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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. Variously 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. Moult, 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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Nycticorax caledonicus Rufous Night Heron

COLOUR PLATE FACING PAGE 1021

Ardea caledonicus Gmelin, 1789, Syst. Nat. 1: 626; based on *Caledonian Night Heron* of Latham, 1785, Gen. Syn. Birds 3: 55 — New Caledonia.

Specifically named after the type-locality.

OTHER ENGLISH NAMES Nankeen Night Heron or Crane.

Nankeen is defined in OED (*inter alia*) as a ‘kind of cotton cloth, originally made at Nanking (in China) from a yellow variety of cotton’ and as ‘a yellow or pale buff; the colour of nankeen’. The word is now rarely used and most people do not know its meaning, except perhaps as having a vague connection with Nanking (Nan-Ching). Moreover it describes a colour that is not like that of the plumages of *N. caledonicus*. **Rufous**, as already often used in Wallacea and New Guinea, clearly describes the plumage better.

POLYTYPIC Nominate *caledonicus* occurs in New Caledonia; *manillensis* Vigors, 1831, in w. Indonesia and Philippines; *hilli* Mathews, 1912, in Wallacea, New Guinea and Aust.; *crassirostris* Vigors, 1839, on Bonin Is (extinct); *pelewensis* Mathews, 1926, in Palau and Caroline Is; *mandibularis* Ogilvie-Grant, 1888, on Bismarck Arch. and Solomon Is.

FIELD IDENTIFICATION Length: male 55–65 cm, female 55–60 cm; wingspan: male 95–110 cm, female 95–105 cm; weight c. 800 g. Stocky rufous-backed heron with black crown, thick neck and legs, short square tail and rather heavy bill. Sexes similar but females slightly smaller. Seasonal colour change in bare parts. Immature and juveniles separable.

DESCRIPTION **ADULT BREEDING.** Face, white with cinnamon wash; crown and nape, grey-black; two or three long narrow white plumes from nape, tipped with black when new; hindneck, back, tail and upperwing, deep cinnamon-rufous. Underparts, white with cinnamon wash on sides of neck and upper breast; undertail, pale cinnamon-rufous with grey bloom; underwing, white with pale cinnamon-rufous flight feathers. Bill, black. Bare facial mask (including lores), pale green, briefly becoming blue during courtship. Iris, yellow with varying orange tinge in breeding season. Legs and feet, cream-yellow to bright orange-yellow, becoming bright pink during courtship and early breeding. **JUVENILE.** Top of head, black-brown streaked with buff. Chin and upper throat, white; rest of neck, heavily streaked brown and buff. Most of upperparts, including upper tail-coverts, dark brown heavily spotted buff; off-white rump usually concealed by scapulars. Upperwing barred dark brown and rufous brown with large tear-shaped buff spots at tips of all feathers. Most of underparts, heavily streaked cream and brown; vent and under tail-coverts, white. Tail, rufous brown, barred brown at ends, with numerous off-white tips to feathers. Under wing-coverts, off-white streaked grey-brown; remiges as upperwing with strong pale-grey wash. Bill, dull yellow-olive with black on tip and along top of upper mandible. Lores, yellow-olive. Iris, yellow. Legs and feet, olive-grey to lime-green. No immature plumage; during post-juvenile moult into adult plumage, distinctive stage during which top of head, and upperparts, similar to adult and rest of plumage similar to juvenile. Moult thereafter gradual; last juvenile feathers lost usually from fore-neck and wing.

SIMILAR SPECIES Adult Rufous Night Herons cannot be confused with other herons, certainly not with **Black-crowned Night Heron** *N. nycticorax*, which has black back and grey wings. Only juveniles or immatures can be con-

fused. Juvenile **Black-crowned Night Heron** (only likely to occur as vagrant in our region), generally brown with olive-brown wings (flight-feathers) rather than rufous-brown, more elongated pale spots on back and wings and darker heavier streaking on underparts. **Australasian Bittern** *Botaurus poiciloptilus* larger, with longer neck, less hunched stance, more uniformly dark brown on upperparts, finely vermiculated or barred on wings rather than clearly spotted but perhaps most easily distinguished by habitat, being found solitarily in marshes, especially in stands of reeds, whereas Rufous Night Heron tends to be gregarious and to large extent arboreal. **Striated Heron** *Ardea striata* much smaller than Rufous Night Heron, usually without rufous colouring in plumage and usually in estuarine and tidal habitats.

Seen singly or in large groups near shallow fresh and saline waters of floodplains, swamps, creeks, estuaries and mangroves. Also found on treeless offshore islands. Generally solitary, nocturnal when feeding, stalking slowly or standing hunched in wait for prey before striking, but have various feeding techniques (see Food). Roost by day in large groups in leafy trees. Occasionally fly and feed by day. In flight resemble flying fox, with more rapid wing-beats than other large herons. Often rise in noisy flocks from roosts. Voice, guttural quack or quark, usually uttered in flight or in alarm.

