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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.

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## 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 *Porphyryula* 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.

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*Fulica atra* Eurasian Coot

COLOUR PLATE FACING PAGE 617

*Fulica atra* Linnaeus, 1758, *Syst. Nat.*, ed. 10, 1: 152 — Europe; restricted to Sweden by Linnaeus, *Fn. svec.*

*Fulica* is Latin for 'coot' as used by Virgil and Pliny; derived from *fuligo* (soot); *ater, atra* is also Latin for 'dull black' and so tautological; not distinctive for a species of coot.

OTHER ENGLISH NAMES Australian Coot (NZ), Toorie.

POLYTYPIC Nominate *atra* ranges widely in Europe and Asia, south to n. Africa, s. China, India, Sri Lanka; *australis* Gould, 1845, Aust. and NZ; *novaeguineae* Rand, 1940, central New Guinea; *lugubris* S. Müller, 1847, Java to nw. New Guinea.

**FIELD IDENTIFICATION** Length: 35–39 cm; wingspan: 56–64 cm; weight: male 570 g, female: 520 g. Medium-sized waterbird, close in size to Dusky Moorhen *Gallinula tenebrosa* but more robust. Wholly slate-black, with white bill and frontal shield. Sexes similar; male slightly larger. No seasonal variation. Juvenile and immature separable.

**Description Adult** Head and neck, glossy black; rest of plumage slightly paler slate-black above and slate-grey below; when flying, remiges can appear paler grey in contrast to darker blackish wing-coverts, giving two-tone effect on both wing surfaces. Bill, white, usually with blue-grey tinge; large white frontal shield. Iris, bright red. Legs and feet, medium to dark grey; feet have flat lobes like those of grebes and quite unlike other rails. **Juvenile** Duller above and much paler below than adult, with smaller shield. Upperparts, greyish-brown. Chin and throat, white; rest of underparts, light grey, grading to whitish on centre of lower breast and belly. Bill and shield, pinkish white with dusky subterminal band. Iris, brown. **Immature** Very similar to adult but upperparts slightly paler and greyer, and often a few white feathers or mottling on chin and throat.

**Similar species** None.

Gregarious waterbird, characteristic of large open bodies of deep fresh or brackish water. Often in flocks of several hundreds, forming dense rafts in shallows or well out from fringing vegetation, and in association with ducks. Often come ashore to graze on short pasture, even in large groups. Flight usually low, fast and direct, with rapid shallow wing-beats; appear much bulkier, more duck-like than Dusky Moorhen, with large feet trailing behind tail; take off with long pattering run across water, splash down breast first with feet lowered. Swim high, with neck hunched, back rounded, small head jerked back and forward but much less so than in Dusky Moorhen. Dive well but only for short time, often jump before diving. Gait on land a twisting walk and awkward waddling run, assisted by flapping wings. Commonest call a single loud *crark*.

**HABITAT** Terrestrial, estuarine and, rarely, marine wetlands. Prefer shallow, permanent or ephemeral wetlands with high diversity of submerged or emergent aquatic vegetation, often with open and deeper water (>2 m) for diving (Anon. 1973; Briggs 1979; Martin *et al.* 1979; Corrick & Norman 1980; Broome & Jarman 1982; Czechura 1983; Jaensch 1983); fresh to saline (Goodsell 1990), sometimes hypersaline, e.g. Dumbleyung L., sw. WA (Jaensch *et al.* 1988); mesotrophic or eutrophic. Rivers, creeks, pools, billabongs, swamps, lakes, lagoons, floodwaters, salt pans, claypans, freshwater meadows and grass and reed swamps; occasionally in estuaries, though rarely on creeks lined with mangroves; often on man-made impoundments. Sometimes on calm sea (Claridge 1981); rarely, on wetlands with floating ice or almost entirely iced over (Green 1960; Tas. Bird Rep. 8).

Roost, loaf or shelter among dense, emergent vegetation; in large, open areas of water; on grassy margins of wetlands; on mats of floating vegetation (Jackson & Lyall 1964; Anon. 1973; Ross 1978; Jaensch *et al.* 1988). Once recorded standing on seaweed covered ledge with gentle waves washing over feet (Claridge 1981).

Forage in open, deep or shallow water in wetlands, especially where submerged aquatic vegetation occurs; on floating mats of aquatic vegetation; in grassy areas next to wetlands (Small 1960; Anon. 1973; Ross 1978; Czechura 1983; Jaensch *et al.* 1988).

Breed in permanent or ephemeral wetlands, including floodwaters, among or at edge of floating or dense emergent aquatic vegetation or other emergent vegetation such as weeds, shrubs or trees; sometimes on islands within wetlands (Condon & Rix 1936; Fletcher 1960; Hobbs 1961; Jackson & Lyall 1964; MacDonald 1968; Masters & Milhinch 1974; Lawler 1989; Aust. Atlas).

Displaced by drainage of wetlands (van Tets 1969; Campbell). Occur on reservoirs, ornamental lakes in towns, dams, round bore-drains and sewage ponds. Quickly colonize suitable artificial habitat, such as dams, e.g. colonized L. Aniwhenua on Rangitaiki R. in NZ within a year (J.G. Innes). In arid areas, artificial wetlands act as refuges (Brooker *et al.* 1979).

**DISTRIBUTION AND POPULATION** From Atlantic, through Europe, N to 61°N and S to Mediterranean and n. Africa, and E through Siberia to Sea of Okhotsk, Japan and Korean Pen.; also from India, E to Indo-China and se. China; Moluccas and Sulawesi, New Guinea; Aust. and NZ.

**Aust. Mainland** Widespread; mainly E of line between Streaky Bay and L. Argyle; and W of line from Esperance to Port Hedland. In e. Aust., most widespread in e. Qld, throughout NSW and Vic., and e. and s. SA; more scattered C. York Pen.,

