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Order GRUIFORMES

Diverse assemblage of small to very large wading and terrestrial birds. Morphologically diverse, with few unifying characters within the Order. Anatomical details are summarized by Sibley & Ahlquist (1990). Possibly polyphyletic, though DNA comparisons indicate that the Order is monophyletic, composed of highly divergent groups that are more closely related to one another than to members of any other order (Sibley & Ahlquist 1990). The boundaries of the Order and relationships with other Orders and between families in this Order are uncertain (Sibley 1960; Sibley & Ahlquist 1972, 1990; Cracraft 1973; G.F. van Tets).

Peters, Wetmore (1960) and Storer (1971) recognized 12 families: Eurypygidae (monotypic Sun-bittern of tropical America); Otididae (bustards); Gruidae (cranes); Heliornithidae (finfoots of tropical Old and New World; three monotypic species); Aramididae (monotypic Limpkin of tropical and subtropical America); Psophiidae (trumpeters of tropical America; three species in single genus); Cariamidae (seriemas of central S. America; two monotypic genera); Rhynochetidae (monotypic Kagu of New Caledonia); Rallidae (crakes and rails); Mesitornithidae (mesites of Madagascar; three species in two genera); Pedionomidae (monotypic Plains-wanderer of Aust.); and Turnicidae (button-quails).

The Plains-wanderer is now recognized as being a charadriiform on evidence of morphology (Olson & Steadman 1981) and DNA-DNA hybridization (Sibley *et al.* 1988). Sibley *et al.* (1988) and Sibley & Ahlquist (1990) placed the Turnicidae in a separate Order, the Turniciformes *incertae sedis* (which we follow here; q.v.) and included Aramididae within the Heliornithidae but otherwise retained a similar arrangement of families. The Mesitornithidae, Rhynochetidae and Otididae have also been regarded as separate Orders.

Only Gruidae, Rallidae and Otididae occur in our region; other families are not considered further here.

REFERENCES

- Cracraft, J. 1973. *Bull. Am. Mus. nat. Hist.* 151.
Farner, D.S., *et al.* (Eds) 1971. *Avian Biology. 1.* Academic Press, New York.
Olson, S.L., & D.W. Steadman. 1981. *Smithson. Contrib. Zool.* 337: 1-25.
Sibley, C.G. 1960. *Ibis* 102: 215-29.
—, & J.E. Ahlquist. 1972. *Bull. Peabody Mus. nat. Hist.* 39: 1-276.
—, — 1990. *Phylogeny and Classification of Birds.* Yale Univ. Press, New Haven.
—, *et al.* 1988. *Auk* 105: 409-23.
Storer, R.W. 1971. Pp 1-18 **In:** Farner *et al.* 1971.
Wetmore, A. 1960. *Smithson. misc. Coll.* 139.

Family RALLIDAE rails, crakes and gallinules

A group of small to medium-sized (12–65 cm long), generally slender, terrestrial birds, usually of wetlands, often very secretive and skulking. Almost cosmopolitan, not occurring in polar regions and waterless deserts. In our region, 17 breeding species in 11 genera, five accidentals (one doubtful) and three extinct. Relation to other Gruiformes not fully resolved; skeletal morphology suggests close alliance to Psophiidae (trumpeters) and Heliornithidae (sungrebes) (Cracraft 1973); Aramididae, Eurypygididae and Cariamididae of S. America, and Rhynochetidae of New Caledonia and the extinct Aptornithidae of NZ also closely related; some or all of these families could be included as sub-families in Rallidae (G.F. van Tets). DNA–DNA hybridization evidence shows Rallidae form a distinct cluster separate from cranes and their allies (Sibley & Ahlquist 1990). Olson (1973b) recognized two sub-families: the monotypic Himantornithinae and the Rallinae, with Himantornithinae intermediate between Rallinae and Psophiidae. The Jacanidae (Charadriiformes; q.v.) may be derived as aquatic specialists from *Gallinula*-like stock and more appropriately placed within the Rallidae (G.F. van Tets).

Arrangements within the Rallidae have varied: Peters recognized 52 genera; Thomson (1964), 45; Olson (1973b), 35; Ripley (1977) 17; BWP, 32–39; Campbell & Lack (1985), 18; and Sibley & Ahlquist (1990) 34 (142 species). Rallidae vary anatomically in relation to diet and habitat. Olson (1973b) suggested they evolved from terrestrial to aquatic but admits evolution may have occurred several times. For practical purposes, broad division often made into (1) rails, crakes and wood-rails, most of which are terrestrial (in HANZAB region: *Rallina*, *Gallirallus*, *Dryolimnas*, *Porzana*, *Eulabeornis*, *Crex*); and (2) coots and gallinules (including swamphens, native-hens and waterhens), which tend to be more aquatic (in HANZAB region: *Amauromis*, *Gallinula*, *Porphyrio*, *Fulica*, *Gallicrex*). The affinities of the genera and, in brackets, the number of volant and flightless species recorded in HANZAB region given below. *Rallina* (2, 0): one species occurring Aust. and New Guinea and another vagrant to Aust.; close relatives are *Canirallus* and *Sarothrura* of Africa, *Mentocrex* of Madagascar and *Rallacula* of New Guinea (Olson 1973b). *Gallirallus* (1, 4): widespread in Indo-Pacific region; one or more species of volant *Gallirallus* are thought to be ancestral to several insular species in the sw. Pacific, including *lafresnayanus* of New Caledonia and *sylvestris* of Lord Howe I. (Olson 1973b; Fullagar & Disney 1981; Schodde & de Naurois 1982; Diamond 1991). *Dryolimnas* (1, 0): one species (*pectoralis*) occurring Aust. and Auckland Is; closely related to *Gallirallus* and *Rallus*; *pectoralis* often placed in *Rallus*. *Amauromis* (1, 0): one species occurring Aust., New Guinea, Philippines and Moluccas. *Porzana* (5, 0): worldwide, with four species native to our region and one vagrant; we follow Mees (1982) by including *Poliolimnas* in *Porzana*; Olson (1973b) thought *Porzana* may have evolved from *Amauromis*. *Eulabeornis* (1, 0) endemic to n. Aust. and Aru Is, and according to Olson (1973b), an allopatric close relative of *Habroptila* (1, 1) of Wallacea and New Guinea. *Crex* (1, 0) breeds in Eurasia and migrates S, mainly to Africa; vagrant to Aust. and, doubtfully, to NZ. *Gallicrex* (1, 0): vagrant from se. Asia to Christmas I. (Ind.); may also have derived from *Amauromis*. *Gallinula* (2, 1) worldwide distribution, with three species in our area; also an *Amauromis* derivative; sub-genus *Tribonyx* is endemic to Aust. with a fossil record going back to Pliocene (Olson 1975); differ from *Gallinula* in broad bill, long tail and short toes. *Porphyrio* (2, 2) appears to be a *Gallinula* derivative, with sub-genus *Porphyryla* intermediate in shape and plumage between *Gallinula* and nominate *Porphyrio* of Africa, Asia and Aust.; the sub-genus *Notornis* of Lord Howe I. and NZ consists of obvious derivatives of the nominate, but are terrestrial with an exceptionally deep bill and short toes. *Fulica* (1, 0): worldwide distribution, with one species in our region, and two flightless extinct species in NZ; probably derived from *Gallinula*-like stock (Olson 1973b).

Bodies, short, often laterally compressed for ease of movement in dense vegetation. Neck, short or moderately long; 14–15 cervical vertebrae. Males, often slightly larger than females. Wings, short, broad, rounded; in volant species, flight appears low, weak and generally not sustained though some species capable of long-distance movements, occurring on or colonizing oceanic islands (e.g. Purple Gallinule *Porphyrio martinica*, Watercock *Gallicrex cinerea* in HANZAB region). Some island species are flightless, yet many others migrate or disperse over long distances. In HANZAB region, all species have 11 primaries (p11 minute) and 10–12 secondaries; in Family, 10–20 secondaries, smaller species have ten and some flightless species have fewer primaries (BWP); diastataxic. Short sharp curved claw on alula. Tail, short, square to rounded, soft; often raised or flicked up to signal colours of under tail-coverts; normally 12 (6–16) rectrices. Bill varies: often rather slender, straight and slightly longer than head, and in some species, slightly decurved; or quite short and laterally compressed (crakes, most gallinules, coots); or massive and laterally compressed (some species of *Porphyrio*). Gallinules and coots have smooth, plate-like horny frontal shield (continuous with ramphotheca) on forehead. Nostrils usually in large depression (not in *Porphyrio*), pervious and perforate in some species. Sense of smell said to be well developed (Ripley 1977). Legs, well developed, usually strong, long to quite short, often laterally compressed. Toes, long and slender but may be rather short and heavy; hind toe, large, slightly raised. In most gallinules (not native-hens *Gallinula*, Takahe *Porphyrio mantelli* and White Gallinule *P. alba*) and some crakes, toes greatly elongated and legs modified for walking on floating vegetation; in coots, toes have enlarged lateral lobes to aid swimming, and pelvis and legs modified for diving. All species can swim; dive easily and can sink, using wings under water if necessary. Many species climb easily among thick vegetation; downy young of some (and

possibly adults) use wing-claw to assist climbing. Oil-gland bi-lobed, feathered in most species. Caeca, long. Syrinx, simple; tracho-bronchial. Feathers, fairly loose and soft, frayed and even hair-like in some; small after-feather usual.