HABITAT Littoral and estuarine habitats and terrestrial wetlands and grasslands. Mainly nocturnal; forage over soft or firm substrate; in still or slow-moving shallow water, on exposed shores, banks and flats in wetlands, or in swampy vegetation; often where sheltered by tall emergent or ground vegetation, and near trees used for roosting (Gosper 1981; Recher & Holmes 1982; Schulz 1989). Can forage in deep water, by making aerial sallies or plunging from perches (Mathews 1909a; Hobbs 1956). Inland, prefer permanent waterbodies on floodplains, especially billabongs, watercourses and pools with wooded edges; and swamps with tall emergents (e.g. *Eleocharis*, *Typha*, *Phragmites*, *Scirpus*). Also use wet meadows, flooded grassland and seepage from springs; shallow fresh swamps with short emergent vegetation and abundant aquatic flora; shrubby or wooded lakes and swamps

(e.g. *Eucalyptus*, *Melaleuca*, *Casuarina*, *Muehlenbeckia*) (Hobbs 1956; Vestjens 1977; Corrick & Norman 1980; Gospers 1981; Fjeldsa 1985; Jaensch et al. 1988; Schulz 1989). In settled areas, use urban wetlands, ornamental ponds, picnic grounds, grassy verges of airfields (Stokes et al. 1984); during plagues of mice, recorded feeding fearlessly during day in dry fields, on verges of roads, in streets and gardens, railway stations, and round grain sheds and garbage bins (Hobbs 1976). Occur on saline habitats less often, but birds regularly found on mangrove-lined coasts, estuaries and tidal reaches of watercourses. Also saltmarshes, dunes, coral or rock reefs, and shallows of atolls (Le Souëf 1902a; Warham 1961; Gospers 1981; Stokes et al. 1984; Schulz 1989).

Nest in dense cover of trees or shrubs in saline or fresh wetlands e.g. mangroves, *Melaleuca*, *Eucalyptus*, *Muehlenbeckia* (Braithwaite & Clayton 1976; Vestjens 1977; Close et al. 1982; Garnett 1985; Seton 1971; Vincent & Paton 1986). Also breed on treeless offshore islands, nesting in variety of open situations; on ground among low scrubby vegetation (*Abutilon*, *Tribulus*, *Amaranthus*); under rock overhangs; on piles of coral rock on tropical cays (Warham 1961); and in caves and on sparsely vegetated ground on rocky islands (Le Souëf 1902a). In Booligal, NSW, prefer to nest in swamps with high levels of organic matter, complex flora and diverse invertebrate population, in early stages of succession after drying and refilling (Crome 1988). Have nested in zoological gardens in Melbourne and Adelaide (Parker et al. 1979).

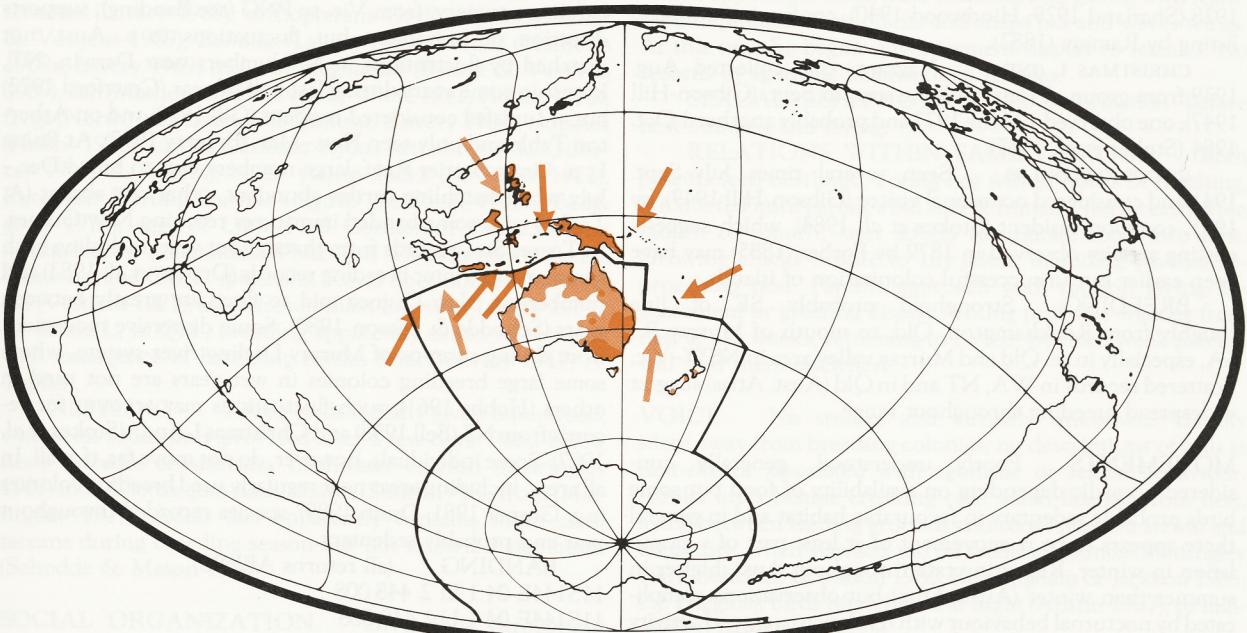
Daytime roosts in dense cover; in leafy trees close to or away from water, in reeds or other waterside vegetation, or in log jams in rivers (Schulz 1989); occasionally in bare dead trees (Crawford 1972). Roosting sites of birds breeding on treeless islands poorly recorded, but at Baudin Rocks, SA, roost in dense low shrubs (*Nitaria schoberi*) (Parker et al. 1979).