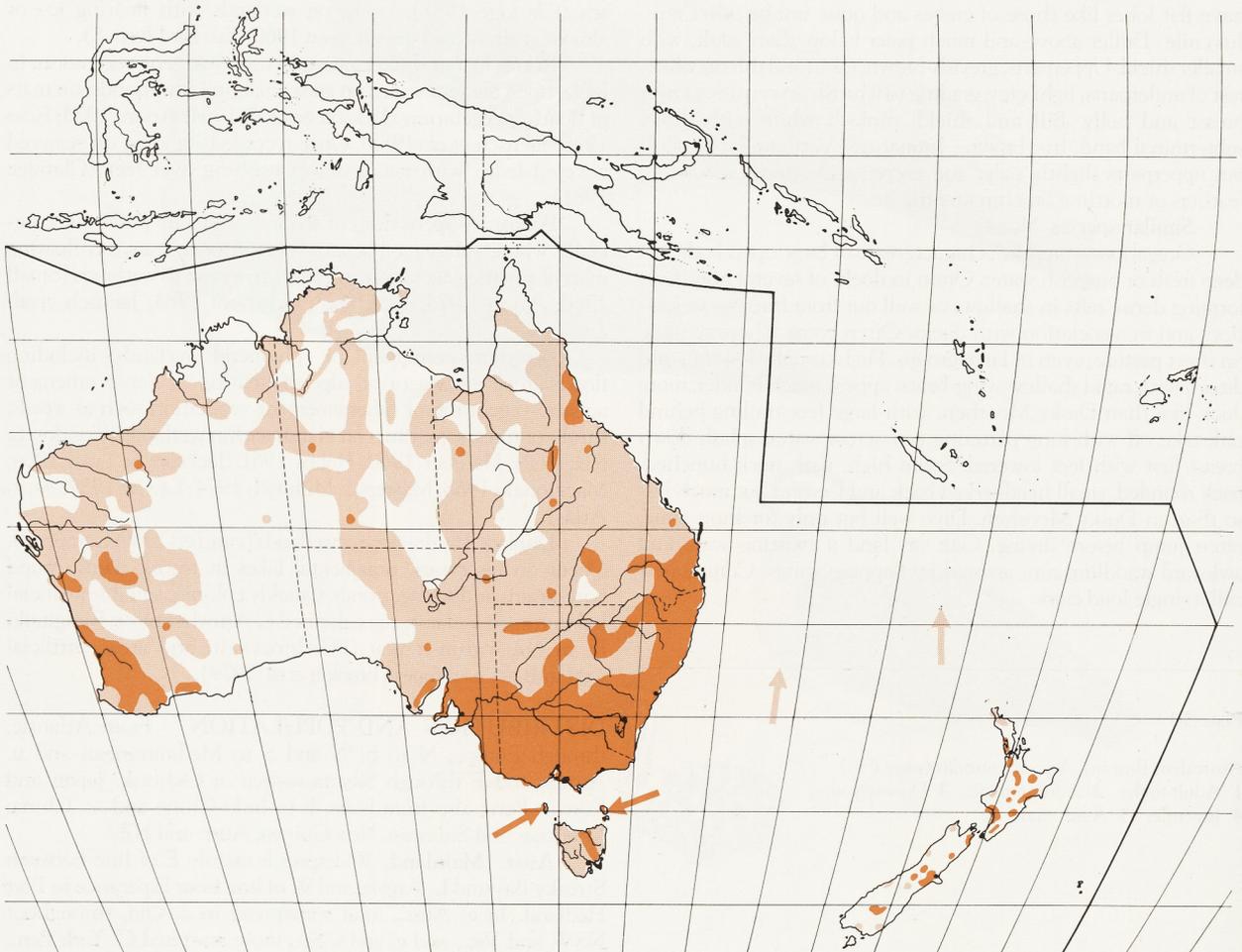
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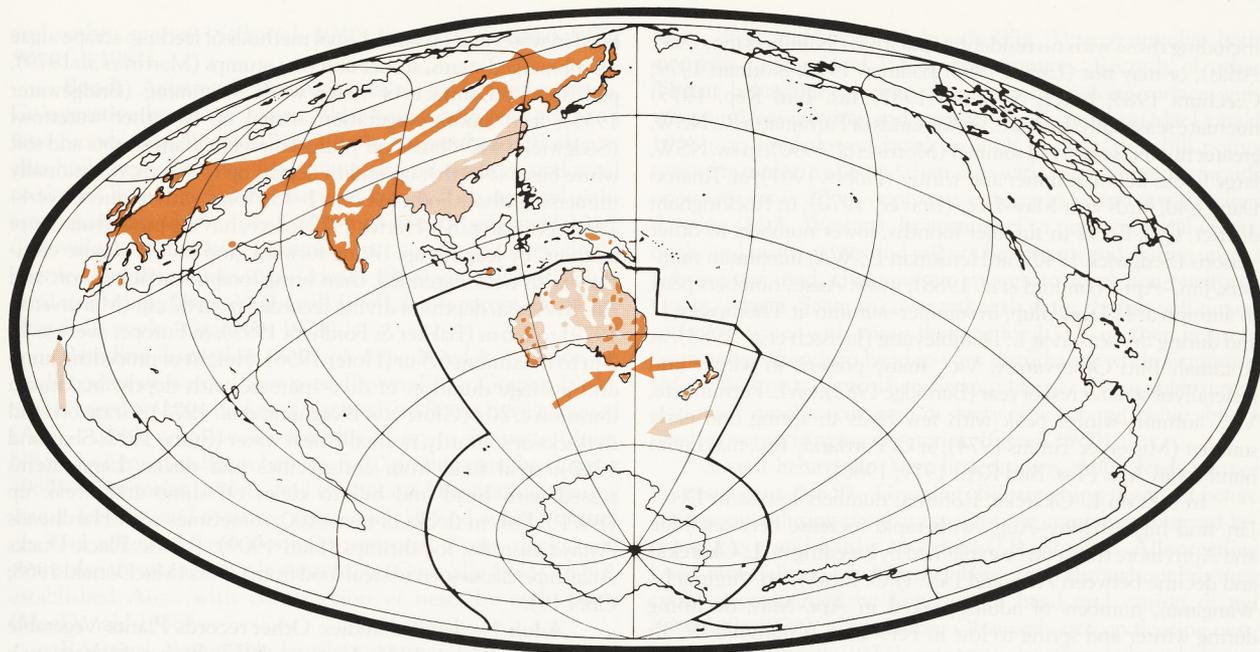
Australian Bustard *Ardeotis australis* (page 636)  
1 Adult male; 2 Adult female; 3 Downy young  
4 Juvenile; 5 Adult male

central and w. Qld, n. SA and throughout NT. In WA, mainly in SW, from Esperance to Jurien Bay; scattered records in Goldfields, Pilbara and Kimberley Divisions. Several isolated records in w. deserts (Aust. Atlas). **Tas.** Mainly in E but also n. areas. Only w. record, single, Bathurst Harbour (Green & Mollison 1961; Thomas 1979; White 1985; Patterson & Gore 1992; Aust. Atlas). Common, breeding King I. (Green & McGarvie 1971; McGarvie & Templeton 1974); breed Flinders I. (Green 1969; Tas. Bird Rep. 2). After influx to Tas. in 1957, expanded into many areas of Tas. where previously absent (Sharland 1960). On mainland Tas., first bred at Cleveland, Sept. 1909 (Fletcher 1910); no other definite records till nest and eggs recorded at L. Dulverton, Dec. 1971 (Napier 1973). Several breeding records in N and E, 1977–81 (Aust. Atlas).

**NZ** Widespread but scattered; information supplied by J.G. Innes, including CSN *passim*, NZ Atlas, and references cited. **NI** Recorded all districts; not recorded breeding Northland and n. Taranaki. **NORTHLAND:** Te Werahi Swamp, Te Pahi L., Ngataki, L. Owhareiti, L. Waipirohita, L. Waingata, L. Kahuparere; regional population, maximum 20 birds (D. Crockett). **AUCKLAND:** Breed L. Pupuke, Western Springs; recorded L. Kereta, and occasionally at Mangere Sewage Ponds and other lakes; c. 60 birds (A. Goodwin; M. Taylor). **WAIKATO:** breed Hamilton L.; recorded Ls Hakanoa, Whangape, Whakamaru; c. 10 birds (M. Barnes; S. and J. Rowe). **VOLCANIC PLATEAU:** Breed Rotorua Ls (Rotoiti, Tarawera, Okareka, Rotoma, Rotoehu), L. Taupo, and L. Aniwhenua; recorded Rotokakahi, L. Rotorua, l. Rerewhakaaitu, Rotokuru Ls,

L. Rotopounamu and Waimarino R.; c. 420 birds, including 371 on six Rotorua Ls, Jan. 1991 (R. Jackson; Innes *et al.* 1982). **BAY OF PLENTY:** Matata Lagoon, breeding; c. 10 (P.C.M. Latham). **GISBORNE:** breed L. Whakamarino, Tuai L., Tiniroto; recorded near Wairoa and Rere; not recorded N of Gisborne; c. 60 birds (J. Henley). **HAWKE'S BAY:** L. Tutira, L. Te Pohue, Lindsay Ponds, Runanga L., Valley Road Pond, Horseshoe L., Mangahei, Murphy's Pond, L. Purimu; c. 300 birds, including 200 L. Tutira (Mackenzie 1962; C. McRae; OSNZ). **WELLINGTON:** vagrant. **WAIARAPA:** breed Te Parae, Masterton, Tupurapura; recorded Masterton Sewage Ponds, Waitui, L. Wairarapa; c. 20 birds (T. Dennison). **MANAWATU:** breed recorded Palmerston North; recorded L. Vipon, L. Horowhenua, near Waitare; c. 30 birds (R. Guest). **WANGANUI:** breed Ls Virginia and Westmere; recorded Kaitoke (MacDonald 1968; Granville 1973). **TARANAKI:** breed Hawera; recorded L. Marahau, near Waitotara, Nowell's L., L. Mangamahoe, Barrett's Lagoon, Waitara; c. 15 birds (M. Davis; D. Medway). **SI** Disjunct populations E of Southern Alps; vagrant West Coast and Nelson. **NELSON:** singles, Druggan's Dam, near Paturau R. **MARLBOROUGH:** breed Taylor Dam and formerly L. Elterwater; recorded Ls Rotoiti and Jasper; c. 80 birds (B. North). **CANTERBURY:** breeding recorded L. Tekapo, Cheviot, L. Heron, Woodend Lagoon, L. Emma; scattered records elsewhere; 500–800 birds (C. Challies; R. Holdaway; C. O'Donnell). **OTAGO:** breeding recorded L. Hayes, Alexandra, L. Wakatipu, Otematata; recorded L. Waipori, Boundary L., L. Waiholo, L. Benmore, Frankton; c. 130 birds (P. Schweigman). **SOUTHLAND:** formerly bred Wairaki R.; recorded





Winton, Invercargill, Thornbury, L. Te Anau (R. Sutton). WEST COAST: single, 's. Westland', 1945; Haast, 1964; L. Poerua, 1964; L. Paringa, 1977 (S. Lauder).