Plumage, generally sombre browns, chestnut, black, or greys; iridescent purplish-blue and green in *Porphyrio*. Barring on flanks common. Vent and under tail-coverts may contrast with rest of plumage. Upperparts, spotted, barred, streaked, or plain. Bare parts often brightly coloured and forehead shield conspicuous. Sexes usually similar or nearly so (except in *Sarothrura* and *Gallixrex*). Pre-breeding moults restricted or absent, with no seasonal changes in appearance (except in *Gallixrex*) but colours of bare parts change in some species, coinciding with moults. Post-breeding moult, complete. Remiges may be moulted irregularly, or simultaneously, with consequent flightless period. Post-juvenile moult partial; can be followed by partial pre-alternate moult or by complete second pre-basic. Young, downy, and unlike other precocial birds, black (sometimes iridescent) or dark brown, which may be an adaptation for hiding in dense vegetation; evidently a derived condition (Olson 1973b). In some species, downy young have brightly coloured bills or skin on head or both, which may function for signalling (Fjeldså 1977). Downy young of *Gallinula*, *Porphyrio* and *Fulica* also have white or yellow terminal bristles on down. Post-natal development slower than in some other precocial birds, such as Galliformes and Turniciformes, with initial emphasis on development of legs and feet and not wings; flight-feathers develop last. Juveniles generally similar to but duller than adults.

Numerous flightless forms; incidence of flightlessness perhaps greater than in any other group except ratites and penguins. Flightlessness has evolved many times within the Rallidae, often and repeatedly on islands without predators and probably independently each time; appears to evolve rapidly and so probably of little phylogenetic significance above the level of species (Olson 1973a). Selection reduces flight-muscle and pectoral girdle, possibly through neoteny (Olson 1973a); usually corresponding increase in development of leg muscles. Frequency of flightlessness suggests that rails are predisposed to it; they are certainly pre-adapted for coping with some of the restrictions it imposes: many volant species are behaviourally flightless, e.g. avoiding predators by running away; many are temporarily flightless during wing-moult (a feature shared with several other groups containing flightless forms), when secretive and elusive; and post-natal development of flight is slow. In many species, populations of insular flightless species exterminated by introduced predators (e.g. Chatham Island Rail *Gallirallus modestus*, Dieffenbach's Rail *Gallirallus dieffenbachi*). Subfossils from our region have been reviewed (Olson 1977) and include flightless and often large species of coot, waterhen, rail and wood-rail and the distinctive snipe-rail *Capellirallus*. For discussion of biogeography of *Gallirallus* see Olson (1973b), Fullagar *et al.* (1982), Schodde & de Naurois (1982), and Diamond (1991).

Most inhabit all sorts of terrestrial, estuarine and littoral wetlands, from sea-level to mountain highlands. Some genera found in lowland and montane forests; others in wet grasslands; still others, e.g. Takahe *Porphyrio mantelli*, *Crex*, tussock grasslands, hay-fields and similar places, not necessarily with wet areas. Some species migratory; many dispersive; others apparently sedentary. Patterns of movements in HANZAB region generally not known, perhaps because they appear to take place at night and perhaps because the birds are so secretive and silent when not breeding that absences may be more supposed than real. Gallinules and coots appear to be more sedentary than crakes and rails, though at least the Black-tailed Native-hen *Gallinula ventralis* is notably irruptive, in response to floods and droughts of inland Aust.

Omnivorous, or in some species mostly vegetarian. Species with long thin bills probe for invertebrates in soft ground and litter. Eat all sorts of plants and submerged vegetation, insects, molluscs, crustaceans, eggs and young of other birds, small fish and carrion. Some gallinules graze, e.g. Tasmanian Native-hen *Gallinula mortierii* and coots. Only *Fulica* dives for food; they and *Gallinula* will up-end. Often wash food in water.

Mostly solitary or in small groups, though densities can be very high in some wetlands; *Gallinula* (e.g. Black-tailed Native-hen *Gallinula ventralis*) and *Fulica* form large flocks, especially in winter; after onset of inland droughts, irruptions may involve thousands of birds. Roost solitarily except in species that flock; generally at night on ground in cover; occasionally in bushes and trees. Some species nocturnal or crepuscular. Most species nest solitarily; some strongly territorial, advertising territories with loud persistent calling and chasing of intruders. Dense vegetation and apparently secretive habits make it hard to study social organization and behaviour in most species. Agonistic and sexual behaviour often conspicuous with wing-spreading, tail-flicking, fighting with use of bill and feet and other ritualized features of display. Pair-bond usually monogamous and only for one season but may be sustained. Polygyny known in captivity and suspected in wild, e.g. in *C. crex*; polyandry occurs in Tasmanian Native-hen *Gallinula mortierii* and possibly Weka *Gallirallus australis*. Co-operative breeding in some gallinules, e.g. Dusky Moorhen *Gallinula tenebrosa*. Pair-formation and courtship little known except in some gallinules and coots, in which a variety of chasing, bowing, nibbling, mock-preening and feeding, and courtship feeding takes place; no elaborate ceremonies at time of nest-relief. Copulation and other activities take place out of water or on specially built platforms. Most species very vocal, with screams, trills, whistles, booms, rattles, trumpets, grunts or barks; can be ventriloquial; mostly silent when not breeding but social species have loud rallying cries. Stand at rest (sometimes on one leg) in hunched posture with head sunk on shoulders, or lie down; sleep with head on back and bill among feathers. Bathe in shallow water, alternately ducking head in water and flipping water over back or by beating half-open wings in water; coots may bathe while swimming. Leave water to oil and preen after bathing. Sun themselves after preening. Allopeening common. Scratch head directly. Some species (e.g. *Porphyrio porphyrio*, *P. alba*, *P. mantelli*) recorded manipulating and grasping food in foot or holding down large items with feet.

Breed seasonally and protractedly. Nest fairly deep and cup-shaped; in some rails, domed; in wetlands, often with ramps up to nests. In thick vegetation, often near or on surface of water but some species nest high in trees; use old nests of other birds or nest on ground far from water; materials from any available plants; built by both sexes. Horned Coot *F. cornuta* of S. America builds islands of small stones. Some build nests that float or are attached to aquatic vegetation; nests on water may be built up rapidly if water-level rises. Non-functional nests often found in gallinules and *Gallinula*, which also build nursery nests after young hatch. Eggs, blunt oval; smooth and fairly glossy; dull white to tan ground-colour, blotched and spotted red-brown to black; unspotted in *Rallina*. Clutch-size, 5–10 (1–18) but dump-laying or laying by more than one female in same nest may complicate estimation of size of clutch laid by an individual. Usually one or two broods and replacement layings up to three times. Lay at intervals of 24 or 48 h. Incubation usually by both sexes but in some by female alone or with only small share by male. Incubation period, 14–24 days per egg; start of incubation varies from first to last egg and so hatching synchronic or asynchronic. Egg-shells left in nest or removed. Generally have two large lateral and one small median brood-patches. Young hatch in down, precocial, nidifugous; at first fed bill to bill, becoming self-feeding within few days or not until 8 weeks old. Normally tended by both parents and, in a few species, offspring of previous broods may help to feed young, e.g. *Gallinula*, occasionally *Porphyrio*. Fledging period, 30–60 days (20–70) and then independent except in co-operative breeders. First breeding usually when 1 year old or less.

REFERENCES

- Campbell, B., & E. Lack. 1985. *A Dictionary of Birds*. Poyser, Calton.
- Cracraft, J. 1973. *Bull. Am. Mus. nat. Hist.* 151.
- Diamond, J. 1991. *Auk* 108: 461–70.
- Fjeldså, J. 1977. *Guide to the Young of European Precocial Birds*. Skarv. Nature Publs, Strandgården, Tisvildileje.
- Fullagar, P.J., et al. 1982. *Emu* 82: 131–6.
- Mees, G.F. 1982. *Zool. Verh., Leiden* 191.
- Olson, S.L. 1973a. *Smithson. Contr. Zool.* 152.
- 1973b. *Wilson Bull.* 85: 381–416.
- 1977. Pp 339–73 **In:** Ripley 1977.
- Ripley, S.D. 1977. *Rails of the World*. Fehely, Toronto.
- Schodde, R., & R. de Naurois. 1982. *Notornis* 29: 131–42.
- Sibley, C.G., & J.E. Ahlquist. 1990. *Phylogeny and Classification of Birds*. Yale Univ. Press, New Haven.
- Thomson, A.L. (Ed.) 1964. *A New Dictionary of Birds*. Nelson, Lond.

Porzana tabuensis Spotless Crake

Rallus tabuensis Gmelin, 1789, *Syst. Nat. ed.* 13, 1: 717, based on Tabuan Rail of Latham, 1785, *Syn.* III: 235 — Tonga-tapu, Tahiti, and neighbouring islands.

Named after the type-locality.

OTHER ENGLISH NAMES Leaden, Swamp, Spotless Water or Tabuan Crake, Little Swamphen, Little Native-hen, Motor-car Bird, Blue Rail, Waterhen, Blue or Swamp Rail, Putoto, Puweto, Little Tarler bird, Taro Bird (Norfolk I.).

POLYTYPIC Nominate *tabuensis* Aust., NZ, Chatham Is, Philippines, Polynesia, New Caledonia and islands of sw. Pacific; two other subspecies extraliminally.

FIELD IDENTIFICATION Length 17–20 cm; wingspan 26–29 cm; weight 40–50 g. Small dark reddish-brown and slate-grey crake, usually appearing wholly dark; slightly smaller and with finer bill than Australian Crake *Porzana fluminea*. Sexes similar. No seasonal variation. Juvenile separable.

Description Adult Head and neck, slate-grey with varying light-grey to whitish patch on chin, sometimes extending in narrow strip to lower throat. Mantle, back, scapulars and inner wing-coverts, dark reddish-brown, grading to darker brown on rump and upper tail-coverts. Tail, blackish-brown. Upperside of remiges and primary coverts, dark brown to blackish, with thin white leading-edge to outermost primary, sometimes visible in flight. Underbody, slate-grey, grading to grey-black on under tail-coverts, which are narrowly barred white. Underwing, slate-grey with white barring on coverts. Bill, black. Iris, deep red; orbital ring, red. Legs and feet, salmon pink. **Juvenile** Similar to adult but generally paler and browner, with conspicuous white chin and central throat; some with diffuse white supercilium in front of eye. Upperparts, duller brown; head and underparts duller dark grey-brown, browner on flanks and dull white on centre of breast and belly. Iris, duller brownish-orange at first, turning red. Legs and feet vary from dark olive-brown through brownish grey to brownish flesh; many develop adult colour before post-juvenile moult complete.