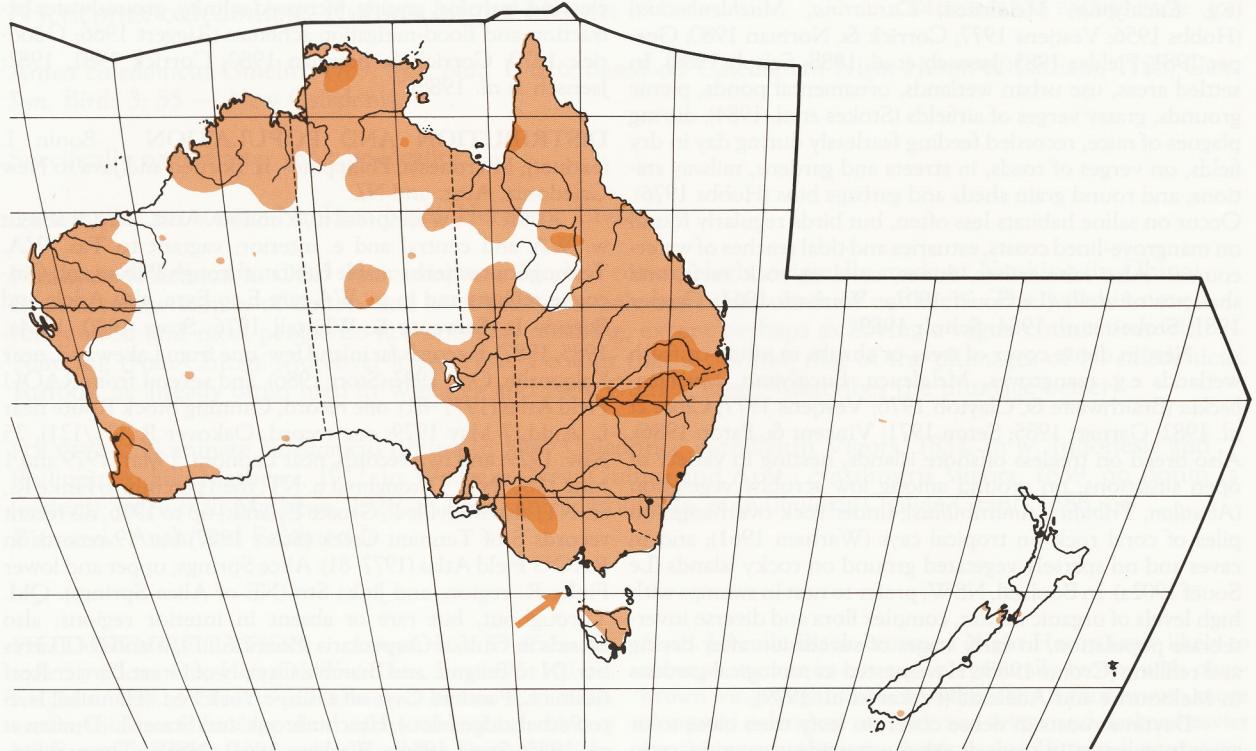
Regularly occur in urban areas, where favour introduced trees, especially pines and cypresses, for roosting and nesting (Gill 1970; Davis & Reid 1974; Serventy & Whittell 1976; Pescott 1983). Nesting habitat in natural freshwater wetlands and floodwaters has been destroyed and modified by drainage,

clearing, burning, grazing, increased salinity, groundwater extraction and flood-mitigation schemes (Riggert 1966; Goodrick 1970; Corrick & Norman 1980; Corrick 1981, 1982; Jaensch et al. 1988).

DISTRIBUTION AND POPULATION Bonin I. (extinct); Micronesia; Philippines, n. Borneo and Java to New Caledonia, Aust. and NZ.

AUST. Widespread n., e. and sw. Aust., rare or absent w. WA and central and e. interior; vagrant to Tas. WA. Throughout where suitable habitat, through Pilbara and Gascoyne regions and in se. WA rare E to Eyre; also Adele and Barrow Is (Serventy & Whittell 1976; Storr 1980, 1984a, 1985, 1987). Records far inland few: one from Lakewood, near Kalgoorlie, Oct. 1942 (Storr 1986), and several from RAOU Field Atlas (1977–81): one record, Canning Stock Route near L. Auld, 7 May 1979; one record, Oakover R. (21/121), 25 Nov. 1979; and two records, near Leonora, 1 Mar. 1979 and 1 June 1980. NT. Throughout n. NT, then patchily to Finke R., se. NT, also Melville I., Groote Eylandt; up to 1976, no recent records S of Tennant Creek (Storr 1977) but 19 records in RAOU Field Atlas (1977–81): Alice Springs; upper and lower Finke R. region; and Jinka Stn (NE of Alice Springs). Qld. Throughout, but rare or absent in interior regions; also islands in Gulf of Carpentaria (Bountiful I.), islands of Torres Str. (N to Boigu I. and Bramble Cay), N of Great Barrier Reef (Raine I., Pandora Cay), off e. Cape York Pen. (Hannibal Is, S to Pethebridge Islets), Hinchinbrook and Fraser I. (Draffan et al. 1983; Storr 1984b; Warham 1961). NSW. Throughout, most numerous in Murray-Darling Basin, also coastal and near-coastal areas but scarce se. NSW, rare or absent elsewhere (Hobbs 1961; NSW Bird Rep. 1982; Morris 1975; Morris et al. 1981; Wood 1985). Vic. Throughout, most numerous in Murray R. region, central to n. Vic., also s. and e. coastal and near-coastal areas, rare or absent elsewhere (Wheeler 1967; Vic. Atlas). SA. E. SA, N to Diamantina R., most numerous in se. SA, also Kangaroo I. (Condon 1969; Parker et al. 1979). Tas. Migrate across Bass Str. via King I.,





where also breed (Green 1977; Green & McGarvie 1971), but rare vagrant to n. and e. Tas., with at least eight records (Green 1977; Sharland 1981; Aust. Atlas).

NZ. Unsuccessful introduction at Wellington 1852 (Buller 1872); vagrants recorded from NI and SI in 1856, 1888, 1892, 1958, 1961, 1964, 1985 (Falla et al. 1981; NZCL; CSN 33), and may have bred near Blenheim 1957–59 (Falla et al. 1981).

LORD HOWE I. Vagrant: one at Hunter's Bay, Dec. 1928 (Sharland 1929; Hindwood 1940), confirming untraced listing by Ramsay (1882).