**Norfolk I.** Singles: winter 1971 (Hermes *et al.* 1986); July 1978 (Moore 1981).

**Lord Howe I.** Two, 9 Apr. 1975; four, 24 May 1975 (NSW Bird Rep. 1975).

**Macquarie I.** More than seven, 4 May–12 Oct. 1957 (Keith & Hines 1958); June–Oct. 1975 (Green 1989).

**Breeding Aust.** Mainly in SE, from se. Qld to s. Eyre Pen., and SW, mainly from Esperance to Jurien Bay. Scattered records throughout range, mostly in ne. and inland Qld, n. and e. Tas., ne. SA, Goldfields, Pilbara and Kimberley Division, WA, and s. NT (Aust. NRS; Aust. Atlas). **NZ** See above.

**Populations Aust.** Annual indices of abundance from aerial surveys (transect counts) of wetlands in c. 12% of land area of e. Aust. 1983–89 were: 55,436; 263,266; 58,589; 46,034; 29,003; 2755; 4866; during these surveys important areas were: (1) Redbank Weir system on Murrumbidgee R. (1983, 41–60% of total numbers counted); (2) L. Galilee (1984, 61–80% of total numbers counted); (3) wetlands on floodplain of Murray R. at Copi Plains, E of Loxton (1986, 21–40% of total numbers counted); (4) wetlands on floodplain at confluence of Lachlan and Murrumbidgee Rs (1986, 21–40% of total numbers counted); and (5) L. Moondarra (1987, 21–40% of total numbers counted) (Braithwaite *et al.* 1985a,b, 1986, 1987; Kingsford *et al.* 1988, 1989, 1990). On L. Cowal, NSW, 6–10 nesting pairs/ha, Nov. 1989 (Lawler 1989). On 52 km<sup>2</sup> section of L. George, 1961–63, 100–5000 individuals recorded (Lamm 1965). Counts in Vic. in summer surveys, 1987–92 (Martindale 1988; Hewish 1988; Peter 1989, 1990, 1991, 1992) summarized in Table 1. Counts in sw. WA, 1986–88, were: 15,297 on 148 wetlands; 12,710 on 157 wetlands; 23,967 on 179 wetlands respectively (Jaensch & Vervest 1988a,b). In Kimberley Division, 1986–88, maximum counts 51,756 on L. Argyle (c. 740 km<sup>2</sup>) and 74,258 on L. Gregory (c. 120 km<sup>2</sup>) (Jaensch & Vervest 1990). In sw. WA, 1981–85, on 90 of 197 nature reserves; greatest numbers: 10,500 on Dumbleyung L. NR (4081 ha); 5200 on Thomson's L. NR (509 ha); 4436 on Joondalup L. NR (469 ha); 4200 on Forrestdale L. NR (243 ha); and 3600 on Wannamal L. NR (81 ha) (Jaensch *et al.* 1988). In

Table 1

DATE	NO. BIRDS	WETLANDS WITH BIRDS	NO. WETLANDS COUNTED
1987	84,892	162	332
1988	76,854	197	472
1989	68,213	253	626
1990	93,963	296	668
1991	131,165	388	786
1992	109,634	303	659

Swan–Canning R. estuary, populations estimated at 100–3999 (Jaensch 1987). On 0.8 ha swamp on Canning R., 120 recorded in weekly counts (Hnatiuk 1987). In Aust., populations stable but characterized by large changes in abundance. Numbers can change suddenly (e.g. Sharland 1960); sudden large-scale fluctuations have been recorded as birds move to flooded regions, breed and then disperse *en masse*; at Hunter R. wetlands, numbers increased sharply, Apr. 1972 after long absence, then suddenly dropped after peaking in Nov. 1972 (Gosper 1981). **NZ** Total population estimated 1655–1955 birds; regional populations given above. Increasing in range and abundance in NZ. First recorded, Lovells Flat, c. 1875 (Oliver); eight records in SI between 1875 and 1954 (Falla 1953; NZCL); first NI record at L. Tutira, Sept. 1954 (Braithwaite 1956). After invasion in 1957, records increased (Falla 1958). First breeding recorded Arrowtown, Otago, SI, Oct. 1958 (Small & Soper 1959); breeding first recorded on NI at L. Okareka, spring 1962 (Jackson & Lyall 1964) and Virginia L., 1964 (MacDonald 1966). Said to have been taken to NZ in 1869, but not known if released (Long 1981). Like Aust., populations fluctuate; e.g. at Hamilton L., NZ, numbers increased from arrival in 1976 to 1987, then declined sharply and steadily to 1992 (M. Barnes; S. Rowe).

Few shot (Norman 1979); in sample of 603 birds taken at Serendip, Vic., nine had shotgun pellets embedded in tissue (Norman 1976).

**MOVEMENTS** Dispersive. No apparent large-scale seasonal pattern of movements (Anon. 1973; Broome & Jarman 1982; Aust. Atlas; Vic. Atlas). In NZ, individuals appear in all districts,

including those with no resident populations. Numbers may (Vic. Atlas), or may not (Lamm 1965; Badman 1979; Norman 1979; Czechura 1983; Leach & Hines 1987; Tas. Bird Rep. 1975) fluctuate seasonally. In Aust.: on wetlands of Parramatta R., NSW, greater numbers observed summer (Morris *et al.* 1990); in sw. NSW, large flocks in late summer and winter (Hobbs 1961); at Tinaroo Dam, Qld, birds visit May–Dec. (Bravery 1970); in Rockingham district, Qld, flocks in summer months, lower numbers in other seasons (Sedgwick 1940); at Herdsman L., WA, maximum numbers, Jan.–Apr. (Bamford *et al.* 1988); in sw. Aust., numbers peak in autumn at L. Joondalup, in summer–autumn at Thompsons L. and during dry season at L. Dumbleyung (Jaensch *et al.* 1988); at Rotamah Bird Observatory, Vic., many present in winter and generally absent for rest of year (Burbidge 1982); on L. Purrumbete, Vic., autumn–winter peak with few birds in spring and early summer (Missen & Timms 1974); at C. Portland, Tas., maximum numbers in Apr. (Tas. Bird Reps 1979, 1980).

In NZ: on L. Okareka, Rotorua, numbers lowest in Dec.–Jan. and highest May–Aug., with rapid increase between Mar. and Apr. (more than can be explained by breeding on L. Okareka) and decline between Aug. and Dec. (J.G. Innes); on Virginia L., Wanganui, numbers of adults peaked in Apr.–May, declining during winter and spring to low in Feb.–Mar. (Granville 1973); on Hamilton L, NZ, no seasonal changes apparent (M. Barnes; S. Rowe).