Similar species None; small size, all-dark plumage, pinkish or reddish legs and feet unmistakable. Calls distinctive.

Singly, in pairs or loose groups in dense vegetation round margins of freshwater swamps; in well-vegetated saltmarsh, mangroves and dry scrubs and dry forest floor (on islands), beaches. Generally secretive, wary and shy but can be tame; rarely venture into open to feed as do other *Porzana* crakes, often remaining within dense cover when foraging. Often move along branches, fallen logs or among aquatic plants. Gait when foraging a slow stalking walk with tail constantly flicked; wade, swim and dive readily. Rarely seen in flight; over short distances, flight laboured and fluttering on short rounded wings with legs dangled as other crakes. Voice varied and distinctive: usual call is a fast high-pitched trill preceded by a soft quarrelling sequence; also loud sharp high-pitched note (cf. usual double note of Australian Crake), sometimes interspersed with short loud harsh nasal harr and short trilling whistle.

HABITAT Permanent or ephemeral, terrestrial and littoral wetlands, usually with continuous blocks of tall emergent reeds, rushes, sedges or other vegetation (Hadden 1970; Ogle & Cheyne 1983; Kaufmann 1987): rivers, streams, tidal creeks and lagoons, lakes, inundated depressions, peat bogs, saltmarsh and artificial

wetlands. Prefer wetlands with flowing water, but avoid deeper, swifter sections (Fletcher 1916c; Bryant & Amos 1949). Also in agricultural and suburban areas, heathy flats and coastal scrub (Whitlock 1914; Ford 1965; Soper 1969). May occupy non-wetland habitats on islands: on Kermadec Is, occur among sparse fern ground cover under canopy of Pohutukawa (Edgar *et al.* 1965); on Poor Knights Is, occur in mixed, low forest (3–4 m canopy) with sparsely vegetated understorey and thick leaf litter, but with dense low cover growing in gaps where windfall has opened canopy (Buddle 1941a; Onley 1982a); on islands off s. WA, inhabit dry, sterile, rocky or stony habitats without standing water (Kitchener *et al.* 1975; Serventy & Whittell 1976); common among mangroves on Houtman Abrolhos (Sandland 1937; Tarr 1949; Serventy & Whittell 1976; Garstone 1978; Storr *et al.* 1986). Occur in saline, brackish or fresh water (Whitlock 1914; Sandland 1937; Serventy & Whittell 1976); in sw. Aust., salinity 0.7–2.45 g/l and pH 6.9–8.2 (Lavers 1971; Morris 1975; Goodsell 1990); only crake normally occurring in acidic (pH <6), fresh (<0.3 ppt), heavily vegetated swamps of sw. WA (R.P. Jaensch).

Usually forage on mud or in shallow water, either in the open or beside concealing vegetation, at margins of wetlands (Bryant & Amos 1949; Howard 1962; Vestjens 1972; Patterson 1989). Prefer to feed at base of reeds, rather than in sedges and rushes (Bryant & Amos 1949). Also recorded feeding among blackberry thickets (Fletcher 1916a). On Poor Knights Is, forage among leaf-litter on forest floor (Buddle 1941a; Onley 1982a); on Kermadec Is, recorded feeding along tidelines, next to low, tangled, salt-tolerant vegetation, among leaf-litter, branches and foliage of vegetation, clumps of *Cyperus* in freshly excavated soil round petrel burrows, and round nests of noddies *Anous* (Soper 1969; Merton 1970).

Usually breed in large, unbroken stands of dense, tall emergents such as reeds, rushes, sedges, grass tussocks and stands of dense shrubs, e.g. *Melaleuca*, growing near water of swamps, creeks and drains (Littler 1910; Fletcher 1916a,b; Fraser 1972; Jaensch 1984, 1989), but may be up to 90 m from nearest water (Whitlock 1914). Occasionally in tussocks in paddocks or beneath ferns and blackberries (Fletcher 1914; Hadden 1972). In NZ, overhanging willows may be important requirement (Hadden in press).

Suitable habitat lost through drainage of wetlands (Kendrick 1966; Ogle & Cheyne 1981; Onley 1982a). Frequently use artificial sites, including wetlands such as saltworks, sewage farms, margins of reservoirs, farm dams, irrigation channels, bores, drains and culverts; farmland, golf courses, lawns and gardens (Heathcote 1945; Bryant & Amos 1949; Watson 1955; Hadden 1970, 1972; Qld Bird Reps; NSW Bird Reps; Vic. Bird Reps; Vic. Atlas). In

Deniliquin area, NSW, suggested that rise in water table through irrigation possibly enhanced habitat (Penhallurick 1981); similarly, now occur in *Typha* swamps associated with irrigation schemes in Riverland, SA (R.P. Jaensch). Wild pigs are detrimental to habitat of Spotless Crane on Poor Knights Is, because they restrict regeneration of low mixed forest; pigs also dig over leaf-litter, which prevents its accumulation and the resulting build-up of invertebrates; also destroy low nesting cover and probably directly interfere with nesting birds (Onley 1982a); Buddle (1946) considered activities of pigs favours Crakes by encouraging growth of suitable nesting tussocks of native grasses in newly opened forest. However, the adverse effect of pigs on habitat outweighs any benefits for breeding habitat (Onley 1982a).

DISTRIBUTION AND POPULATION From Philippines, S through Indonesia and New Guinea to Aust., NZ and sw. Pacific islands, E to Marquesas.

Aust. Probably plentiful in many areas, but overlooked because so shy (Aust. Atlas). **Qld** Few records, sparsely distributed; w. C. York Pen., islands of Torres Str. (Booby, Thursday Is), from Cairns, S through Atherton Tablelands to Townsville; many sites in SE; in SW, Davenport Downs and E of Longreach (Bravery 1970; Draffan *et al.* 1983; Garnett & Bredl 1985; Qld Bird Reps 1983, 1984, 1989; Aust. Atlas). **NSW** All districts; mainly S of 33°S, with records N of there mostly in coastal regions or in Darling R. Basin (Morris *et al.* 1981; NSW Bird Reps; Aust. Atlas). **Vic.** Most records from Murray R. Also in NE, central districts and Western Plains (Vic. Atlas). Isolated records from Gippsland: near Orbost, Ls Entrance, L. Wellington and Wilson's Prom. (Cooper 1970; Vic. Bird Reps 1981, 1985). **Tas.** All records in N and E, from Hunter I. to Huonville (Thomas 1979; Tas. Bird Reps 3,4). First record King I., July 1972 (Tas. Bird Rep. 2). **SA** Most records S of 34°S, with occasional records in mid-N (Aust. Atlas); recorded twice on e. Eyre Pen. (Pedler 1978). Several records from NE, including L. Eyre basin (Cox & Pedler 1977; Badman 1979; Aust. Atlas). **WA** Generally in SW, from Rossiter Bay to c. 30°S; resident on Houtman Abrolhos, with occasional records on adjacent mainland round Port Gregory; isolated records from near Shark Bay and at Kathleen Valley; several records from

Pilbara, round Hamersley Ra.; no Aust. Atlas records in Kimberley Division, but several records from round Kununurra, where possibly breeding resident, and Mitchell Plateau (Ford 1962; Moriarty 1972; Storr 1980, 1985, 1987; Howard 1986; Storr *et al.* 1986; Jaensch 1989; Aust. Atlas). **NT** Vagrant, or possibly regular migrant in small numbers, to Top End: several records from round Darwin (Thompson & Goodfellow in prep.); unconfirmed record from Finke R. (Whitlock 1924).

NZ Widespread and sparsely distributed, but poorly recorded. In NI, mainly recorded Northland, Waikato and sw. coast; also Three Kings, Poor Knights (Aorangi) and Mayor Is. In SI, scattered records all districts, including Stewart I.; single breeding record, N. Canterbury, Oct.–Nov. 1992 (Bull & Gaze 1975; Pierce 1980; Onley 1982a; Hadden in press; CSN 21, 30, 36; Oliver; NZ Atlas; NZCL; B.D. Heather).

Norfolk I. Rare; formerly widespread (Schodde *et al.* 1983). Recorded several times between 1790 and 1909, when breeding recorded (Basset Hull 1909; Schodde *et al.* 1983). Rediscovered Nov. 1980 (Moore 1981) and seen again in 1982 (Moore 1985).

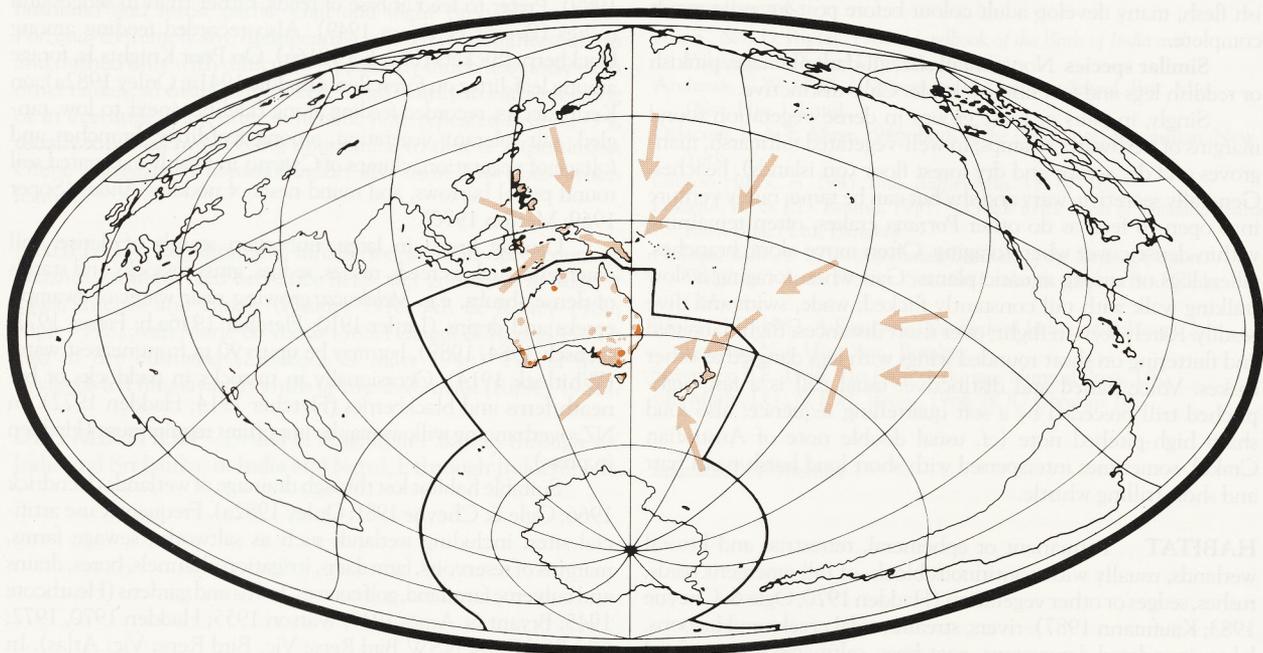
Kermadec Is Occurs on Meyer Islet; early records on Raoul I., but not recorded there since 1911 (Merton 1970).