CHRISTMAS I. (IND.). Vagrant: one collected Aug. 1939 from group of four, and one seen in Sept. (Gibson-Hill 1947); one observed 10 June 1977 and probably another 1 Oct. 1984 (Stokes et al. 1987).

COCOS-KEELING IS. Seen several times July–Sept. 1941 and considered occasional visitor (Gibson-Hill 1949); by 1981, common resident (Stokes et al. 1984), which suggests nesting activity observed in 1879 by Forbes (1885) may have been earlier but unsuccessful colonization of islands.

BREEDING Stronghold probably SE of line roughly from Rockhampton, Qld, to mouth of Murray R., SA, especially in se. Qld and Murray valley area in NSW–Vic. Scattered records in WA, NT and in Qld (Aust. Atlas) suggest widespread breeding throughout range.

MOVEMENTS Poorly understood, generally considered nomadic depending on availability of food but some birds probably sedentary in favourable habitat and in general there appears to be n. movement of at least part of s. population in winter. Reporting rate throughout Aust. higher in summer than winter (Aust. Atlas) but observations complicated by nocturnal behaviour with tendency to extend activity into daylight when breeding (Hanscombe 1915). Neverthe-

less, reporting rate in s. Aust. 31% that of n. Aust. in winter, 81% in summer suggesting some regular movement N. Considered spring and summer visitor to L. Purrumbeet, Vic. (Missen & Timms 1974), sw. NSW (Sept.–Apr.; Hobbs 1961) and Hunter R. valley (Oct.–Apr.; Gosper 1981) and reporting rate highest Vic. during summer (Vic. Atlas). Appear to leave sw. NSW in late summer regardless of availability of food (Hobbs 1976) and absent from reed beds near Adelaide, SA, June–July (Parker et al. 1979; Gill 1980). One long-distance banding recovery, from Vic. to PNG (see Banding), supports direction of movement but fluctuations in s. Aust. not matched by fluctuations in N. Numbers near Darwin, NT, lowest in some years during last half of year (Crawford 1972) but at Innisfail considered resident (Gill 1970) and on Atherton Tableland only seen Nov.–Mar. (Bravery 1970). At Raine I., n. Great Barrier Reef, large numbers visit to breed Dec.–July when hatchling turtles abundant, otherwise absent (A. Taplin) with some banded immatures reaching New Guinea. In Torres Str., records from throughout year, including both summer and winter breeding records (Draffan et al. 1983) and numbers in New Guinea said to fluctuate greatly between years (Schodde & Mason 1980). Some dispersive movement from drying swamps of Murray-Darling river system, where some large breeding colonies in wet years are not used in others (Hobbs 1961); such fluctuations may account for records from NZ (Bell 1958) and Christmas I. (Ind.) (Stokes et al. 1987). Some individuals, however, do not move far, if at all. In all areas, including areas near regularly used breeding colonies (e.g. Gosper 1981; Dunn 1989), species recorded throughout year and probably sedentary.

BANDING (all returns ABBBS)

- 11S144E 04 1 U 2 448 008
- 11S144E 04 1 U ? 449 008
- 11S144E 12 1 U 6 463 003

31S116E 02 1 U 1 1301 016
 35S144E 01 P U 1 250 165
 35S144E 01 1 1 8 2980 354

FOOD Mostly aquatic animals, principally fish but also frogs, freshwater crayfish and insects, but an opportunist that takes any suitable prey when available including newly hatched sea-turtles, nestlings, house mice and human refuse. **BEHAVIOUR.** Usually stand and wait in erect or crouched posture or walk slowly (Recher & Holmes 1982). Also drop from up to 2 m onto aquatic prey, emerging from water with difficulty (Hobbs 1956), drop briefly on to water surface with wings raised (Mathews 1909a), pursue terrestrial prey overland and scavenge among garbage (Hobbs 1976). Small prey thrown rapidly into rear of bill and swallowed, large prey bashed against hard objects (Hobbs 1957). Feed alone or in large flocks (White 1915). Most feeding at night but, particularly when breeding, will also feed in daylight, rarely throughout day (Hanscombe 1915; White 1915).

ADULT Poorly recorded. At L. Cowal, NSW (eight stomachs; Vestjens 1977) freshwater crayfish 25% freq., shrimps 13, slaters 13, centipedes 13, spiders 50, damselfly ads. 13, nymphs 13, earwigs 25, crickets 50, water bugs 25, ground beetles 75, beetles 63, water beetle ads. 25, larv. 25, weevils 25, fly larv. 13, caterpillars 13, wasps 13, ants 13, fish *Carassius auratus* 75, *Gambusia affinis* 50, frogs 38. In sw. NSW (100 stomachs) House Mouse *Mus musculus* 60% freq. (Hobbs 1976). At Darwin (one stomach, 35 items; van Tets et al. 1977) freshwater crayfish *Cherax albidus* 6% no.; insects earwig 3, orthopterans Acrididae 3, beetles Carabidae 3, Aphodius 3, Dynastinae 8, hymenopterans wingless ants 75, *Camponotus*, *Idomyrmex*.