In Aust., numbers can change suddenly (e.g. Sharland 1960), possibly in response to weather conditions; influxes include: Laverton, Vic., Mar.–Aug. 1951 (Watson 1955); Derwent R., Tas., e.g. in spring 1898 and June 1900, Apr. 1984 (Tas. Bird Rep. 1984; North); near Broome Hill, WA, winter 1898 and 1900 (North); L. Boonderoo on Nullarbor Plain, 4 Feb. 1978 (Brooker *et al.* 1979); Cooper's Ck, L. Eyre drainage, Oct.–Nov. 1977–78 (Badman 1979). Local increases may occur when suitable habitat becomes available (Vic. Atlas). Also move from unsuitable habitat, such as: draining wetlands (van Tets 1969); wetlands recently having extended periods of high water-levels (Lamm 1965); possibly turbid wetlands with little aquatic vegetation (Martin *et al.* 1979). Claimed to move from areas affected by drought (Sedgwick 1940; Storr 1984; Hnatiuk 1987; Jaensch *et al.* 1988) though at Serendip, Vic., no obvious relation between numbers, water-level or rainfall (Norman 1979). Greater variation in numbers on less favoured wetlands (Broome & Jarman 1982).

Cross Bass Str., probably often; also Tasman Sea and other oceans. Recorded from islands of Bass Str. (Tas. Bird Rep. 1973); in Apr. 1956, almost all Tas. birds (c. 1000) left Hobart district overnight, not later seen on e. coast of Tas., so probably moved to mainland (Sharland 1960; Cooper 1981; Aust. Atlas). In 1957, substantial influx into Tas. (Sharland 1958), which coincided with influx in NZ (Falla 1958) and first record for Macquarie I. (Keith & Hines 1958). Large increase in numbers round Hobart in 1975 (Tas. Bird Rep. 5) coincided with first records on Lord Howe I. (NSW Bird Rep. 1975) and more sightings on Macquarie I. (Green 1989).

**Banding** Of 3177 birds banded in Vic., 1953–77, 65 recoveries: 45 at original site; average distance travelled by rest was  $295 \pm 230$  km with four moving more than 500 km; distant recoveries usually on or near coastal wetlands, though one moved from Serendip to Broken Hill, NSW. Of 413 banded at Yalkuri, SA, and four banded in Bombala, NSW, four recoveries, one 200 km from banding site (Norman 1979).

**FOOD** Evidence in A'asia suggests almost entirely herbivorous (aquatic vegetation, seeds, grass), but aquatic insects, molluscs, crustaceans and occasionally eggs recorded. **Behaviour** Diurnal.

Feed in water and on land. Usual methods of feeding: scrape algae off submerged stems, stones and tree-stumps (Martin *et al.* 1979); pick food off surface of water while swimming (Bridgewater 1935); feed among vegetation stirred up by other waterfowl (Sedgwick 1940); break off young emergent plant shoots and soft white bases (North); up-end in depths up to 40 cm, occasionally immersing whole body, in bouts 1–13 s long, with frequency of 4–19/min (mean c. 8) (Hurter 1972); dive, having pressed air out of feathers, by leaping up, tilting forward, and diving almost vertically with neck extended, then bring food to surface to sort and eat. In A'asia, depths of diving recorded from 80 cm (Martin *et al.* 1979) to 2.6 m (Bakker & Fordham 1993); in Europe, average 1–2 m to maximum 6.5 m (Hofer 1958). Height of preceding jump and average duration of dive increase with depth; maximum duration c. 20 s (Glutz von Blotzheim *et al.* 1973). Graze on land in flocks or solitarily, normally near water (Stone 1912; Sharland 1960); steal food from conspecifics and ducks. Large items tossed with head and bill to clean off slime and break up (BWP). Fish in flocks of up to 100, sometimes with Hardheads *Aythya australis*, for shrimps (Hall 1909). Pacific Black Ducks *Anas superciliosa* seen to steal food from Coots (MacDonald 1968; CSN 19).

**Adult** No detailed studies. **Other records** **Plants** Vegetable matter (McKeown 1944; Vestjens 1977; Barker & Vestjens); aquatic plants (MacDonald 1968; Oliver; Cleland; Lea & Gray); seeds (North); **Algae**: Chlorophyceae (Martin *et al.* 1979); *Nitella* lvs (Cleland); **Poaceae**: lvs (Stone 1912; Sharland 1960; Oliver); grass from mown lawns (Granville 1973); *Pennisetum clandestinum* lvs (B. Lepschi); *Paspalum paspaloides* (Bridgewater 1935); **Potamogetonaceae**: *Potamogeton* lvs; **Ruppiaceae**: *Ruppia* lvs; **Hydrocharitaceae**: *Vallisneria gigantea* (Aust. RD); *Elodea* lvs (MacDonald 1968); **Nymphaeaceae**: *Nymphaea alba* lvs (Granville 1973); **Ranunculaceae**: *Ranunculus trichophyllus* (Small 1960); **Salicaceae**: *Salix* lvs (MacDonald 1968; Granville 1973); **Haloragaceae**: *Myriophyllum* lvs (Small 1960). **Animals** Small animals (MacDonald 1968). **Molluscs** (Oliver; Gould). **Crustaceans**: freshwater shrimps (Hall 1909). **Insects** (Oliver): aquatic insects (Bridgewater 1935; Gould; North). Coarse grit (Vestjens 1977; Lea & Gray); gravel (Cleland); sand (McKeown 1944).

**Young** No detailed studies in A'asia. Sometimes fed by siblings from earlier broods (MacDonald 1968). For extralimital information, see Kornowski (1957) and BWP. Recorded eating bread (MacDonald 1968). **Intake** No information.

**SOCIAL ORGANIZATION** Some information, but not so well known as in n. hemisphere (see BWP). Except where indicated, account based on study at Virginia L., NZ, by Granville (1973), and material from Jackson & Lyall (1964), MacDonald (1966, 1968), and Brown & Brown (1980). Generally gregarious, though occasionally solitary (e.g. Badman 1979). Territorial during breeding season: breeding pairs and unmated individuals defending territories; non-breeding birds flock near breeding territories. Territorialism outside breeding season not studied. On Okareka L., NZ, as breeding declines in Mar.–May, large ( $\leq 180$ ) flocks form, with most birds joining flocks by May (J.G. Innes), though some individuals remain on breeding sites (Jackson & Lyall 1964); in one flock of 120 on Rotoiti L., Volcanic Plateau, >90% had no frontal shield, or it was grey and reduced, i.e. juveniles (G. Taylor). In Aust., relation between breeding and flocking not studied; flocks of 10–100 (Badman 1979) or up to 10,000 or more form, in late summer and winter (Hobbs 1961); after flocks formed, some birds may breed nearby; some large flocks possibly moulting groups (Aust. Atlas). Feed loosely together when in flock; often with ducks; kleptoparasitism recorded between

and within species (Sedgwick 1940; Binns 1954; Edgar 1972; Woodall 1984).

**Bonds** Apparently monogamous; no further information. **Co-operative breeding** Larger, older young help feed chicks of later broods (MacDonald 1966, 1968). **Parental care** Both parents build nest, incubate, feed young, defend territory, and repel predators. Building of nest sometimes shared, with one bird gathering material, which mate builds into nest (MacDonald 1968; Granville 1973). Family remains intact some time after chicks start feeding themselves (MacDonald 1966); remain with adults until next spring (Jackson & Lyall 1964); leave parental territory after 8–12 weeks (Granville 1973).

**Breeding dispersion** Solitary; some breed in isolation on small bodies of water (Brown & Brown 1980; Gosper 1981), others breed on large bodies of water where flocks have gathered (Aust. Atlas); occasionally colonies of up to 30 nests (Aust. NRS). In lignum-red gum habitat, 6–10 nesting pairs/ha (Lawler 1989). **Territories** In breeding season, used for nesting, rearing young, feeding, and roosting; aggressively defend against intruders from adjacent territories; non-territorial Coots, ducks, and swans also threatened, but less intensely (Granville 1973). In NZ, established Aug., with construction of nests by early Sept. (MacDonald 1968).

**Roosting** Presumably largely nocturnal. Observed rolling eggs of Hoary-headed Grebe *Poliiocephalus poliocephalus* out of nest and roosting on structure (O'Connor 1962). Perch on roots, trees (North), and rocks beside ponds. Spend less time resting during day than do ducks (Brown & Brown 1980).

**SOCIAL BEHAVIOUR** Little information within HANZAB region but well known elsewhere (e.g. BWP); sources as for Social Organization and also Aust. NRS. Shy, but tame where used to people, e.g. urban parks (North). Displays rather conspicuous. Behaviour not typical of gallinules because Coot more aquatic than others.

