throat similar to male, but dark central streaking tends to be heavier, though not always, and may be due to individual variation (R.P. Jaensch); outer webs of feathers in midline of throat, dark brown (121) to black-brown (19), with light-brown (123A) outer edge and base. **UPPERPARTS.** Sides of mantle as male. Rest of mantle, scapulars and back look reddish brown, usually tinged or narrowly streaked olive-buff. Feathers reddish brown (c23) with dark-brown (c21) outer web, and concealed black-brown bases; these bases most extensive in mantle, causing darker appearance. In some, scapulars and back have buff (124) to olive-buff fringes, broadest on outer edge, and narrowest at tips, where often lost with wear; in some, buff restricted to narrow outer edges of scapulars. Rump-feathers as back, but with dark-grey (83) bases sometimes partially exposed. Upper tail-coverts, black (89). **UPPERWING.** Tertiaries and tertial coverts as scapulars. Innermost marginal coverts and marginal coverts near carpal joint, red-brown (c32). Alula, primary coverts and secondaries, dark grey-brown (c121) with rufous-brown (c340) tips c. 7 mm wide when fresh, about twice width of tips of males. Except when worn, dark grey-brown (c121) primaries have rufous-brown (c340) central tips; p10 has rufous brown (c340) outer web. **UNDERPARTS** have slightly heavier streaking than in males, extending to belly. Thigh-feathers buff (124) with dark-brown (121) bases.

**DOWNY YOUNG** Down, long and dense on head, neck, upperparts, upperwing and flanks, pink-buff (139) to pale brown (c39), later fading to buff (124). Down on chin and upper throat sparse, white; lower throat and centre of underparts, bare.

**JUVENILE** **HEAD AND NECK.** Forehead, crown and nape streaked black and red-brown; feathers black (89) with red-brown (32) edges. Hindneck, uneven rufous-brown; feathers rufous-brown (c340) with dark-brown (121) shafts or shaft-streaks, sometimes with narrow buffish tips. Supercilium, buff-yellow (c53) to rufous-brown (c340), generally paler than in adult; ear-coverts, olive-buff with fine dark-brown (121) shaft-streaks. Feathers bordering bare facial skin behind and below eye sometimes dark brown (121), sometimes as ear-coverts. Foreneck and sides of neck, buffish streaked dark brown; feathers buff (124) to olive-buff with broad dark-brown (121) shaft-streaks. Chin and centre of upper throat, as adult female. **UPPERPARTS.** Mantle, back and most scapulars, blackish heavily streaked buff; feathers, dark brown (121) to black-brown (119) with buff (124) fringes grading to light-brown (123A) subterminal fringes; fringes narrowest at tips, where seldom lost with wear. Longest scapulars, dark brown



(121) with rufous wash at tips and distal edges. Rump-feathers, semi-plumulaceous with pennaceous shaft-streaks and tips; dark brown with dark-grey (83) bases and narrow cream (c54) to off-white tips. Upper tail-coverts, dark brown (20) to black-brown (19). TAIL, as adult. UPPERWING. Lesser, median and most greater secondary coverts yellow-buff (53) to orange-buff (153) with dark-brown (121) central wedge, broad at base, tapering to point at tip; forms heavily streaked wing-patch. Outer secondary coverts, rufous-brown (c240) with narrow dark-brown (c121) shaft-streaks; rest of upperwing like adult female but remiges and primary coverts, slightly paler with more prominent tips (R.P. Jaensch). UNDERPARTS similar to adult female; thigh-feathers dark brown (121) with orange-buff (118) fringes. UNDERWING as adult.

**IMMATURE** Two males examined had assumed definitive body plumage but had worn primaries with rufous-brown (c340) central tip, similar to juvenile and female. One of these had enlarged gonads, which suggests breeding may occur in second summer.

**ABERRANT PLUMAGES** One juvenile (MV) had white fringes to feathers of mantle, back and rump, grading to buffish at tip, giving white streaked appearance. One male and one female skin examined had rather uniform black-brown (c19) upperparts.

**BARE PARTS** Based on photographs in Pringle (1985), Aust. RD and unpublished, supplemented by label data from AM, ANWC, HLW, MV, SAM, WAM.

**ADULT** Iris, light yellow (157); orange, orange-yellow, lemon-gold and cream-yellow also reported. Culmen, grey-black (82) from base to tip of upper mandible. Rest of bill, buffish (124) to light yellow (c157); greenish yellow reported on many labels, perhaps post-mortem change of colour. Facial skin, yellow with narrow black mark from eye to nostril. Adults at nest have been photographed with mostly red (13) facial skin, pink-red (10) behind and below eye, and with orange-red (c15) suffusion to basal half of bill (excluding culmen); orange-red suffusion less extensive in females than in males. This condition presumably akin to rapid red flush observed in subspecies *payesii* for varying periods during courtship, copulation and nest-relief (Langley 1983). Feet and legs, greyish-olive (c43) with straw-yellow (57) edges to scutes; soles and hind edge of tarsus, yellowish to yellow-green; claws, horn to brown.

**DOWNY YOUNG** Iris, black-brown (119). Bill, dull pink (5) to dirty pink (3, 4); tip is first area of culmen to become grey-black (82). Bare facial skin, grey-blue (88), becoming olive-yellow (52) before down lost. Bare skin in centre of throat and underparts, pink. Legs and feet, grey-olive (42) with blackish (82) claws and pinkish (4) soles.

**JUVENILE** Iris, pale yellow (c157) to yellowish white (c92); greenish tinge to outer iris lost before juvenile body feathers replaced. Bill, pink-white, becoming buff-yellow (c53) before replacement of juvenile plumage, with narrow olive-brown (29) strip from eye to nostrils, and narrow eye-ring yellow (c157) grading to pale green (59) behind. Feet and legs, green (60) to olive (50) with orange-yellow soles and hind edge to tarsus. Claws grey (84) to dark grey (83) with buff (123D) underside.