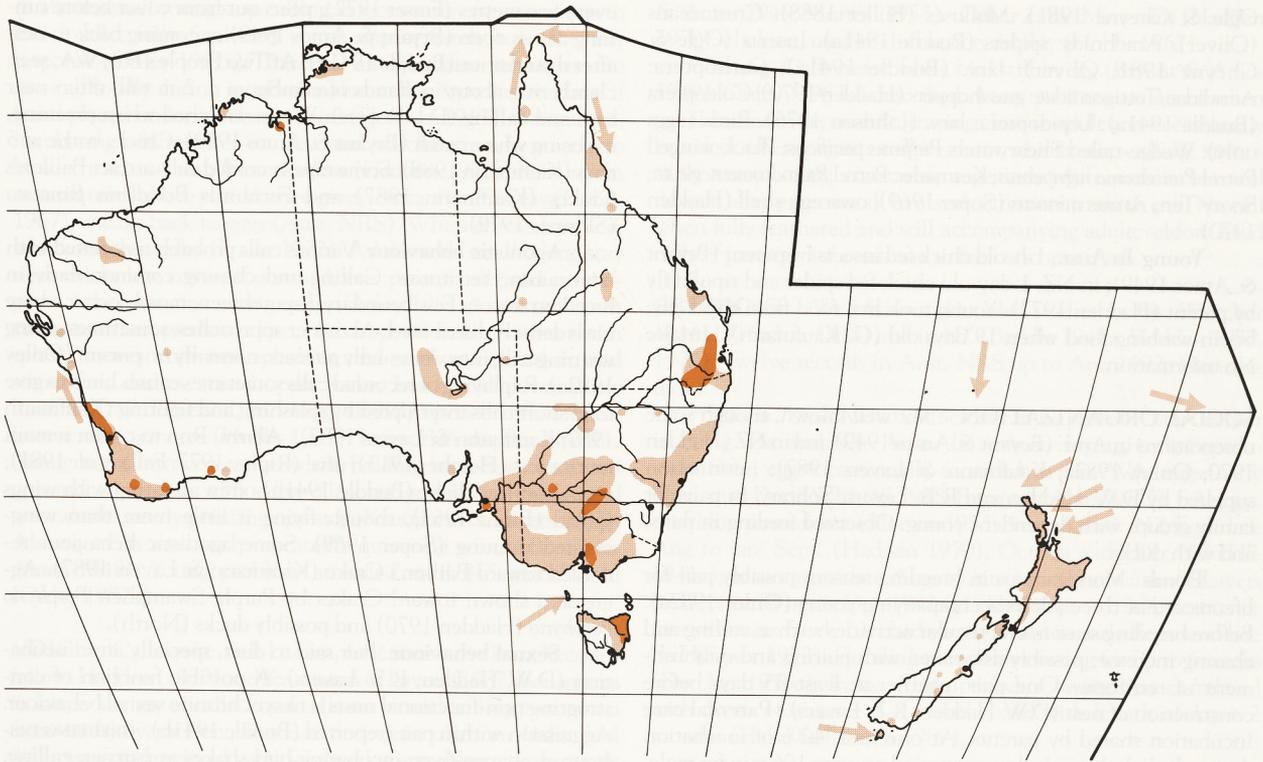
Chatham Is Recorded but status not known.

Breeding Few records, but probably throughout range in s. Aust. and NZ.

Irruptions May be induced by good rainfall. Large influx recorded round Wentworth, June–Dec. 1984 (NSW Bird Rep. 1984); fairly common round Narrandera following good rains in July 1981 (NSW Bird Rep. 1981). Good numbers recorded in s. Vic. in 1948 and 1985 (Bryant & Amos 1949; Vic. Bird Report 1985). Unusual numbers in s. SA (including many immatures) disappeared suddenly about Feb. 1912 (White 1913). Specimen taken near Wanjarri after rain (Moriarty 1972).

Population In Murray–Darling Basin, five pairs recorded in area of rushes 800 x 25 m (Morton 1953). In sw. WA, minimum of: 25 recorded on Grasmere NR, 192 ha; 20 on Bengier Swamp NR, 572 ha; 19 on Thomson's L. NR, 213 ha; 18 on Yarnup Lagoon NR, <30 ha (Jaensch *et al.* 1988); 51 at Forrestdale L., 199 ha (R.P. Jaensch). On Aorangi, Poor Knights Is, c. 100 pairs recorded in 66 ha in 1940 (Buddle 1941a); in 1920s pigs had





altered habitat and populations were low; population rapidly increased in 1940s after removal of pigs in 1936; by mid-1950s, numbers dropped to a level that remained constant through 1960s and 1970s; numbers expected to decline in future as favourable habitat reduced; in 1980, <78 birds (<50 adults; four juveniles; 24 chicks) found (Onley 1982a). At Pukepuke Lagoon (86 ha), seven nests in 1982 (Kaufmann 1987; Kaufmann & Lavers 1987). In Whangamarino wetlands (7100 ha), 89 birds recorded (Ogle & Cheyne 1983). On Meyer Islet, Kermadec Is, maximum of 40 birds (Soper 1969). Population on Norfolk I. reduced by rats (de Ravin 1975). Often killed by cats throughout range. Occasionally struck by vehicles (CSN 24). Recorded feeding with domestic fowl (Bryant & Amos 1949; Tarr 1949).

MOVEMENTS Unknown; secretive; reporting rates probably affected by conspicuousness, which may vary during year (e.g. possibly less conspicuous in winter when not calling). Only recorded from n. Qld, Oct.–May, and possible passage migrant in s. Qld in Oct. and May (Storr 1984); possibly regular migrant on C. York and to Booby and Thursday Is in Torres Str.; casualties on islands of Torres Str. reported in Jan., Feb., May, Dec. (Draffan *et al.* 1983; Stokes 1983; Garnett & Bredl 1985; Ingram *et al.* 1986; Aust. Atlas). Fewer records in S in winter claimed to suggest movement (Condon 1968; Jaensch *et al.* 1988; Tas. Bird Reps 1989, 1990; Aust. Atlas); recorded islands of Bass Str., but no winter records from Tas. (North; Tas. Bird Rep. 1972; Aust. Atlas). In Vic., pattern of reports is seasonal though few records each year (Vic. Bird Rep. 1985; Vic. Atlas). Records from n. Aust., Pilbara, islands of WA and elsewhere suggests that birds move well beyond normal range (Serventy & Whittell 1976; Aust. Atlas). Occurrence and numbers may alter suddenly (White 1913; Morris 1975; Penhallurick 1981; Tas. Bird Rep. 1989) or change seasonally (Kaufmann 1987), possibly in response to rainfall or receding

water (Fletcher 1914; Moriarty 1972; Vestjens 1972; NSW Bird Rep. 1981; Vic. Atlas). Young move to drier habitats (Onley 1982a).

Banding At Pukepuke Lagoon, NZ, of 17 banded birds, four recaptured in same traps within 1 year (R.B. Lavers); in NZ, bird released 20 km from place of capture on 5 Dec. 1964 was recaptured at banding site c. 6 weeks later (Kendrick 1972).

FOOD Seeds, fruits, shoots of grasses and aquatic plants, adult and larval insects, molluscs, crustaceans, spiders and carrion.

Behaviour Crepuscular, though suggested more diurnal than other rails (Bryant & Amos 1949). Usually feed on ground; on Kermadec Is also found in trees, foraging among foliage and nests of noddies *Anous* (Soper 1969). Glean on mudflats, in reed beds, shallow water, tideline and driftline of rivers, in petrel burrows, forests, and short grass; also swim readily. Scratch in litter with feet, clearing areas up to 23 cm diameter and turn over litter with sideways push of bill (Buddle 1941a). Able to survive without fresh water (Sandland 1937). Suggested they may compete for food with Baillon's Crake *P. pusillus* (Kaufmann & Lavers 1987). Recorded washing food (Johnson 1976).