**Agonistic behaviour** Aggression occurs during establishment and defence of territories. Outside breeding season, foraging juveniles often forced into deeper water by aggressive adults (Bakker & Fordham 1993). **Threats** leading to fights between territorial birds described by Granville (1973): (1) birds swim watchfully in tight circles, raising feathers of wings and tail vertically whenever they turn apart (Fig. 1); lasts 2–3 min before birds end encounter by diving or swimming away; (2) birds charge to face each other with heads lowered and stretched forward and wings held up (Fig. 2); do not turn away; hold for a few seconds, then birds swim away; (3) birds rear up c. 30 cm apart after charging, then retreat a little and swim watchfully in tight circles.

**Fight** Fly at opponent, striking out with feet and bill; beat wings,

jump, dive, and splash vigorously (Fig. 3); may involve both members of pair, and last several minutes. Records of other **Threat** behaviour: on water, resident runs along surface with wings and feet moving, and intruder rapidly retreats (MacDonald 1968); on land, lowers head, extends neck so that bill points toward intruder, walks and then runs with wings flapping towards opponent for c. 20 m; opponent retreats by running with wings flapping (M.A. Weston). In aggression to non-territorial Coots, ducks and swans, wings and tail not held erect, and rearing up and fighting not used; charge often enough to repel non-territorial Coots. **Alarm** Swim to cover rather than fly, though will run on surface of water with wings flapping for 10–20 m, then begin to swim away; often turn head to view disturbance while swimming (M.A. Weston); once, when Swamp Harrier *Circus approximans* stationary nearby, remained in safety of water, not being able to reach cover in fringing vegetation (Green 1960).

**Sexual behaviour** Very little known. Adult feeds partner on nest (Aust. NRS). **Greeting** Bill-touching observed before change-over during incubation. Possible courtship observed between Coot and Dusky Moorhen (J.R. Starks). **Allopreening** Used, especially on head, by members of pair throughout breeding cycle; accompanied by lowering of head and raising of tail (Granville 1973). **Copulation** Observed once on floating nest-platform (Granville 1973); pair swam briefly side by side before male mounted female on nest; platform sank under weight of birds and female became immersed when male pushed her head under with bill; male dismounted and both preened; lasted 45 s.

**Relations within family group** When building nest, adult swam to nest with material, passed it to sitting bird, which incorporated it into nest (Bright 1935). During incubation, eggs turned with bill before settling. Young leave nest soon after hatching (Jackson & Lyall 1964). Brooded either on egg-nest or specially built brood-nests. Chicks have food brought to them for first 7–10 days; call persistently when being fed; fed at rate of once every 10 s. Swimming bird observed giving food to brooding adult, which then fed chicks (Aust. NRS). Parent observed preening young. Chicks give high-pitched call when separated from parents. **Anti-predator responses of young** Leave nest; like adults, will swim to cover. **Parental anti-predator strategies** Vary; some birds aggressive and noisy, others hide and watch from distance. During incubation, stay close to nest. If nest approached, may peck intruders (Bright 1935); recorded performing **DISTRACTION DISPLAY**, where incubating bird crouched at side of nest with wings spread and neck outstretched, while partner jumped up and down on surface of water (Jackson & Lyall 1964). In response to Swamp Harrier, incubating bird flies up to attack, then drops down to cover eggs (Brown & Brown 1980). Brooding bird pulls vegetation over itself (Napier 1973); if disturbed, chicks and

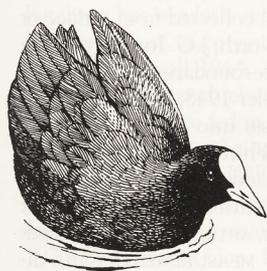


Fig. 1 Threat

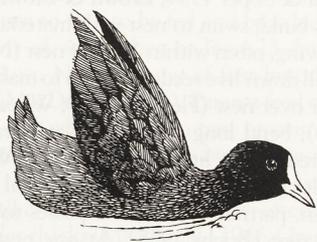


Fig. 2 Charge

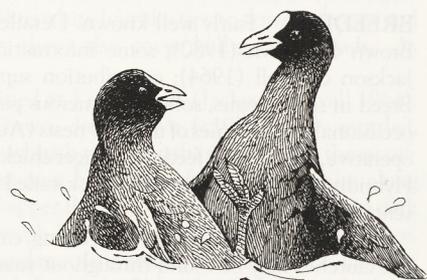
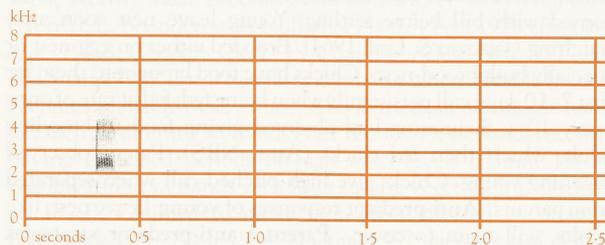


Fig. 3 Fight

adult may quietly move to another brood-nest. Young depend on parents for food for c. 5 weeks, leaving territory after 8–12 weeks (Granville 1973); eventually driven away by adults (Jackson & Lyall 1964); adult recorded pecking chick on head (Aust. NRS).

**VOICE** Little information from HANZAB area; no detailed studies; some information in Granville (1973). For extralimital account see BWP. Adults generally noisy; especially territory-holders in breeding season and when selecting territories (Brown & Brown 1980); during and after incubation period calling decreases as young approach size of adult (Small 1960). Variety of calls, most common a harsh strident *crark* and a sound similar to chopping noise of axe (Small & Soper 1959). Outside HANZAB area, BWP gives at least one call for each of combat, alarm, contact and courtship. Response to someone approaching nest varies; some birds very aggressive and noisy, others slip away quietly and watch from distance (Brown & Brown 1980). No information on sexual and regional differences. **Non-vocal sounds** Patter across water before take-off (NZRD); mating displays include striking water with wings (Aust. RD).

**Adult CONTACT CALL:** (following BWP) varying; typical call: loud, harsh *crark* (Small & Soper 1959); call similar to sound of axe chopping wood (Small & Soper 1959); *kratak-krat-krat* of Sharland (1945) probably this call; functions not known (see sonagram A). **Other calls** In NZ, one member of pair gave soft *pitt-pitt-pitt* before mutual preening or as greeting (Granville 1973). Hiss loudly through partly open bill at human approaching nest (Jackson & Lyall 1964; Granville 1973). Call resembling noise of cork being drawn from bottle (Lyall 1963).



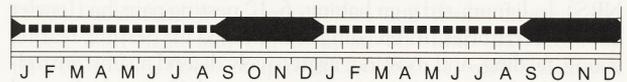
A J. Hutchison; Manjimup, WA, May 1976; P11

**Young** In NZ, chicks <10 days old give persistent drawn-out plaintive monosyllabic *weeee*; when older, a disyllabic *wee-eeep* during feeding by parents; calling more intense when adult resurfaces after diving; one chick separated from parents for 30 min gave constant *weeet* until reunited with parents (Granville 1973). No information on development of adult calls.

**BREEDING** Fairly well known. Detailed study in s. WA by Brown & Brown (1980); some information from NI, NZ, by Jackson & Lyall (1964); contribution supplied by J.G. Innes. Breed in simple pairs, solitary, numerous pairs on same wetland, occasionally in colonies of up to 30 nests (Aust. NRS); may be cooperative, older chicks feeding younger chicks (MacDonald 1966). Hybridization in captivity with Black-tailed Native-hen *Gallinula ventalis* (Dunn 1990).