Other records: molluscs (White 1942) incl. freshwater mussels (Bedggood 1973); crustaceans (North) incl. freshwater crayfish (White 1942; Bedggood 1973; Hall 1974) *Cherax bicarinatus* (Rau 1947), *Eustacus armatus* (≤ 30 cm length; Hobbs 1957), crabs (Mathews 1909b; White 1942) incl. *Holthuisiana transversa* (Berney 1907); insects (North) incl. odonatans Anisoptera larv. (Barker & Vestjens 1989), winged termites (Lavery 1969), orthopterans Gryllotalpidae (Barker & Vestjens 1989), *Bermius* (Lavery 1969), beetles (Mathews 1909a; Lavery 1969) incl. *Anoplognathus* (Barker & Vestjens 1989); fish (Mathews 1909a; North; White 1942; Hobbs 1976); frogs (North) incl. *Litoria alboguttatus* (Lavery 1969), tadpoles (Hobbs 1976); turtles *Chelonia mydas* hatchlings (MacGillivray 1917; A. Taplin); birds: young ducks (Le Souëf 1922), European Starling *Sturnus vulgaris* (Le Souëf 1902b; Bedggood 1973), eggs of Little Pied Cormorant *Phalacrocorax melanoleucus*, Australian White Ibis *Threskiornis molucca*, Straw-necked Ibis *T. spinicollis*, Royal Spoonbill *Platalea regia* (Vestjens 1977); seeds *Echinochloa colonum* (Lavery 1969). At Raine I., n. Qld., breeding apparently timed to coincide with emergence of hatchling turtles (MacGillivray 1917; A. Taplin).

NESTLING Young birds initially given liquid food, with semi-solids only provided after a few days. Food below nests includes crustaceans: freshwater crayfish (Mattingley 1907) incl. *Cherax quinquecarinatus* (Smith 1948); frogs (Mattingley 1907). Adult diet apparently contains more crustaceans during breeding season but not known if significant (Schodde & Mason 1980).

SOCIAL ORGANIZATION Gregarious throughout year; in groups from a few to several hundred individuals, but

solitary birds may disperse hundreds of kilometres (Schodde & Mason 1980). Composition of groups not recorded. Roost and breed communally, establishing small territories close round roosting and nesting site, but feed solitarily. Apparently establish individual feeding territories, but size unknown.

BONDS Monogamous, lasting one season. Do not breed often or regularly until third year when in full adult plumage, but birds may breed in immature plumage in bountiful seasons (Braithwaite & Clayton 1976). Both parents incubate and tend young until after fledging; total time until independence not known.

BREEDING DISPERSION Colonial. In small (<10 nests) to large (up to 3000) colonies; often with other herons, spoonbills, cormorants and ibises (Braithwaite & Clayton 1976; Le Souëf 1902a; Seton 1971; Aust. NRS). In mixed colonies, typically keep in discrete, often dense, units in higher leafy parts of trees. Colonies may occupy up to 21 ha (Braithwaite & Clayton 1976). Each pair maintains own territory to limit of pecking distance. Most courtship and copulation behaviours probably occur in territory. Mobile young clamber about with impunity through colony without evoking hostility from adults.

ROOSTING During nest-building and courtship, pairs roost in nesting territory. Roosting site of adults with young in nest not recorded. Outside breeding season, typically diurnal, communal in small (<10) to large (hundreds) groups. Numbers present at roosts increase when food plentiful. May use same roosts for years, desert them periodically or use for only a few weeks. May crowd into one or two trees at roost for concealment in canopy. While sleeping, hunch on perches with heads and bills withdrawn into breast or twisted back into long feathers of upper neck. Preen occasionally (Schodde & Mason 1980).

SOCIAL BEHAVIOUR Very few detailed records.

AGONISTIC BEHAVIOUR THREAT. Male stands fully erect and makes rasping sound or snaps bill. When opponents close, male crouches and glares, with feathers and plumes erect, points and snaps bill and waves wings. At this time he begins advertisement display to females. No records of agonistic behaviour in females.

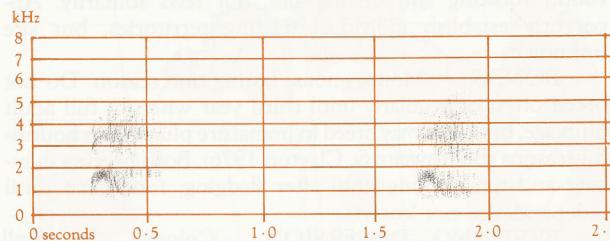
SEXUAL BEHAVIOUR No information before nest-building and laying.

RELATIONS WITHIN FAMILY GROUP Both parents feed nestlings. Young beg within hours of hatching, but not fed until parent's bill seized. Initially, fed directly from mouth to mouth, later adults regurgitate food into nest. Growing chicks hostile to any adult, including parents approaching nest. Parents approach with caution giving appeasement or greeting display. Young probably wander from nest at c. 2 weeks, returning to be fed. By third week parents will feed them elsewhere.

VOICE No studies and virtually unknown. Usually silent away from breeding colonies; no descriptions of calls at nest-site or associated with agonistic or sexual behaviour. Adults utter hoarse croaking calls when flushed from nest, flying between feeding grounds and roost sites, on arrival and departure, when alarmed and on feeding grounds (Mattingley 1907; Schodde & Mason 1980; Buckingham & Jackson 1985; P.J. Higgins); birds often heard at night (Austin 1907), to midnight (Hanscombe 1915).

ADULT Call a hoarse croak; reasonably high-

pitched, described as rolling *qu-ock* or *qu-arck* (sonogram A). Adults reported to utter chuckling purring when about to feed young (Mattingley 1908). No further information.



A R. Buckingham; Melbourne, Vic., Mar. 1980; P35

YOUNG Said to beg with shrill clamorous *kak-kak-kak* in first two weeks and squawk when disputing among themselves; after leaving nest (yet still flightless) utter high-pitched screech when alarmed and said to be generally noisy (Schodde & Mason 1980).

BREEDING Poorly known. No detailed studies. Breed colonially, often in vast numbers, up to 3000 or several thousands (Mattingley 1907; Braithwaite & Clayton 1976), with other species of herons, cormorants, ibises and spoonbills. Usually in central parts of swamps and flooded areas, covering an area of up to c. 20 ha (Braithwaite & Clayton 1976); possibly in mangroves on Fitzroy R., nw. Aust. (North). Solitary nests along streams have been reported (Campbell). Birds recorded breeding in juvenile plumage (Braithwaite & Clayton 1976; B.A. Lane).