Adult No detailed studies. **Aust.** Plants (crops, stomachs and observations): seeds (MV); vegetable leaves (Gould); reed tillers (Fletcher 1914); Poaceae: blades (Gould); Rosaceae: *Rubus* ripe fruit (Bryant & Amos 1949). Animals: Molluscs: gastropods (Gould). Crustaceans: ostracods (Vestjens 1977); amphipods (Fletcher 1914); Collembola (Vestjens 1977). Insects (MV): Ephemeroptera; Coleoptera: water beetles; Chrysomelidae; Diptera: larv. (Vestjens 1977); Calliphoridae: larv. (Bryant & Amos 1949). Mammals: carcass of cow (Dickson 1935). Grit (Vestjens 1977). **NZ** Plants: seeds of aquatic plants (Buller 1888; NZRD); Poaceae: tender leaves (Buller 1888); seeds (Fraser 1972). Animals: Annelids: oligochaetes (Buddle 1941a; Hadden 1970;

Ogle & Cheyne 1981). Molluscs (Buller 1888). Crustaceans (Oliver). Arachnids: spiders (Buddle 1941a). Insects (Ogle & Cheyne 1981; Oliver): larv. (Buddle 1941a); Orthoptera: Acrididae/Tettigoniidae: grasshoppers (Hadden 1970); Coleoptera (Buddle 1941a); Lepidoptera: larv. (Johnson 1976). Birds (eggs only): Wedge-tailed Shearwaters *Puffinus pacificus*; Black-winged Petrel *Pterodroma nigripennis*; Kermadec Petrel *Pterodroma neglecta*; Sooty Tern *Anous minutus* (Soper 1969); own egg-shell (Hadden 1970).

Young In Aust., 1-h-old chick fed insects by parent (Bryant & Amos 1949); in NZ, 1-day-old chick fed spider and tipulid fly by parent (Hadden 1972). Young took live food from third day; began washing food when 19 days old (G. Kaufmann). **Intake** No information.

SOCIAL ORGANIZATION Not well known, though some observations in Aust. (Bryant & Amos 1949) and in NZ (Hadden 1970; Onley 1982a; Kaufmann & Lavers 1987); information supplied by D.W. Hadden and R.B. Lavers. Solitary, in pairs, or family groups with dependent young. Observed feeding in pairs, and with ducks.

Bonds Monogamous in breeding season; possibly pair for life; record of three adults accompanying young (Onley 1982a). Before breeding season, crepuscular activities such as calling and chasing increase; possibly associated with pairing and establishment of territories. One pair together at least 35 days before construction of nest (D.W. Hadden; R.B. Lavers). **Parental care** Incubation shared by parents. At one nest, 40% of incubation during daylight by male; longest period on eggs: 106 min for male, 160 min for female; break during long bouts: 5–21 min for male, 1–26 min for female (Kaufmann & Lavers 1987). At first, both adults feed young at nest (Kaufmann & Lavers 1987). Newly hatched young accompanied by two adults; when young fully feathered one adult attends; probably attended until 4–5 months old (Onley 1982a).

Breeding dispersion Breed as solitary pairs in territories. Pair may build several non-functional nests near egg-nest (e.g. Fletcher 1913; Kaufmann & Lavers 1987). In s. Murray–Darling region, possibly five pairs in 800 x 25 m strip of rushes adjoining watercourse (Morton 1953); 13–19 occupied territories in 86 ha at Pukepuke swampland, w. coast NZ (Kaufmann 1987). **Territories** Strongly territorial, responding to recorded calls at any time of year, but particularly 2 weeks before laying (Kaufmann & Lavers 1987; NZRD); rarely leave territory (Bryant & Amos 1949). Solitary birds may also hold territories (Onley 1982a). Territories usually flat with thick low cover (Onley 1982a); size varies; where habitat suitable, pairs nest close together, and territories said to be as small as 5–12 m² (Bryant & Amos 1949; Hadden 1970); on Aorangi I., NZ, size of territories near creek 45 x 50 m or more (Onley 1982a).

Roosting Nocturnal. Non-functional nests occasionally used as roosting platforms; settle at nightfall (Fletcher 1914; Hadden 1970). Young often brooded by adult on platform, particularly at night (Oliver). Sun on stick protruding from water, a clod of earth at base of reeds (Fletcher 1916c; M.W. Basho).

SOCIAL BEHAVIOUR Basis of account as for Social Organization. Not well known because secretive and inhabit dense cover; move furtively, darting between cover. Behaviour usually only observed at nest (e.g. Hadden 1970), but Onley (1982a) describes territorial behaviour on open forest floor on Poor Knights Is. Behaviour similar to Baillon's Crake, particularly Distraction Display. Cautious; when in open, adult stops and looks round

every few metres (Fraser 1972); peers out from cover before running across open (Bryant & Amos 1949) or coming back to nest after disturbance (Buddle 1941a). At Two People's Bay, WA, seen clambering about in stands of cumbungi c. 2 m tall, often near tops and calling (D.I. Rogers). Wings stretched when preening, exposing white patch (Bryant & Amos 1949). Chicks bathe at 5 days (Kaufmann 1988). Some tape-recorded calls attract Baillon's Crakes (Kaufmann 1987) and Fernbirds *Bowdleria punctata* (Skinner 1979).

Agonistic behaviour Various calls probably associated with maintaining territories. Calling and chasing common early in breeding season. Few boundary disputes seen; mostly occur where birds densely distributed. As owner approaches, sometimes giving warning trill, intruder usually retreats; normally no pursuit (Onley 1982a). Replaying of recorded calls sometimes causes birds to give loud short calls interrupted by splashing and fighting (Kaufmann 1987; Kaufmann & Lavers 1987). **Alarm** Run to cover; remain motionless (Fletcher 1913); dive (Ripley 1977; Falla *et al.* 1981); give short low flight (Buddle 1941b) often alighting with wings spread (Binns 1953), though flying is little more than wing-assisted running (Soper 1969). Some agonistic behaviour recorded toward Baillon's Crake (Kaufmann & Lavers 1987). Aggression shown toward Crakes by Purple Swamphen *Porphyrio porphyrio* (Hadden 1970) and possibly ducks (North).

Sexual behaviour Pair said to duet, specially after incubation (D.W. Hadden; R.B. Lavers). A possible function of constructing non-functional nests is to synchronize sexual behaviour. Aggression within pairs reported (Buddle 1941b). **GREETING DISPLAY:** at change-over, incubating bird shakes as partner, calling, approaches; incubating bird may walk away, or may stand beside partner before leaving; relieving bird may bring and incorporate nest material (Hadden 1970). Call in warning if partner separated (Fletcher 1913). **Copulation** Recorded once; during laying period, 18 m from nest; calling heard, then male followed female round *Carex* tussock several times; female stood on tussock with body arched and bill pointed downwards; after several seconds male mounted and, balancing with outstretched wings, lowered himself; copulation took several seconds. Male dismounted, walked into bush; female stretched head up, and followed male (Kaufmann & Lavers 1987).

Relations within family group Incubating bird pulls vegetation round itself. After hatching, adult occasionally broods (Bryant & Amos 1949); chicks remain in nest for up to 2 days (Ripley 1977), then resort to non-functional nests for several days; recorded on non-functional nest built by another pair (Kaufmann & Lavers 1987). Newly hatched young accompanied by two adults, and usually stay near one of them; later feed more widely, 20–30 m away from adult, but still appear to follow adult round territory; fully feathered young accompany one adult at distances of up to 40 m (Onley 1982a). Both adults at first feed young at nest (Kaufmann & Lavers 1987). **BEGGING:** occurs up to 6 weeks of age; chick runs to adult, sits on tarsi and toes, and waves wings asynchronously (Kaufmann 1988). In captivity, chicks fed without assistance when 17 days old (Kaufmann 1988). Onley (1982a) found that chicks called constantly as they grew up and that adults did not respond by returning to them or calling to them; fully feathered young silent (*contra* Fletcher [1913], who described contact calls that cause chicks to follow adults, recalled brood after danger, and that chicks answered with squeaks). **Anti-predator responses of young** Squat in cover (Fletcher 1913; Whitlock 1914), sometimes under nest (Buddle 1941b); scramble from nest to vegetation (Soper 1969); run rapidly and try to hide, though will quickly give up if they cannot. Independent juveniles do not call, but hide until predator close, then run. If parent calls

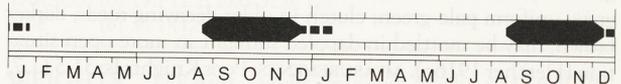
in alarm, small young stop calling; larger young often continue to call loudly; fully feathered young appear rarely to make any response (Onley 1982a). **Parental anti-predator strategies** Do not call loudly during incubation, but call in warning or alarm if hand placed under incubating bird (Fletcher 1913). If disturbed, incubating adult stands on nest and watches; moves quietly to beside nest, and stands motionless (Hadden 1970); remains on nest till reeds above parted, then gives Distraction Display (Hobbs 1967); sneaks back to eggs (Aust. NRS). When chicks handled, adults watch nearby (Fraser 1972). Adults with small young stay near thick, low cover; if alarmed, one parent calls and investigates, other remains with young (Onley 1982a). **DISTRACTION DISPLAYS:** when predator close, bird drops off nest into water with splash, moves from nest splashing and rustling vegetation, and sometimes dashes across open water; head held down, body hunched, tail depressed, and wings slightly opened and drooped; lasts several minutes (Hobbs 1967). In another display, bird flits from ground into vegetation while holding back horizontal, tail up, and wings out with edges close to ground, primaries and secondaries nearly pointing upwards (Kaufmann & Lavers 1987). Also squat in mud with repeatedly quivering wings (Bryant & Amos 1949). Young probably attended until 4–5 months old (Onley 1982a).

& Amos 1949; Morton 1953). **Other calls** *Mint-mint* (Hadden 1970); clicking, used in distraction display (Hobbs 1967).

Young Calls heard while bird still in egg (Bryant & Amos 1949). Onley (1982a) described: **WEAK TWITTERING** given when small and not very mobile, staying close to adult and occasionally brooded; when parents call in alarm, chicks stop calling; **SINGLE THIN RISING CALL:** constantly repeated, while mobile but still downy; after parents call in alarm, often continue to call. No call when fully feathered and still accompanying adult; seldom heed calls of parents and continue to feed unconcerned.

BREEDING Well known. Detailed studies in Tas. (Fletcher 1914, 1916a,b,c, 1918) and in NZ (Buddle 1941a; Hadden 1970, 1972). Twelve records in Aust. NRS up to Apr. 1992. Monogamous.