## MOULTS

**ADULT POST-BREEDING** Pre-basic. Complete. Probably elusive during moult; none of 33 specimens examined, including 30 collected Sept.-Mar., showed any moult.

Primaries new to slightly worn in Sept. and Oct., worn in Mar; moult probably occurs late autumn or winter. In most non-moulting herons and bitterns, slight differences in wear of individual primaries can be seen; in *I.m. dubius*, wear of primaries uniform, implying rather rapid moult.

**POST-JUVENILE** First pre-basic. Moult of body-feathers and wing-coverts completed before first spring; at this time, remiges are retained and worn. Juvenile remiges probably replaced during complete second pre-basic moult, but not known when this occurs.

**MEASUREMENTS** *I.m. dubius*. (1) Adults, skins (AM, ANWC, HLW, MV, SAM, WAM).

	MALES	FEMALES
WING	(1) 137.7 (4.83; 130-150; 18)	133.7 (3.22; 128-138; 13) **
8TH P	(1) 96.4 (2.79; 92-102; 17)	92.2 (3.70; 87-100; 13) **
TAIL	(1) 44.0 (2.17; 40-48; 14)	43.0 (2.42; 39-48; 12)
BILL	(1) 44.6 (1.73; 42.0-47.8; 18)	43.8 (1.75; 41.1-48.2; 13)
BILL D	(1) 10.32 (0.701; 9.2-11.9; 17)	9.70 (0.337; 8.9-10.2; 13) **
TARSUS	(1) 42.8 (2.19; 38.0-47.4; 18)	41.5 (1.203; 39.9-43.7; 12)
TOE	(1) 49.0, 49.4, 53.4	46.9

Subspecies *dubius*. 2. Unsexed juveniles, skins (AM, ANWC, HLW, MV, SAM, WAM).

WING	(2) 124, 126, 131
8TH P	(2) 84, 89, 89
TAIL	(2) 36, 37, 39
BILL	(2) 37.6 (1.83; 34.8-39.6; 6)
BILL D	(2) 10.04 (0.321; 9.6-10.4; 5)
TARSUS	(2) 40.6 (2.71; 37.8-44.3; 4)
TOE	(2) 47.6

**WEIGHTS** Subspecies *dubius*. Aust., between Sept. and Mar.: 83.9 (16.9; 59-120; 15; combined data from ABBBS, ARI, AM, ANWC, MV).

**STRUCTURE** Wing, rather short and rounded. Eleven primaries; p9 longest, p10 0-7 shorter, p8 0-2, p7 2-5, p6 6-10, p5 10-16, p4 15-22, p3 21-29, p2 27-36, p1 31-46; p11 minute. No emarginations; outer web of p10 narrow. Fourteen secondaries, including four tertials; c. three short humerals. Tail, slightly rounded, ten feathers (Dementiev & Gladkov 1952 reported 12), t1-t5 2-10. Hindneck, unfeathered but covered by backswapt feathers of sides of neck. Loes, eye-ring and skin above gape, bare. Pair of powder-down tracts on sides of breast, another on sides of rump. Bill, long, about same length as head and of tarsus, and narrow, with well-defined culmen. Culmen and tomia slightly downcurved; undersurface of lower mandible slightly upturned in front of gonys. Narrow nostrils in groove below culmen; tomia slightly serrated at tip. Tarsus and toes, scutellate, upper seven-eighths of tibia feathered; middle claw pectinate. Middle toe longest, outer c. 72%, inner c. 76%, hind c. 57%.

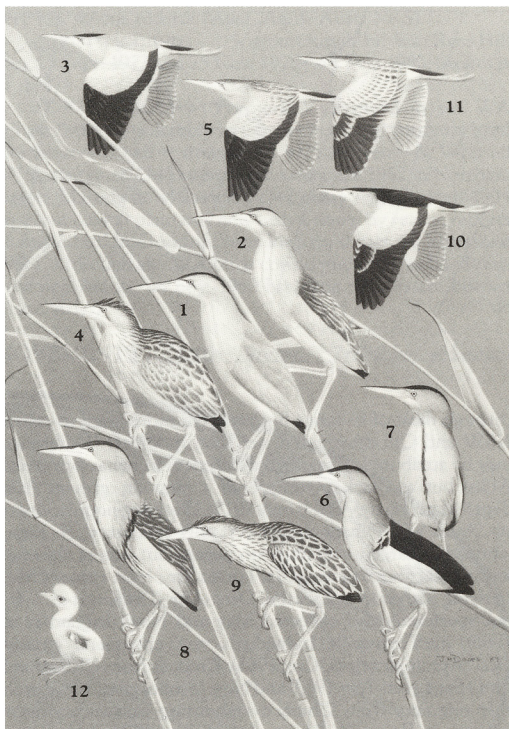
**GEOGRAPHICAL VARIATION** Three extralimital subspecies: *minutus*, *payesii* and *podiceps*; for further information on these see BWP, Brown *et al.* (1982), Langley (1983) and Hancock & Kushlan (1984). Voous (1960) suggested it may be best to consider Aust. birds specifically distinct from other populations.



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**Volume 1 (Part B), Plate 75**

**Yellow Bittern *Ixobrychus sinensis***

1. Adult male
2. Adult female
3. Adult male (flight)
4. Juvenile
5. Juvenile (flight)

**Little Bittern *Ixobrychus minutus***

6. Adult male
7. Adult male with courtship flush
8. Adult female
9. Juvenile
10. Adult male (flight)
11. Juvenile (flight)
12. Downy young

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