**Season S. Aust.** Aug.–Feb.; laying, early Sept. to early Jan., but clutches may be found throughout year. NSW: laying, early Sept. to late Nov. but eggs recorded in late July and up to mid-Jan. (Maclean 1976; Aust. NRS). Vic.: breed, Aug.–Jan. (Bedggood 1980); eggs, early Sept. to early Jan. (Aust. NRS). SA: eggs, mid-Sept. to mid-Dec. (Attiwell 1972). Tas.: clutches, late Sept. to mid-Nov. (Fletcher 1910); eggs, mid–late Dec., seven nests with

eggs over New Year period (Napier 1973); young, early Dec., mid-Dec. (Patterson & Gore 1992). **King I.:** breeding, Dec. (McGarvie & Templeton 1974). **S. WA:** usually breed July–Nov.; some clutches started throughout year; laying correlated with peak rainfall plus 2 months (Halse & Jaensch 1989); laying, mid-Sept. to early Jan. with peak in Nov.; later clutches probably replacements (Brown & Brown 1980; Aust. NRS). **N. Aust. NT:** eggs, Feb. and March (Storr 1980); ne. Qld: laying, Mar. (Lavery *et al.* 1968). **Qld:** breed, Aug.–Oct. (Horton 1975). **NZ** Eggs reported early Sept. to early Feb. (NZ NRS); NI: clutches found from early Sept. to late Dec., young recorded from early Sept. to early June (Jackson & Lyall 1964; CSN 33, 34, 36, 37, 38); pairs usually lay two clutches per season (MacDonald 1966); SI: clutches found in late Sept. and late Nov., young recorded from Nov. to mid-Mar. (Small & Soper 1959; CSN 23, 24, 28, 37).



s. Aust.

**Site** In rushes or clumped vegetation in open water or at edge of lakes, ponds, billabongs, irrigation dams, sewage ponds, flooded grassy area, rarely under cover on bank adjacent to water, or under jetty; occasionally floating; in clump of sword-grass or lignum bush growing round dead saplings, under blackberry, in tea-tree, fork of tree above water, often on or against dead trees in flooded areas, on stump or in hollow centre of stump in lake; one nest in scrape in kikuyu grass on small island in irrigation dam; some nests built on top of rubbish in water; old nest of Black Swan *Cygnus atratus* under bush (Fletcher 1910; Carnaby 1933; Sharland 1960; Brown & Brown 1980; Aust. NRS; J.G. Innes). **MEASUREMENTS:** height above water, 25–30cm, up to 75 cm (Brown & Brown 1980; Aust. NRS). Sometimes refurbish nest from previous season (Aust. NRS). Re-use same nest for replacement clutches (Brown & Brown 1980; Aust. NRS), or build new nest nearby (Jackson & Lyall 1964).

**Nest Materials** Large bulky structure, built up to 30 cm above water-level, with bulk below water-level, and usually anchored to rushes, submerged log or branch, occasionally to floating weed, water-lilies (White 1918; Brown & Brown 1980; Campbell; North; Aust. NRS; J.G. Innes). Various described as cup-shaped, basket-like, mound or pyramid with depression in centre, untidy platform (Fletcher 1910; Condon & Rix 1936; Jackson & Lyall 1964; Aust. NRS). Made of rushes, lignum, sticks, twigs, leaves, bark, rootlets, water-weed; unlined or lined with grass, sheaths and stems and leaves of reeds (Fletcher 1910; Small & Soper 1959; Brown & Brown 1980; Aust. NRS). Both sexes build; swim to nest with material collected from surface or by diving, often within 10 m of nest (North; J.G. Innes); trample or pull down live reeds or rushes to make foundation, sometimes a cover over nest (Fletcher 1910; Wheeler 1948; Jackson & Lyall 1964); bend long strands of water-grass into shape, sometimes covered with a little floating weed (White 1918); bite material into lengths (Fletcher 1910); material added to nest during incubation, partner collects and passes to sitting bird who places it onto nest (Bright 1935). At one nest, sitting bird pulled reeds round it to rebuild nest (Aust. NRS). **MEASUREMENTS (cm):** diameter, 25–50 (Granville 1973; NZ NRS), 23–35.5 (n=4); depth, 38–43; inside diameter, 18–21 (n=3); depth, 6.5–13 (n=4) (White 1918; Condon & Rix 1936; Campbell). May build several (up to five) platforms after eggs laid, for roosting and brooding, especially if original nest disturbed or destroyed (MacDonald 1968;

Granville 1973); desert readily if disturbed during construction (Fletcher 1910).

**Eggs** Oval; close-grained, smooth, lustrous (North); oval, slightly compressed at one end; coarse, slightly glossy (Campbell); dull white-brown or greyish white (North), dull white or light stone (Campbell), creamy white with brownish-pink tinge (Jackson & Lyall 1964; NZRD), fairly uniformly sprinkled with dots and small rounded spots or freckles, occasionally blotches of black or purplish brown, with a few faint underlying markings of dull violet-grey (Condon & Rix 1936; Campbell; North). **MEASUREMENTS:** 50.0 (1.36; 48.3–52.6; 13) x 33.9 (0.9; 31.2–35.1) (North); two eggs in Tas.: 48.3 x 35.6 and 45.7 x 33.0 (Fletcher 1910).

**Clutch-size** In Aust. (Aust. NRS): average, 5.8 (1–14; 151): C/1 x 1, C/2 x 2, C/3 x 9, C/4 x 14, C/5 x 48, C/6 x 35, C/7 x 19, C/8 x 12, C/9 x 7, C/10 x 2, C/13 x 1, C/14 x 1; larger clutches may be laying by two females. In s. WA: 5.7 (4–10; 74); first clutch, 6.0 (5–8; 6); replacement clutches, 4.8 (3–7; 8) (Brown & Brown 1980). In NZ, usually 4–7 (1–10) (MacDonald 1968; Granville 1973; NZNRS).

**Laying** Eggs laid on consecutive days (Brown & Brown 1980); at intervals of 24–48 h (Aust. NRS); at one nest, four eggs laid over 15 days (NZ NRS). From Aust. NRS, two instances of dump-nesting: additional eggs appeared in nest after clutch unchanged for at least 3 and 6 days (Aust. NRS). Once, three eggs from C/5 disappeared after 9 days of incubation; incubation continued and four more eggs laid; two eggs hatched 23 days after original clutch laid (Brown & Brown 1980). At Virginia L., NZ, most pairs raised two broods in 1966–67 and 1967–68 seasons (MacDonald 1968). Replacements laid after loss, up to twice (Brown & Brown 1980).

**Incubation** Both sexes incubate (NZ NRS); begins before clutch complete (Brown & Brown 1980): after third egg of C/6 (n=2; NZ NRS); when clutch complete (n=1; Granville 1973). Sitting bird pulls vegetation over itself, obscuring nest from view (Napier 1973). Change-overs about hourly at one nest (NZ NRS). **INCUBATION PERIOD:** 23, 24 x 4, 25, 26 days (Brown & Brown 1980). Hatching probably asynchronous (Granville 1973). Egg-shells eaten at one nest when chicks hatched (NZ NRS).

**Young** Precocial, nidifugous; hatch in black down with down round eye and skin on top of head, vermilion; bristles round face and down back of neck tipped yellow; part of wings, yellow; frontal plate and basal half of bill, vermilion, becoming orange towards tip, which is white; legs and feet, dark olive-grey; iris, hazel. Bright colouring fades after c. 3–4 weeks, replaced by dull greyish-white down on front of neck and breast. Almost full grown before black shows on neck, and frontal shield appears (Condon & Rix 1936; Jackson & Lyall 1964). **Parental care, Role of sexes** Both sexes accompany young; leave nest soon after hatching but regularly return to nest to be fed and brooded; still use brood-nest in company of adult when at least 23 days old (Jackson & Lyall 1964; Aust. NRS). Young of first brood may assist feeding later chicks (MacDonald 1968). Parents feed chicks for first 7–10 days; fed in nest when small; in nest or swimming when older; partner brings food and passes to bird on nest who feeds chicks; chicks fed bill to bill; young start foraging at c. 4 weeks; dependent on parents until c. 5 weeks; larger chicks often share food with younger or smaller chicks (MacDonald 1966; Granville 1973; Patterson & Gore 1992).

**Fledging to maturity** Family groups stay together some time after young can feed themselves (MacDonald 1966); stay with adults till next spring then driven out (Jackson & Lyall 1964).