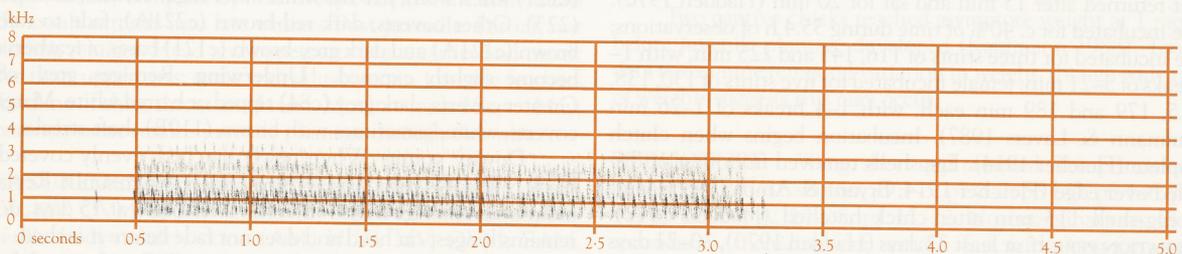
Season Little variation across range, probably start earlier in S, e.g. Tas. and NZ. **Aust.** In e. Aust.: laying, early Sept. to early Dec.; eggs occasionally recorded in Jan. WA: eggs, early Nov., mid-Dec. (Whittell 1938; Bryant & Amos 1949); SA: eggs, mid-Nov. to mid-Jan. (Morton 1953; Aust. Atlas). **NZ** Eggs, late Aug to late Sept. (Hadden 1970), Oct. to early Dec. (Buddle 1941a); active nests late Aug. to late Jan. (Kaufmann & Lavers 1987); first SI nests, Oct. 1992 (Hadden in press); may nest twice in a season as newly hatched young found in early Sept. and late Jan. (Fraser 1972). Flooding may delay nesting for up to 6 weeks (Fletcher 1916c). In sw. Aust., period of laying best correlated with depth of water + 2–3 months, and with length of day + 2 months (Halse & Jaensch 1989).



Site Usually over water, beside flowing streams, near edge of swamps, within 5 m of edge of bed of *Typha*. In clumps of rushes *Lepidosperma longitudinale*, centre of grass tussock, clump of blackberry, small shrubs in rushes, in fork of fallen branch in dense *Microleana*, against stump of tree-fern, under tangle of ferns and blackberries; in sw. WA, in tall sedges (*Baumea*, *Typha*) or in thickets of shrubs (*Melaleuca*) and fine sedge (R.P. Jaensch); in NZ, nests at higher elevations usually on ground at base of sedge *Carex* (Fletcher 1914; Buddle 1941a; Bryant & Amos 1949; North). Recorded breeding near noisy school yard (Fletcher 1913). May build several non-functional nests before constructing nest for laying; rest and brood on these, or sometimes use as sites for second nesting; some nests 75–90 cm apart (Fletcher 1914, 1916c; Hadden 1970). **MEASUREMENTS (cm):** height of nest above water, 32 (24; 3–91; 11); one nest, SI, NZ, 41 cm above water (Hadden in press); depth below top of vegetation, 71 (46; 15–150; 9) (Aust. NRS); thickness of nest, 0–107 cm (Fletcher

VOICE Calls quite well known, functions not clear. Account follows Hadden (1970) and Kaufmann & Lavers (1987); sonograms in latter. Variety of calls. Loud calls are *pit* and trilling *purr*, given from mid-July to Dec., but not during incubation. Individual differences and regional variation, not known. **Non-vocal sounds** During distraction display, splash (Hobbs 1967; Hadden 1970, 1972) and audibly flutter wings.

Adult Loud calls (1) **TRILLING PURR** (sonagram A): rapid series of high-pitched notes, c. 25/s, with slight and rapid decrescendo; lasts 1–3 s (Bryant & Amos 1949). Resembles sound of motor (Fletcher 1913, 1914; Bryant & Amos 1949), an alarm clock going off and running down (Fraser 1972), and sewing machine at high speed (Whitlock 1914). Loudest call, but occasionally given softly. Probably same as warning trill of Onley (1982a). Usually immediately preceded by quarrelling sequence which sounds as if it comes from two birds; not very loud, and does not carry (R.P. Jaensch). (2) **PIT:** lasts 0.1–0.3 s; given singly or repeated. Probably same as harsh scolding *crack-crack*, repeated rapidly about six times of Buddle (1941a). Often interspersed with other short loud calls: (3) **TRILLING WHISTLE** and (4) harsh and very nasal *har*. **Soft calls** Low in pitch and loudness; apparently contact calls: (5) **BUBBLINGS** and (6) **MURMURING:** frequently given in duet, presumably by pair; (7) **MOOK:** occasionally graduates into Bubbling, but Murmuring and Bubbling appear to be distinct. Calls described as similar to air and water escaping from bottle (Fletcher 1914), water gurgling over stones (Fletcher 1916c), or sound of narrow-necked bottle being dipped in water (Bryant



1916c). Second clutches laid near site of first nest (Bryant & Amos 1949).

Nest, Materials Nest, cup- or saucer-shaped, loosely woven out of dry grass, rushes, lined with fine short lengths of same material (Whittell 1938; Kaufmann & Lavers 1987); nests found SI, NZ, were tightly woven (Hadden in press). Lower part made of rush stalks, with cupped platform of finer leaves (Buddle 1941a). May be attached to reeds (Whittell 1938). Most building occurs in morning and evening (Fletcher 1916c). Usually constructed out of material plucked from surrounding vegetation (Fletcher 1914; Hadden in press). Depression formed by stems and half-exposed roots of grasses, thinly lined with dead grass (Whitlock 1914). Female bends reeds to form canopy over nest (Fletcher 1914). Some nests have up to three stages or ladders leading down to water, constructed out of same material as nest; higher nests do not have ladders (Fletcher 1914, 1916c). Material may be added to nest during incubation (Hadden 1970). **MEASUREMENTS** (cm): in Tas.: outside diameter, 13; inside diameter, 8; depth, 4 (Fletcher 1914). In NZ: diameter, 14 (2.5; 10–20; 14); depth, 10 (3.4; 5–15; 13) (Hadden 1970); bulky structure, 20–23 cm diameter, 5–20 deep (Buddle 1941a).

Eggs Ellipse, rounded or blunted at each end; close-grained, smooth, slightly lustrous; dull creamy-brown with numerous indistinct flecked markings of light chestnut-brown, uniformly distributed over shell, or with few irregular spots and streaks of a darker hue, chiefly on one end where a small cap is sometimes formed. First clutch of season claimed to be greener and paler than later ones, perhaps cryptic among greener reeds of spring growth (Fletcher 1914); also one clutch located in growth of grass, uniform pale-green; clutch in older decaying reeds, darker brown; may be mottled in dappled sunlight in more open situation (Fletcher 1916c). **MEASUREMENTS**: Poor Knights Is: 31.5 (1.7; 29.5–34.5; 16) x 23.5 (0.5; 22.5–24.0) (Buddle 1941a); SI, NZ: 29.9 x 22.9, 31.8 x 23.0, 30.0 x 23.4 (one clutch; Hadden in press); later eggs 4–5% larger than those laid earlier (Kaufmann & Lavers 1987). **WEIGHT**: three eggs, NZ, 9.0, 9.1 and 9.5 g (Kaufmann & Lavers 1987).

Clutch-size Little critically assessed data. Usually 3–4 eggs per clutch (Fletcher 1914, 1916c); some clutches of two eggs during drought, six eggs during favourable conditions (Fletcher 1916b,c). If nesting delayed, may raise only one brood of larger clutch-size rather than two smaller broods (Fletcher 1916c). In NZ: average 2.6: C/2 x 6, C/3 x 8 (Buddle 1941a); in SI, one clutch of three (Hadden in press). Later clutches larger than earlier ones; C/3 in Aug. and Sept., C/5 in Dec. (Kaufmann & Lavers 1987).

Laying At intervals of 24 h (Bryant & Amos 1949). Most eggs laid between 09:00 and 12:00. New clutch laid 7 days after first clutch taken (Fletcher 1914).

Incubation Both sexes incubate. During 116 min observation at one nest, first adult sat for 36 min when change-over observed, second adult sat for 7 min then left when disturbed, first adult returned after 13 min and sat for 20 min (Hadden 1970). Male incubated for c. 40% of time during 35.4 h of observations; male incubated for three stints of 116, 145 and 225 min, with 1–2 breaks of 5–21 min; female incubated for five stints of 130, 138, 154.5, 179 and 189 min each, with 1–4 breaks of 1–26 min (Kaufmann & Lavers 1987). Incubation begins when clutch complete (Fletcher 1914). Egg-shells removed from nest or discarded over edge (Fletcher 1914; Bryant & Amos 1949); adult ate egg-shell 113 min after chick hatched (Hadden 1972). **INCUBATION PERIOD**: at least 22 days (Hadden 1970), 20–21 days (Hadden 1972); 14–16 days (Fletcher 1914) and 16–18 days (Fletcher 1916a), though Fletcher's appear short. Adult incubated

infertile eggs for 32 days (Bryant & Amos 1949). Hatching may be synchronic or asynchronic; larger clutches tend to be asynchronic (Kaufmann & Lavers 1987). All hatch within 24 h (Fletcher 1916a); two clutches of three eggs each hatched between evening and next morning (Buddle 1941a; Hadden 1972); eggs may pip or crack up to 2 days before hatching (Bryant & Amos 1949).