SEASON Broadly in spring and summer. Timing probably much influenced by rainfall, flooding and water-conditions. Not synchronized, so that after middle of season active nests may be at all stages (building to fledging young) at same time. At Booligal, NSW, active nests from before 12 Sept. to after 22 Jan. with peak numbers Nov.-Dec. (Braithwaite & Clayton 1976). Some evidence of similar timing in ne. NSW (North). In n. Qld, eggs taken in Apr., even as late as June (Campbell). In sw. WA, main laying season from Aug.-Dec., with some laying in summer (Jan., Mar.); more clutches started in Sept. and Oct. than in any other month; time of laying correlated with time of greatest average rainfall + 3 months (Halse & Jaensch 1989).

SITE Usually on horizontal limbs in crowns of trees; in forks under canopy; on top of shrubs and *Lignum Muehlenbeckia*; also in reed-beds. Formerly (1900) on Bird I., Safety Bay, WA, on ground (Le Souëf 1902a).

NEST, MATERIALS Loosely constructed, flattish platform of sticks. Nests of adult-plumaged birds just large enough to hold the clutch, 20-30 cm in diameter, 3-4 cm thick; nests of juvenile-plumaged birds perhaps 4-5 times more bulky, 35-50 cm in diameter, 8-15 cm thick, also often placed lower than those of adult-plumaged birds, 1-3 m above water, whereas range of heights in whole colony up to 20 m (Braithwaite & Clayton 1976). Nests on ground at Bird I. were mere ring or half-ring of sticks to prevent eggs from rolling away (Le Souëf 1902a). Density of nests in colonies not recorded. Building by both sexes; males collect material and may pilfer it from nearby nests, bring it to female, who arranges it in nest, often with thin end of sticks pointing to centre (Aust. NRS). Building takes place during daylight and at night. No information on traditional use of sites or nests.

EGGS Elliptical to oval and elongate oval; somewhat coarse grained in texture, slightly glossy; pale-bluish green (North; Campbell) but chalky, not glossy, green and delicately grained when laid, fading to pale blue with incubation and becoming stained (Le Souëf 1902a).

MEASUREMENTS:

50.1 (48.8-51.6; 4) x 37.0 (35.3-38.9) (Campbell);
51.9 (49.5-54.6; 12) x 37.2 (33.8-40.1) (North).

Ranges of 72 eggs: 48-58 x 34-40 (Schodde & Mason 1980).

CLUTCH-SIZE No quantified data. Usually three, sometimes four (North); four (Campbell); usually two or three, maybe as much as five (Hancock & Elliott 1978). Hanscombe (1915) had one pair that definitely had two broods, one in winter, one in summer.

LAYING Claimed to be laid at intervals of 48 h.

INCUBATION Starts with laying of first egg. By both sexes, probably starting with first egg because hatching asynchronous. **INCUBATION PERIOD**. Supposed to be 21-22 days as in Black-crowned Night Heron. No further information.

NESTLING Semi-altricial, nidicolous. No doubt, fed by both parents and claimed to be by incomplete regurgitation at first; later, by complete regurgitation into nest-bowl. Start to clamber out of nests when about 2-3 weeks old. No further information except that **NESTLING PERIOD** has been supposed to be about 6-7 weeks. Much information on breeding details given by some authors without original references and appears to have been assembled in likelihood that Rufous has same habit and behaviour as Black-crowned Night Heron, well known in w. Palaearctic (BWP).

FLEDGING TO MATURITY Age of independence from parents not known. Birds certainly breed in juvenile or immature plumage, assumedly when 2-3 years old (Braithwaite & Clayton 1976) but exact ages not known.

SUCCESS No information. Heat waves (42 °C maximum) may cause death of chicks (Aust. NRS). Deformities and high mortality of chicks noted at Geelong, Vic., 1971-73 (Aust. NRS).

PLUMAGES Subspecies *hilli*.

ADULT Definitive basic. Probably attained at about 1-year-old, but only direct published data come from captive birds (Cole 1920); perhaps some variation. Claims that nuchal plumes lost in non-breeding plumage are incorrect. **HEAD AND NECK**. Top of head and nape, grey-black (82), separated from bare facial skin by narrow white to cream (54) supercilium. Two or three (usually two) narrow white nuchal plumes, 15-23 cm long, extend to mantle when fresh; narrow black tips rapidly lost with wear; nuchal plumes of some birds have dark-brown (121) shafts. Plumes strongly concave and often wrap round one another to give appearance of single tubular plume. Sides of neck and face, light brown (223C-223D) grading to red-brown (rufous 35) hindneck, and to white chin, throat and foreneck. **UPPERPARTS**, chestnut-rufous (c139-rufous 221B); greyish tinge to tips of feathers, attributed to powder down (Schodde & Mason 1980), causes less rufous appearance in dull light. **TAIL**, as upperparts. **UPPERWING**, rufous-brown; brown (c119B) wash to outer edges of tertials and alula, and to tips of secondary and median coverts. **UNDERPARTS**, white. **UNDERWING**. Remiges, pale pink-brown (219), grading to white at base. Wing-coverts, white; greater coverts have yellow-brown wash in centre of feather; lesser coverts have light-brown (223C) outer webs.

DOWNTY YOUNG HEAD AND NECK, dark brown (c21) with brown (c123) to whitish face and nape; down filaments on top of head have long buff-yellow (c53) to white tips. UPPERPARTS, dark brown (c21) at mantle grading through light brown (223C) to white at base of tail. UNDERPARTS, brown (c123) grading to white on belly. Extent of white on belly and upperparts varies considerably, perhaps fading with age.