**Success** From 472 eggs laid, 182 (39%) young fledged; young hatched from 51 (53%) of 96 clutches laid (Brown &

Brown 1980). For successful nests: from 66 eggs laid, 55 (83%) hatched (Aust. NRS). From 96 nests: 12 (13%) lost through flooding, 33 (34%) through predation (Brown & Brown 1980). Percent young hatched that fledged, 61–84% (Jackson & Lyall 1964; MacDonald 1968). Eggs taken by Australian Ravens *Corvus coronoides* and Black Rats *Rattus rattus*; Swamp Harriers take eggs and young, eating eggs at nest; young picked from water or hunted through reeds; Purple Swamphens usurp nests for brood-nests (Brown & Brown 1980). Adults and young taken by raptors (Loyn *et al.* 1986). Water-rats *Hydromys chrysogaster* known to take adults (Lowe 1958).

**PLUMAGES** Prepared by D.I. Rogers. Subspecies *australis* from se. Aust.

**Adult** Age attained and age of first breeding unknown. In nominate *atra* attained at end of first year and first breeding at 1–2 years (BWP). **Head and neck** Black (89); feathers have concealed dark-grey (83) bases, becoming slightly brown (121) at tips with wear. Narrow white line on lower eyelid, only visible when eye closed. **Upperparts** Grey-black (c82), with concealed grey (84) bases of feathers; tips develop slight brown tinge with wear. **Underparts** Grey (84), with light-brown (119C) tinge to tips of feathers becoming more pronounced with wear. Under tail-coverts, grey-black (82). **Tail** As upperparts; a few feathers may have narrow cream (c92) tips. **Upperwing** Tertiaries and most coverts, as upperparts. Marginal coverts have broad white outer edges, forming whitish strip on front of carpal joint. Primaries, dark brown (c121), grading to black-brown (c119) at tips and near shaft; p10 sometimes has narrow white leading-edge. Secondaries, grey (c79) with narrow white or occasionally grey-brown (91) tips,  $\leq 2$  mm, narrowest on outermost secondaries and sometimes lost completely with wear. **Underwing** Remiges and greater under wing-coverts, grey (84), reflecting pale grey (86) in some direct light; secondaries have narrow white tips like those on upperwing. Other coverts, grey-black (c82) with concealed grey (84) bases.

**Downy young** **Head and neck** Facial mask and chin, red (210 or 12); highly modified feathers are short and club-like, looking like bare skin from a distance. Crown, sparsely covered by black (89) bristles, which become more extensive with age and obscure bare skin before chick is fully grown. Rest of down on head and neck, black (89) but distal half or more of each feather enclosed by wax-like orange (17), orange-yellow (18) or yellow (55) sheath. In small chicks, these more or less conceal black (89) bases, so neck, ear-coverts and nape appear covered by shock of yellow-orange hair-like tips; with age, these wear and fade to pale yellow or white. **Upperparts** Black (89); down, dense and woolly with yellow (55) hair-like tips similar to those of neck but sparser, especially towards tail and in older chicks. **Underparts** Dark grey (83) with yellow (55) to white hairlike tips to down of breast and flanks; exceptionally these also cover belly. **Wing-pads** As upperparts.

**Juvenile** Attained at 3 or 4 weeks (Jackson & Lyall 1964).

**Head and neck** Crown, dark brown (c19), slightly mottled, especially at sides, by whitish tips to feathers. Chin and throat off-white, looking purest near bill, where feathers are white along length. From base of upper throat to foreneck, feathers have dark grey-brown (light-greyish 21) bases, causing mottled appearance. Extent of dark bases and mottling greater at sides of neck, merging to uniform dark greyish-brown (c19) hindneck. Lores and sides of face, finely mottled grey-brown (c121) and white. **Upperparts** Dark brown (c19) with slight greyish tinge; feathers have concealed grey (84) to light-grey (85) bases. **Underparts** Light grey, grading to off-white on breast. Feathers, grey (84), each barb

grading to white tip; this gives general whitish wash to area rather than forming distinctive scaly appearance. Concealed underdown, dark brown (c121). **Tail** As adult. **Upperwing** Like adult but tips of primaries tend to be more pointed. **Underwing** As adult but some have narrow white tips to greater secondary under wing-coverts.

**Immature** First basic; includes comments on birds in post-juvenile moult. **Head and neck** Throat, and sometimes chin and foreneck, blackish varyingly speckled white. Feathers, white with grey-brown (c121) subterminal band of varying extent; in some the marking is small but in others feathers predominantly grey-brown (paler than adult) except for narrow white tips and concealed whitish shafts. White tips can be entirely lost with wear (retained longest on upper throat); in post-juvenile moult, entire area may look white with a few dark speckles. Rest of head and neck as adult, though remnant juvenile feathers in crown can give mottled appearance. **Upperparts** Dark grey (dark 84 to pale 83), slightly paler than in adults. Remnant juvenile feathers fade to brown (c119B). **Underparts** When moult complete, as adult. Before then, moult of underparts may be interrupted; juvenile feathers lose white tipping with wear and develop slightly browner tinge (c119C) than that acquired by adults. Although this difference is subtle, it stands out because new feathers, which first grow on flanks and upper breast, contrast, leaving markedly pale patch in centre. **Tail, Wing** As adult.

**Aberrant plumages** Partial albino adult from Kerang, Vic., had white band c. 3 cm wide between breast and belly, and broad white tips to tertials; juvenile from Kerang had white trailing-edge to secondaries, 5 mm wide. Unsexed adult from L. Eyre, SA, had irregular light-brown (223C) patches on hindneck, mantle and right wing.

**BARE PARTS** Based on photographs (NPIAW 1985; Moon 1988; Aust. RD; NZ DOC Slide Library; unpubl.: J.N. Davies, R. Davies, T. Lowe).

**Adult** Frontal shield and bill, white, usually with pale grey-blue (c88–86) tinge to bill; occasionally small pinkish-brown (–) smudges on upper tomtia and at junction of bill and shield. Iris, bright red (210–13); orange-red and maroon also reported (MV). Feet and legs, grey (bluish 84) or dark grey (83) to blackish grey (82), tending to be darkest on joints; dark-green or olive tinge reported in some (HLW, MV). Bare parts of nominate *atra* become somewhat duller in winter (BWP); not known if this occurs in *australis*. **Downy young** Basal two-thirds of bill, red (210); distal third largely white except for tiny black (89) tip, largest on lower mandible. Frontal shield, small in chicks, forming neat crimson (8) strip in centre of forehead. Crown, feathered, but so sparsely that bare skin is obvious in small chicks, forming pink-red (c94) bald patch; blue (168B) patches on sides of forehead look like small supercilia. Iris, dark brown (21). Eye-ring, yellowish grey (c80). No available photos show feet and legs; probably blackish grey as in nominate *atra*. **Juvenile** In small juveniles retaining some down on upperparts, neatly defined blackish (82) saddle develops near tip of bill; base of bill below loreal point, also dark grey (83) to blackish (82); distal third of bill, pinkish white (c6); frontal shield and most of basal two-thirds of bill, pink (5); these areas become paler and more yellowish with age; saddle of bill becomes wider with age, fades to grey (84) or dark grey (83) and edges become less well defined; dark markings on sides of bill are last to be lost. Iris, dark brown (c21) in small juveniles (only in two photographs); brown (c28) in large juvenile (only in one photograph). Feet and legs, grey (c84) (only in one photograph). **Immatures** Apparently as adult, but little data for Aust.; records of yellow iris and olive-green feet and legs (MV).