Young Semi-precocial; remain in nest for 24–48 h after hatching (Fletcher 1916c; Hadden 1972); able to clamber out of nest within 4 h of hatching (Hadden 1972). At hatching: down, black with silver tips, which disappear after 24 h; assumes greenish tinge as it dries; bill, black, white or horn at base; egg-tooth, white; orbital ring, blue-grey, not noticeable later; thin white line along edge of lower eyelid (Fletcher 1914; Buddle 1941a; Bryant & Amos 1949); eyes, deep ruby with shade of black (Fletcher 1914), blue-grey (Bryant & Amos 1949); legs and feet, olive-black (Buddle 1941a), blue-grey (Bryant & Amos 1949). Size at hatching (mm): length, 60; bill, 9; tarsus, 14; wing, 11 (Bryant & Amos 1949). **Parental care, Role of sexes** One young fed in nest 158 min after hatching (Hadden 1972). Young able to swim across swift channels when 2 days old (Fletcher 1916c); at approach of danger, young dive over edge of nest, squat in rushes or hide beneath dead leaves below nest; adults perform distraction display; quiver wings in injury-feigning display (Fletcher 1914, 1916a; Buddle 1941a; Bryant & Amos 1949). Young may roost and be brooded on non-functional nests for several days (Bryant & Amos 1949; Kaufmann & Lavers 1987).

Success Nests washed out by flooded creek (Fletcher 1918). For 16 clutches: 61 eggs laid, 33 (54%) hatched; or 2.1 young per clutch (Hadden 1970; Kaufmann & Lavers 1987; Aust. NRS). Claimed that may destroy own eggs when disturbed by people (Bryant & Amos 1949). Adults and young taken by cats (Whitlock 1914); possibly rats *Rattus* (de Ravin 1975); found in stomach of eel (McKenzie 1969).

PLUMAGES Prepared by D.I. Rogers. Aust. *tabuensis*.

Adult First and subsequent basic plumages. Attained in first winter. Age of first breeding unknown. **Head and neck** Forehead, crown and nape, blackish grey (c82) with concealed light-grey (85) bases to feathers; crown can develop faint-brown tinge with wear. Rest of head and neck, dark grey (83), grading to varying usually light-grey (brownish 85) patch on chin, which may extend down midline of throat. In one skin, palest part of throat, white. **Upperparts** Mantle, back and scapulars, dark red-brown (c221A) when fresh, becoming dark rufous-brown (c121A) to brown (c223) with wear. Rump and lower back, dark brown (223). Upper tail-coverts, dark grey-brown (c119). **Underparts** Mostly leaden-grey (87) when fresh, becoming dark grey (83) or dark brownish-grey (brownish 83) when worn. Under tail-coverts, grey-black (82) barred white. **Tail** Blackish brown (119). **Upperwing** Primaries, secondaries, alula and primary coverts, blackish grey (c82) when fresh, becoming dark greyish-brown (c121) when worn; p10 has white outer edge. Tertiaries, dark brown (223). Other coverts, dark red-brown (c221A); fade to rufous-brown (c121A) and dark grey-brown (c121) bases of feathers can become slightly exposed. **Underwing** Remiges, grey (c84). Greater coverts, dark grey (c84) tipped or barred white. Marginal coverts, white, sometimes with brown (119B) shaft-streaks.

Downy young When newly hatched, evenly covered by black (89) down, which has greenish sheen when sunlit. Replacement of down begins first on breast and thighs at 15 days; down remains longest on head and does not fade before it is shed.

Juvenile Moulded in first winter. Differs from adult by: **Head and neck** Forehead, crown, nape and hindneck, dark brown

(c219). Lores, similar but some have a narrow white supercilium not extending behind eye. Ear-coverts and sides of throat, dark grey-brown (greyish 121). Chin and centre of throat, white. **Upperparts** Mantle, back and scapulars, dark reddish-brown (121A), somewhat more brown and less red than in adult. **Underparts** Breast and belly, dark grey-brown, lacking leaden wash of adult; feathers in centre of breast and belly have dirty-white tips that fade and become larger with wear. **Upperwing** Lesser, median and secondary coverts, dark reddish-brown (121A), less reddish and more brown than in adult.

Immature Though first-basic plumage is as that of adult, some birds in first winter can be aged on traces of remnant juvenile plumage. This remains longest on chin, throat and midline of breast and belly, sometimes forming contrasting paler line.

BARE PARTS Adults based on photos (NPIAW 1985; Moon 1988; NZRD); downy young and juveniles based on Kaufmann (1988) and unpubl. photos (G. Kaufmann; D.W. Hadden).

Adult Bill, grey-black (92) to black (89). Orbital ring, pinkish red (c3) to orange-red (c116–94), sometimes tinged pale orange (c106) behind eye. Iris, red (12) to crimson-red (c108A). Tarsus and toes, dark pinkish-orange (c94–116) to salmon (c6). Claws, black (89). **Downy young** When newly hatched: bill, black (89) with bright white egg-tooth (creamy white by fifth day) with pink (c5–c7) nares and pink (c5–c7) saddle between the nostrils; latter marking described as horn-coloured by Buddle (1941b). Iris, black (89). Tarsus and toes, dark brownish-grey (c83) grading to pink behind tarsus and under toes. Bare parts change with age; egg-tooth lost at about 2 weeks; at 3 weeks, pink (pale 5) saddle encroaches on base of lower mandible, being 5 mm wide on lower mandible and 2 mm wide on upper mandible at 4 weeks. Iris passes through dark-olive stage before becoming olive-drab at 4 weeks; then develops increasingly orange tinge. At 4 weeks, tarsus and toes, dark brown (c119A) with pink (c3) on joints and between scales. **Juvenile** At first: bill, black (89) with pink (pale 5) basal third and light-grey (c85) tips to mandibles. By 40–66 days, iris, brownish orange (c132A). At 49 days, tarsus and toes, light grey-brown (c119B–119C) above, grading to light salmon (pale 5) below.

MOULTS Based on records from skins of 47 adults and 19 juveniles and immatures; mostly from se. Aust. (ANWC, AM, HLW, MV, QVM, NTM, SAM, WAM).

Adult post-breeding Pre-basic. Complete; remiges simultaneous (Stresemann & Stresemann 1966; NMNZ data cards). Remiges moulted in late summer or autumn; some birds with fresh wings have been collected as early as late Feb. but some still with worn wings in early May. Tail, simultaneous; can moult before, or at same time as, remiges. Body-moult usually begins on head, then upperparts (mantle first) and flanks; throat and scapulars moult last. Body-moult more protracted than remiges; can begin as early as Sept., usually complete by Mar. or Apr. but in some individuals body-moult extends into late winter. **Post-juvenile** Partial, not including remiges. Head and upperparts begin earlier and moult faster than upperparts; some individuals retain juvenile feathers on midline of chin, throat and breast. Moult recorded Sept.–May; apparently none retains juvenile plumage through first winter.

MEASUREMENTS (1) Aust., adults, skins (ANWC, AM, HLW, MV, QVM, SAM, WAM). (2) Aust., immatures (in post-juvenile body-moult), skins (AM, HLW, MV, QVM, SAM, WAM). (3) NZ, adults, freshly dead (NMNZ). (4) NZ, ages combined, skins (Kaufmann & Lavers 1987).

	MALES	FEMALES	
WING	(1) 86.4 (2.56; 82–92; 27)	84.5 (3.05; 78–91; 17)	*
	(2) 85.1 (3.44; 79–89; 7)	82.9 (1.37; 80–85; 10)	ns
	(3) 85.3 (3.30; 83–90; 4)	80, 82	
STH P	(1) 62.3 (2.28; 58–66; 27)	61.5 (2.50; 56–65; 17)	ns
	(2) 61.4 (2.32; 57–65; 7)	59.8 (1.08; 57–61; 10)	ns
TAIL	(1) 50.7 (2.76; 45–57; 23)	49.2 (3.51; 44–54; 13)	ns
	(2) 49.0 (3.00; 44–52; 4)	47.1 (3.30; 40–52; 10)	ns
	(3) 30.9 (1.54; 29.3–33.1; 5)	29, 33.5	
BILL	(1) 19.2 (1.18; 17.3–22.2; 27)	18.1 (1.13; 16.2–20.2; 14)	**
	(2) 18.4 (0.64; 17.6–19.3; 7)	17.2 (0.77; 16.2–18.3; 10)	**
	(3) 19.5 (1.08; 18.2–20.8; 4)	17.4	
TARSUS	(4) 19.6 (18.2–20.8; 8)	16.3, 16.4, 17.1	
	(1) 29.6 (1.64; 26.1–32.6; 27)	28.2 (1.56; 25.2–32.6; 17)	**
	(2) 29.0 (1.24; 26.8–31.0; 7)	28.5 (0.75; 27.4–29.8; 10)	ns
	(3) 30.9 (1.54; 29.3–33.1; 5)	29, 33.5	
TOE C	(4) 28.2 (31.3–33.1; 8)	29.0, 29.3, 33.5	
	(1) 35.2 (1.77; 32.7–38.2; 15)	35.4 (1.39; 33.3–37.0; 8)	ns
	(2) 35.6 (1.52; 33.5–37.8; 5)	34.6 (1.37; 33.4–36.8; 4)	ns
	(3) 37.6 (3.60; 34–43.4; 5)	34, 34	

(5) NZ, ages combined, skins (Onley 1982b). (6) NZ, adults, live (R.B. Lavers).

	UNSEXED
WING	(5) 83.4 (77–91; 16)
BILL	(6) 18.4 (1.2; 16.7–20.4; 12)
TARSUS	(6) 29.7 (2.2; 23.6–32.6; 12)
TOE	(6) 35.1 (1.8; 32.1–38.3; 12)

WEIGHTS (1) Aust., adults (museum labels: AM, ANWC, MV, QVM, WAM). (2) NZ, adults (Onley 1982b; NMNZ), including males of 34.5 and 47 g, females of 26.8 and 37.6 g with some fat.

	MALES	FEMALES	
(1)	47.7 (5.68; 39–56; 7)	37.4 (13.8; 21–58; 4)	ns
(2)	41.0 (7.70; 34.1–48.2; 4)	37.7 (7.68; 26.8–43.2; 4)	ns

(3) Aust., adults and juveniles combined (AM, ANWC, MV, QVM, WAM labels; ABBBS; K.G. Rogers, A. Rogers, D.I. Rogers). (4) NZ, adults and juveniles combined (Onley 1982b; NMNZ; R.B. Lavers).