JUVENILE HEAD AND NECK. Forehead, crown and nape, black-brown streaked buff (124); feathers, black-brown with buff (124) shaft-streaks. Hairlike filaments of down adhere to tips of feathers of crown of younger birds. Feathers of nape c. 4 cm long, forming slight crest. Chin and upper throat, white with brown (119A to 119B) tip to inner web. Ear-coverts, narrow supercilium, sides of face and rest of neck, off-white to buffish with heavy brown streaking; feathers, buff (124-c54) merging to off-white at base, with dark-brown (119A) edges. UPPERPARTS. Mantle, upper back, and most scapulars, dark brown heavily spotted buff. Feathers, dark brown (119A to c221) with large triangular buff (124) spots at tip, most extensive in mantle. Longest scapulars similar, but varying rufous (c340) mottling, heaviest near shaft, often gives barred appearance at end. Lower back and rump, off-white; feathers, semi-plumulaceous. Central upper tail-coverts, dark brown (119A) with large buff (124) spots at tip. Lateral upper tail-coverts similar, but with buff (124) bars in centre of feather. TAIL, rufous-brown (c121C), barred dark brown (c119A) at ends, with narrow off-white tips; varying dark-brown (119A-119B) mottling at edges. UPPERWING. Marginal and lesser coverts, dark brown (c19) with large buff (124) central tips. Primary coverts and alula have irregular alternating broad bars, some dark brown (221) merging to brown (119B) on inner edge, some rufous-brown (121C) merging to pale rufous-brown on outer edge and to white on inner web; tips, white with cream (54) tinge to tip of outer web. Secondary coverts, similar but with buff (124) edges; inner secondary coverts have dark-brown (119A) inner webs. Median coverts, dark brown (c19) with broad rufous-brown (121C) bars and large buff (124) central tips; tertials similar but with small buff central tips. Other remiges, rufous-brown (121C) with broad dark-brown (119A) inner edges and dark-brown (c20) freckling on outer web; outer web of p10 often barred black-brown. Remiges have white tips; secondaries also have buffish (124) edges. UNDERPARTS. Breast, belly, thighs and flanks, cream with thick greyish-brown streaks; feathers, cream (54) with broad greyish-brown (119B-119A) streak parallel to edge of each web; in lower belly, these streaks restricted to tips of feathers. Vent and under tail-coverts, off-white; under tail-coverts have brown (119B) spot on outer web. UNDERWING. Remiges as above but with pale grey wash. Greater under wing-coverts, brownish grey (c80) with white edges and rose-thorns; secondary coverts have white rosethorns. Other under wing-coverts, off-white with grey-brown (121) subterminal edges, absent on innermost feathers.

Some juveniles redder generally, with light-brown (39) spots and streaks on top of head, upperparts and upperwing. Other birds paler, with cream (54) spotting and streaking, and incomplete cream (54) bars on longest scapulars.

IMMATURE Available skins suggest adult plumage attained in complete protracted post-juvenile moult. Top of head first area to moult; sometimes a few juvenile feathers retained in nape, perhaps giving rise to Cole's (1920) incorrect claim that striped nape feathers characteristic of immature (first basic) plumage. Heavy moult of upperparts begins before

crown-moult complete, new feathers tending to be less rufous than in adult, and at same time less intense moult of underparts, wing and tail. In gradual, perhaps interrupted, period of moult that follows, top of head and upperparts similar to adult; rest, as juvenile although more white feathering in underparts, and wear of wing-coverts and feathers of neck makes white spotting and streaking less boldly defined. Some (not all) birds at this stage have white nuchal plumes. Last juvenile feathers to be replaced are those of foreneck and wing. Cole's (1920) claim, based on captive birds, that resultant plumage duller than adult plumage, is untested; his claim that nuchal plumes absent, at least sometimes incorrect. Possibly sequence of immature plumages affected when breeding occurs in first year; more information needed.

BARE PARTS Based on notes from captive birds (Melbourne Zoo) and photographs (Pringle 1985; Aust. RD; unpublished), except where stated.

ADULT Iris, yellow (55) to straw-yellow (57); an orange (18) tinge sometimes photographed at nest said to be temporary colour often attained during courtship and in advertising and threat displays at nest (Schodde & Mason 1980). According to Hancock & Kushlan (1984), irides can become blushing red when breeding. Eyelids, black (89). Bill, grey-black (82); small green-yellow or cream (92) patch sometimes at base of bill, said to be restricted to younger adults (Schodde & Mason 1980). Bare facial mask, pale green (162D); lores become blue (168B) during courtship. Light-grey (85) lores also recorded in early breeding season. Legs and feet range from buff (123D) to yellow (157) or orange-yellow (c153), becoming bright pink to red during courtship and early breeding (Sutton 1935; Schodde & Mason 1980). Claws, red-brown (c240) or grey-black (82).

DOWNTY YOUNG Iris, orange-yellow (c18) to orange (17). Eyelids, black (89). Bill, cream (c92) with grey-black (82) lower tomia and culmen, and white egg-tooth. Lores, whitish with varying orange-pink (c5) tinge. Legs and feet, olive (150). Claws, grey-brown (121).

JUVENILE, FIRST IMMATURE Iris, pale yellow (157) to orange-yellow (c153). Eyelids, black (89). Upper mandible, grey-black (82) with yellow-olive (c52) tomia; lower mandible, yellow-olive (c52) with grey-black (82) tomia and tip. Bare facial mask, yellow-olive (52); bluish tint may develop in later stages of post-juvenile moult (Cole 1920). Legs and feet, olive-grey (42) to lime green (c59). Claws, reddish brown tipped dark (Cole 1920) or grey-black (82). No information on colours of bare parts while breeding.