**MOULTS** Based on skins (MV, HLW), except where stated. **Adult post-breeding** Definitive pre-basic. Complete; remiges simultaneous, though sometimes one or two feathers do not drop until others are about a quarter grown (Ripley 1977). In nominate *atra*, varying number of flight-feathers bitten off shortly before wing-moult (BWP). Wing-coverts moult simultaneously with remiges in nominate *atra* (Ginn & Melville 1983; Dement'ev & Gladkov 1951; BWP) but not so in only specimen of *australis* examined in wing-moult; primaries 2<sup>10</sup> but only a few lesser coverts were moulting. Rectrices moult shortly afterwards. Body-moult begins on head and upperparts well before wing moulted; moult of underparts completed well after wing-moult complete. Wear of primaries in non-moulting skins indicates that moult occurs late summer or autumn, and a specimen in wing-moult has been collected early Feb. Given variation in timing of breeding, timing of moult probably varies more than available skins suggest; however, relation of moult and breeding not known for *australis*. Nominative *atra* can begin body-moult in early breeding season, but moult slowly while nesting and caring for young; birds not nesting tend to moult wing earlier than breeders, which vary in time of moult; males moult wing slightly earlier than females (Dement'ev & Gladkov 1951; BWP). Duration of flightlessness, unknown; probably similar to American Coot *F. americanus*, which is about equal in size and is 'disinclined to fly for about 4 weeks' (Gullion 1953). **Adult pre-breeding** Alternate. Three of five adults collected in July and Aug. showed body-moult; birds collected in early summer seem to have fresher plumage on head and body than wings. **Post-juvenile** First pre-basic. Partial, head and body. Starts before wing full-grown with head and upperparts, followed by upper breast, flanks and then rest of upperparts. Timing uncertain; recorded in skins from Jan. to May but few young birds collected at other times. Nineteen birds examined in post-juvenile moult were collected at Kerang in Feb. 1957; none had finished more than 20% of moult of underparts, which some had not started, though extent of completed moult of upperparts ranged from 10% to 80%; remnant juvenile plumage of some birds was considerably more worn than that of others more advanced in moult. These observations suggest that post-juvenile moult, especially of underparts, may be interrupted in some birds.

**MEASUREMENTS** SE. Aust., skins; BILL LP = bill from loreal point (distal tip of feathering on lores) (MV, HLW): (1) adults; (2) immatures in first-basic plumage.

	MALES	FEMALES
WING	(1) 185.7 (7.04; 173–194; 6) (2) 186.8 (6.50; 177–195; 4)	176.5 (4.00; 169–181; 9) 180.0 (4.32; 174–184; 3)
8TH P	(1) 124.2 (3.85; 117–129; 6) (2) 124.8 (4.87; 119–132; 4)	117.6 (2.40; 114–121; 9) 120.0 (2.45; 117–123; 3)
TAIL	(1) 49.8 (1.07; 48–51; 6) (2) 49.5 (1.80; 47–52; 4)	47.4 (2.58; 44–53; 10) 48.7 (2.36; 47–52; 3)
BILL LP	(1) 28.3 (1.07; 26.6–29.8; 6) (2) 28.1 (0.27; 27.8–28.5; 4)	26.6 (0.98; 24.9–28.6; 10) 25.7 (1.63; 24.4–28.0; 3)
TARSUS	(1) 56.2 (1.70; 53.6–58.3; 6) (2) 59.3 (0.35; 56.6–58.7; 4)	54.2 (2.82; 50.3–58.2; 10) 54.2 (1.02; 52.9–55.4; 3)
TOE C	(1) 81.2, 84.4 (2) 80.3 (1.34; 78.4–81.3; 3)	78.4 (2.44; 75.2–82.1; 6) 77.0, 80.0

Wing of unaged, unsexed live birds at Serendip, Vic. 184 (8.1; 162–200; 323) (Norman 1979). In nominate *atra*, wing of male significantly longer than that of female; wing of adults significantly longer than that of immatures. Length of wing decreases with wear and there can be year-to-year variation

(Visser 1976; see Fjeldså 1977 for further discussion). BWP gives some information on post-mortem shrinkage of wing of *atra*; Visser (1974) gives information on growth of chicks of nominate *atra*.

**WEIGHTS** SE. Aust., adults: 531 (81.8; 351–660; 16) (MV), including some sexed males of 568 (74.6; 481–660; 6) and sexed females of 522 (51.8; 476–609; 5). Kerang, Vic., shot Feb. 1957, immatures in post-juvenile moult with fully grown wings: 449 (74.6; 351–599; 15) (MV). Birds banded at Serendip, Vic., data pooled throughout year: 510 (70.9; 305–725; 383) (Norman 1979); weights fluctuated from c. 480 (n=46) in June to c. 575 (n=23) in Nov. but birds were not aged so effects, if any, of changing proportions of sex and age unknown. No other Aust. information on seasonal and geographical variation, though such differences occur in nominate *atra* (Visser 1978; BWP). Perdeck (1985) gives equations for predicting fat reserves of nominate *atra* from weights and linear measurements; Visser (1978) gives information on changes in composition of body with starvation.

**STRUCTURE** Wing, short and broad. Eleven primaries; p9 and p8 longest, about equal, p10 14–22 shorter, p7 2–8, p6 7–15, p5 16–26, p4 26–39, p3 36–50, p2 48–63, p1 58–72; p11 minute, sometimes absent; concealed by primary coverts. Sixteen to 20 secondaries, about ten of which are secondary-shaped; rest are tertials; Jeikowski (1971), gives further details on wing pterylography of nominate *atra*. Tail, very short, slightly rounded; 14 rounded feathers (12–16 reported in *atra*; Dement'ev & Gladkov 1951), so soft they can be mistaken for tail-coverts. Bill, short (slightly shorter than head), moderately heavy and laterally compressed; 14–15 mm high at base, c. 9 mm wide. Culmen, decurved and tomlia slightly so; nostrils, long and narrow, situated in nasal groove. Frontal shield, elliptical, running from base of upper mandible to centre of crown, about level with eyes. Shields measured as distance from loreal point x maximum shield width. In six adult male *australis*, largest seen 19.9 x 11.9, smallest 13.0 x 6.3. In ten adult females, largest seen 21.4 x 10.9, smallest 13.0 x 6.3. Beyond showing bill shields to be smaller than in nominate *atra*, above measurements of little significance because information insufficient to describe seasonal variation, which is marked and largest in breeding birds in nominate *atra*; size of shield correlated with size of gonads, and weight. Juveniles and immatures have smaller shields; age at which full size attained, unknown. For more information see Visser (1988) and BWP; histological changes during development of shield in closely related American Coot described by Gullion (1951). Unlike most other rails, body broad and rounded. Tarsus, laterally compressed, scutellate in front, reticulate elsewhere. Toes, long, slender and lobed; middle toe, longest, outer c. 84%, inner c. 79%, hind c. 38%. Hind toe slightly elevated; claws, slightly curved.

**RECOGNITION** Large downy young could be confused with similar aged Dusky Moorhen during transition to juvenile plumage. Usually Coot has much paler bill, becoming whitish (dark olive-green in Moorhen). At some stage, both develop pinkish-orange bill with paler tip and dark-grey saddle; Coot then differs by lobed feet and whitish breast, grading to light grey belly and flanks (greyish breast grading to grey-white belly in Moorhen).

**GEOGRAPHICAL VARIATION** Four subspecies (Ripley 1977; BWP), though Peters recognized only nominate *atra* extraliminally. Differences from *australis*: subspecies *novaeguineae*, darker, especially on underparts (Rand 1940; Ripley 1977), though with similar narrow white tips to secondaries; larger, with larger shield extending behind level of eyes. Nominate *atra* and *lugubris*

both have broad white tips to secondaries; *lugubris* probably smallest and said to have larger shield than other subspecies (BWP); *atra* much larger (BWP); bill lacks blue-grey tinge of *australis* but sometimes tinged pink or yellow; tibia, orange-yellow or orange-red; tarsus, yellow-green or orange-red on sides, dark olive-grey behind and pale in front (BWP). White & Bruce (1986) have suggested that status of *lugubris* and *novaeguineae* needs checking. For biometrics and further information see BWP and references therein.

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Volume 2, Plate 48

Dusky Moorhen *Gallinula tenebrosa* (page 600)

1 Adult; 2 Adult non-breeding; 3 Newly hatched downy young; 4 Juvenile, not fully grown; 5 Immature; 6 Adult

Eurasian Coot *Fulica atra* (subspecies *australis*) (page 625)

7 Adult; 8 Downy young, newly hatched; 9 Juvenile, not fully grown; 10 Immature; 11 Adult