	SEXES COMBINED
(3)	44.4 (10.8; 21–58; 17)
(4)	44.3 (6.52; 28–60.5; 23)

Two captive chicks reached asymptote weight at 1 month, before juvenile plumage developed (Kaufmann 1988). Too few data to examine temporal variation in weight, though wide range of weights suggests this may occur.

STRUCTURE Wing, short and rounded. Ten primaries; p8 longest, p10 10–18 shorter, p9 1–5, p7 0–2, p6 1–3, p5 4–6, p4 7–10, p3 10–14, p2 14–18, p1 17–22. No emarginations. Eleven secondaries, including four tertials. Tail, fairly long for a crane, attenuated or strongly rounded; 10–12 feathers; t1 to outer rectrix 12–18 mm. Bill, slender, slightly deeper than broad at base;

mostly straight but toms and culmen gently decurved at tip; nares, slit-like. Body, laterally compressed. Tarsus, slightly laterally compressed, scutellate. Toes fairly long and slender; inner c. 83% length of middle, outer c. 80%, hind c. 44%.

RECOGNITION Downy young differ from most other crakes in colour of bill: black with pinkish-white saddle at base of bill that spreads onto lower mandible with age. Newly hatched White-browed Crakes *Porzana cinerea* are undescribed and may be similar to Spotless Crakes; their large downy chicks (readily distinguished by incoming plumage) have pink-brown saddle on bill between nares, which may be present in smaller chicks.

GEOGRAPHICAL VARIATION Slight, despite widespread distribution with many island populations. Aust. and NZ birds previously considered separate subspecies *plumbea* differing from nominate *tabuensis* (New Guinea, sw. Pacific islands, Luzon, Kermadec Is and Norfolk I.) in longer wing and brighter, redder upperparts (Ripley 1977). However, colour of upperparts too varying and differences in wing-length too slight to support separation of *plumbea* and *tabuensis*; also slight clinal increase in wing-length with latitude (Onley 1982b). Two subspecies have been recognized in highlands of New Guinea (Ripley 1977), though status needs confirmation (see Amadon 1942; Onley 1982b; White & Bruce 1986).

REFERENCES

- Amadon, D. 1942. *Am. Mus. Novit.* 1175.
 Badman, F.J. 1979. *S. Aust. Orn.* 28: 29–81.
 Bassett Hull, A.F. 1909. *Linn. Soc. NSW Proc.* 34: 636–93.
 Binns, G. 1953. *Emu* 53: 211–24.
 Bravery, J.A. 1970. *Emu* 70: 49–63.
 Bryant, C.E., & B. Amos. 1949. *Emu* 48: 249–75.
 Buddle, G.A. 1941a. *Emu* 41: 56–68.
 — 1941b. *Emu* 41: 130–4.
 — 1946. *Emu* 45: 315–18.
 Bull, P.C., & P.D. Gaze. 1975. *Notornis* 22: 173–4.
 Buller, W.L. 1888. *Buller's Birds of New Zealand*. Whitcombe & Tombs, Christchurch.
 Condon, H.T. 1968. *Handlist of the Birds of South Australia*. S. Aust. Orn. Assoc., Adelaide.
 Cooper, R.P. 1970. *Aust. Bird Watcher* 3: 239–45.
 Cox, J.B., & L.P. Pedler. 1977. *S. Aust. Orn.* 27: 231–50.
 de Ravin, J.A. 1975. *Aust. Bird Watcher* 6: 4–10.
 Dickison, D.J. 1935. *Lowan* 1: 8.
 Draffan, R.D.W., et al. 1983. *Emu* 83: 207–34.
 Edgar, A.T., et al. 1965. *Notornis* 12: 3–43.
 Falla, R.A., et al. 1981. *The New Guide to the Birds of New Zealand*. Collins, Auckland.
 Fletcher, J.A. 1913. *Emu* 13: 45–7.
 — 1914. *Emu* 13: 197–202.
 — 1916a. *Emu* 15: 188.
 — 1916b. *Emu* 15: 193–4.
 — 1916c. *Emu* 16: 46–8.
 — 1918. *Emu* 18: 96–101.
 Ford, J. 1962. *Emu* 62: 61–2.
 — 1965. *Emu* 64: 129–44.
 Fraser, E. 1972. *Notornis* 19: 87–8.
 Garnett, S., & R. Bredl. 1985. *Sunbird* 15: 6–23.
 Garstone, R. 1978. *West. Aust. Nat.* 14: 62–4.
 Goodsell, J.T. 1990. *Aust. Wildl. Res.* 17: 219–29.
 Hadden, D. 1970. *Notornis* 17: 200–13.
 — 1972. *Notornis* 19: 323–9.
 — In press. *Notornis* 40.
 Halse, S.A., & R.P. Jaensch 1989. *Emu* 89: 232–49.
 Heathcote, W. 1945. *BOC Newsl.* 1945.
 Hobbs, J.N. 1967. *Emu* 66: 299–300.
 Howard, M. 1986. *Aust. Bird Watcher* 11: 247–57.
 Howard, P.J. 1962. *Notornis* 10: 86–8.
 Ingram, G.J., et al. 1986. *Sunbird* 16: 12–24.
 Jaensch, R. 1984. *West. Aust. Bird Notes* 32: 6–7.
 — 1989. *RAOU Rep.* 61.
 —, et al. 1988. *RAOU Rep.* 30.
 Johnson, I.W. 1976. *Notornis* 23: 357.
 Kaufmann, G. 1987. *Notornis* 34: 207–16.
 — 1988. *Notornis* 35: 324–7.
 —, & R.B. Lavers. 1987. *Notornis* 34: 193–205.
 Kendrick, J. 1966. *Notornis* 13: 11.
 — 1972. *Notornis* 19: 87–8.
 Kitchener, D.J., et al. 1975. *Rec. West. Aust. Mus. Suppl.* 1.
 Lavers, R.B. 1971. *Wildl. – A Rev.* 3: 26–7.
 Littler, F.M. 1910. *A Handbook of the Birds of Tasmania and its Dependencies*. Author, Launceston.
 McKenzie, H.R. 1969. *Notornis* 16: 62.
 Merton, D.V. 1970. *Notornis* 17: 147–99.
 Moon, G. 1988. *New Zealand Birds in Focus*. Weldon, New Zealand.
 Moore, J.L. 1981. *Notornis* 28: 50–6.
 — 1985. *Notornis* 32: 311–18.
 Moriarty, T.K. 1972. *Emu* 72: 1–7.
 Morris, A.K. 1975. *Aust. Birds* 9: 37–76.
 —, et al. 1981. *Handlist of Birds in New South Wales*. NSW Field Orn. Club, Sydney.
 Morton, H.J. 1953. *S. Aust. Orn.* 21: 5.
 NPIAW. 1976. *Waterbirds in Australia*. Angus & Robertson, Sydney.
 Ogle, C.C., & J. Cheyne. 1981. *Wildlife Serv. Fauna Surv. Unit Rep.* 28.
 Onley, D.J. 1982a. *Notornis* 29: 9–21.
 — 1982b. *Notornis* 29: 75–9.
 Patterson, R.M. 1989. *Tas. Bird Rep.* 18: 29–30.
 Pedler, L.P. 1978. *S. Aust. Orn.* 27: 287.
 Penhallurick, J. 1981. *Canberra Bird Notes* 6: 115–16.
 Pierce, R.J. 1980. *Notornis* 27: 21–44.
 Ripley, S.D. 1977. *Rails of the World*. Fehely, Toronto.
 Sandland, P.T. 1937. *Emu* 37: 144–9.
 Schodde, R., et al. 1983. *ANPWS Spec. Publ.* 8.
 Serventy, D.L., & H.M. Whittell. 1976. *Birds of Western Australia*. Univ. West. Aust. Press, Perth.
 Skinner, J.F. 1979. *Notornis* 26: 22.
 Soper, M.F. 1969. *Notornis* 16: 219–24.
 Stokes, T. 1983. *Sunbird* 13: 53–8.
 Storr, G.M. 1980. *Spec. Publ. West. Aust. Mus.* 11.
 — 1984. *Rec. West. Aust. Mus. Suppl.* 19.
 — 1985. *Rec. West. Aust. Mus. Suppl.* 22.
 — 1987. *Rec. West. Aust. Mus. Suppl.* 27.
 —, et al. 1986. *Rec. West. Aust. Mus. Suppl.* 24.
 Stresemann, E., & V. Stresemann. 1966. *J. Orn., Lpz.* 107 (Sonderheft): 1–439.
 Tarr, H.E. 1949. *Emu* 48: 276–82.
 Thomas, D. 1979. *Tasmanian Bird Atlas*. Fauna Tas. Comm., Univ. Tas., Hobart.
 Thompson, H.A.F., & D.K. Goodfellow. In prep. *Annotated List of the Birds of the Top End*.
 Vestjens, W.J. 1972. *Canberra Bird Notes* 2: 17–18.
 — 1977. *Tech. Memo. Div. Wildl. Res. CSIRO, Aust.* 12.
 Watson, I.M. 1955. *Emu* 55: 224–48.
 White, S.A. 1913. *Emu* 12: 179–85.
 White, C.M.N., & M.D. Bruce. 1986. *BOU Checklist* 7.
 Whitlock, F.L. 1914. *Emu* 13: 202–5.
 — 1924. *Emu* 23: 248–81.
 Whittell, H.M. 1938. *Emu* 38: 54–9.

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Volume 2, Plate 45

Spotless Crake *Porzana tabuensis* (page 559) Nominate *tabuensis*
 1 Adult; 2 Small downy young; 3 Large downy young; 4 Juvenile; 5 Adult

Ruddy Crake *Porzana fusca* (page 557)
 6, 7 Adult

White-browed Crake *Porzana cinereus* (page 567)
 8 Adult; 9 Large downy young; 10 Juvenile; 11 Adult