MOULTS Based on skins from se. Aust (MV).

ADULT POST-BREEDING Complete, primaries irregular (Stresemann & Stresemann 1966) or outwards. Recorded in late Jan. and early Feb. Adult collected 22 Nov. was in primary moult, but four others collected Nov. and Dec. had yet to begin moult.

POST-JUVENILE MOULT Begins with heavy burst of moult on forehead, crown and nape; heavy moult of upperparts begins before moult of top of head complete. Age at which this occurs not known; Cole (1920) found moult of captive birds began 10 months after leaving nest. However, fresh primaries and body plumage of wild birds collected in similar condition in Oct. and Feb. (MV) suggest that moult can begin earlier. Remaining juvenile feathers moulted gradually in subsequent months; unknown if periods when moult interrupted. Last juvenile feathers to be moulted, those of

foreneck, upper breast and wing.

MEASUREMENTS (1) Aust., adults, skins; methods as here (Schodde & Mason 1980). (2) Aust., adults, skins (MV).

| | MALES | FEMALES |
|---------|-------------------------------|--------------------|
| WING | (1) 297.3 (7.8; 58) | 285.8 (8.1; 21) ** |
| TAIL | (1) 103.9 (1.8; 58) | 98.3 (4.0; 21) ** |
| BILL | (1) 73.3 (4.3; 58) | 69.1 (4.7; 21) ** |
| TARSUS | (1) 82.1 (3.6; 58) | 79.3 (4.4; 21) ** |
| UNSEXED | | |
| 8TH P | (2) 209.4 (6.75; 196-218; 18) | |

WEIGHTS Males 690-900, females 550-900 (Schodde & Mason 1980). No information on seasonal variation.

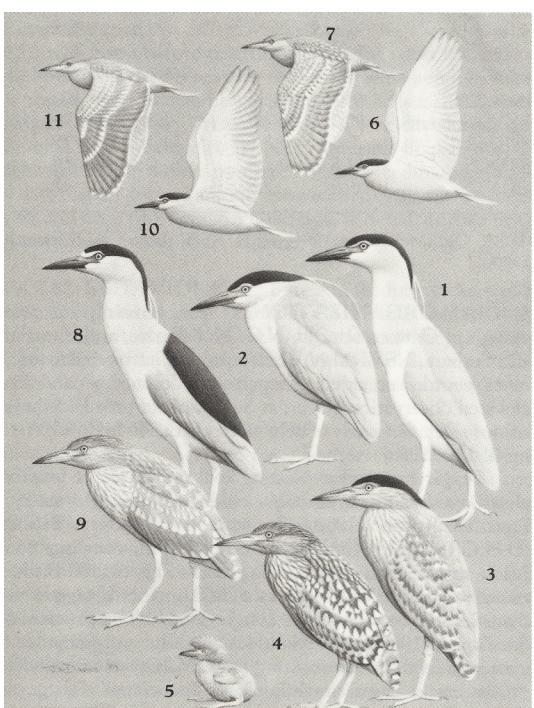
STRUCTURE Wings, broad and rounded. Eleven primaries; p8 longest, p10 6-12 shorter, p9 0-6, p7 1-5, p6 8-17, p5 25-33, p4 38-39, p3 51-62, p2 63-74, p1 74-87. P9 slightly emarginated on outer web, p9-p10 emarginated on inner web. Sixteen to seventeen secondaries, including five tertials. Tail, square; 12 feathers, t1-t6 = 3-10. Three pairs of powder-down tracts; one on breast, one on insides of thighs, and one on extreme sides of rump. Bill about same length as head, heavy and broad at base; culmen decurved at tip, tomia slightly decurved at tip. Neck, short. Legs, proportionately shorter than those of most other Aust. herons; lower quarter of tibia bare; outer and middle toe basally joined by short web; outer c. 30% of middle, inner c. 72%, hind (including claw) c. 60%.

GEOGRAPHICAL VARIATION Aust. subspecies *hilli* (for use of *novaehollandiae* as subspecific name for Aust. race instead of *hilli*, see Schodde & Mason 1980) also occurs New Guinea, Lesser Sundas Is and w. Bismarck Arch. In New Hanover and New Britain, birds suspected to be intermediate between *hilli* and subspecies *mandibularis* (Amadon 1942; Peters), which occurs in e. Bismarck Arch. and Solomon Is. Subspecies *mandibularis* perhaps smaller (e.g. wing 265-277; bill 58-72); adults have rich-chestnut upperparts, chestnut extends round neck and across upper breast; nuchal plumes occasionally washed blackish along entire length; no supercilium (Amadon 1942). In e. Indonesia, birds suspected to be intermediate between *hilli* and subspecies *manillensis* (Amadon 1942; Hoogerwerf 1960; Peters), which occurs in Java, Philippines, Sulawesi and n. Borneo. Subspecies *manillensis* is relatively large (e.g. wing c. 300-330); adults have darker upperparts than *mandibularis* with 'rich maroon' back; underparts much washed chestnut; nuchal plumes 'smoky black or whitish with dusky bases and tips'; no supercilium, or poorly developed, with chestnut mixed with white. Three other subspecies from w. Pacific islands (one extinct) about same size as *hilli*, adults differing chiefly in colour of upperparts. Little geographical variation occurs in juveniles (Amadon 1942). Some evidence for interbreeding with Black-crowned Night Heron *Nycticorax nycticorax* discussed by Hoogerwerf (1966), Hubbard (1976), Hancock & Kushlan (1984) and Sheldon & Marin (1985).

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Volume 1 (Part B), 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

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