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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 *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.

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Gallinula tenebrosa Gould, 1846, *Birds Aust* 6: Pl. 73 — South Australia.

Gallinula is Latin for a little hen or chicken; Gesner (1555) used the name for the Common Moorhen *G. chloropus* with its cocked tail and halting progress; *tenebrosus* means dark or gloomy in Latin and doubtless refers to the drab plumage or skulking habits.

OTHER ENGLISH NAMES Black or Sombre Gallinule or Moorhen.

POLYTYPIC Nominate *tenebrosa*, Aust.; *frontata* Wallace, 1863, throughout Indonesia and perhaps New Guinea; *neumannii* Hartert, 1930, L. Sentani, n. Irian Jaya.

FIELD IDENTIFICATION Length 35–40 cm; wingspan 55–65 cm; weight: 350–700 g. Medium-sized dark waterhen, close in size to Eurasian Coot *Fulica atra* but slimmer, with flat-backed profile and more prominent tail. Sexes similar; some seasonal variation in colour of bill, shield, and leg. Juvenile separable.

Description Adult breeding Head, neck and upperwings, slaty black; rest of upperparts, dark olive-brown. Underparts, slaty black, with feathers of lower breast narrowly tipped white, forming diffuse pale patch on central abdomen; long feathers of flank tipped white on some, showing as narrow broken white line. Tail and central under tail-coverts, black; outer few rectrices and lateral under tail-coverts, white, conspicuous from behind when tail flicked. Bill, bright red, tipped yellow; frontal shield, bright reddish-orange. Iris, red-brown. Tibia gartered with dark red; front and sides of tarsi and tops of toes, red or orange fringed yellow; leg and toe joints and rear of tarsi, olive-green. **Adult non-breeding** Bill, dark red; shield, olive-green, shrunken; legs and feet, olive-green. Some retain varying amounts of colour on bill and legs throughout non-breeding season. **Juvenile** As adult but duller and browner above; underparts paler, particularly lower breast and belly, which have more extensive white fringing. Bill and shrunken shield, dark olive-green, changing gradually to green-yellow at tip. Iris, dark brown. Red garter on tibia develops at about 8 months and remains throughout life. **Immature** As juvenile except bill duller orange with larger pale tip and more diffuse dusky subterminal band; legs and feet, olive-grey.

Similar species None in range.

Gregarious; breeding groups of between two and seven during summer; non-breeders form flocks in habitat that is not suitable for breeding. Inhabit well-vegetated freshwater wetlands from flowing streams to large lakes, reservoirs and urban ponds. Always near cover, to which run or swim when threatened. Gait a slow, uneven, high-stepping walk; and slightly twisting run with head low, often flapping wings at same time. Climb well, sometimes using wings for support. Swim well and buoyantly, with neck upstretched, flat-backed profile and stern clearly higher than front; when swimming slowly, each backward thrust of foot matched by forward jerk of head and, often, flick of tail. Up-end in water when feeding; dive when pressed. Running take-off laboured but, once airborne, flight strong and direct, with rapid

shallow wing-beats; head and neck extended and legs and feet dangling or trailing behind tail; flight often low and not sustained. Most commonly heard call loud, sharp guttural crowing; also, harsher repeated shrieks.

HABITAT Permanent or ephemeral terrestrial and coastal wetlands, usually fresh, but sometimes brackish to saline; including swamps, creeks, rivers, lagoons estuaries, billabongs and artificial wetlands. Require open water (S.T. Garnett); margins of wetlands often vegetated with emergent or floating vegetation, such as reeds, rushes, grass, water-lilies, waterweed, waterfern and algae, but may be forced off wetlands by choking Water Hyacinth *Eichhornia*; may not have peripheral vegetation (van Tets 1969). Seldom far from edge of wetland (S.T. Garnett); often occur on short-grassed surrounds such as parks, lawns, paddocks and herbfields and rarely among tall terrestrial vegetation. Uncommon on saline and ephemeral waters (S.T. Garnett); rarely in mangroves (Gosper 1981).

Breed on ground or over water in fringing vegetation, including rank growth of reeds, rushes, lignum, paperbarks, tea-trees and willows, at margins of wetlands (White 1918; Lord 1936, 1956; Bryant 1940; Serventy & Whittell 1976; North). Forage in open shallow water (to at least 30 cm deep), among floating vegetation or in open water of wetlands, usually within 100 m of cover; also on adjacent land; often on grass and herbfields near water. Rarely, feed among tall terrestrial vegetation (Anon. 1973; Garnett 1978; Czechura 1983; S.T. Garnett). Roost or loaf among reedbeds, on fallen logs or stumps projecting from vegetation, or in trees at wetland margin (Garnett 1978; North).

Favoured by construction of artificial wetlands, such as reservoirs, farm dams, ornamental ponds and lakes in parks and gardens, and nearby grassy areas, but offset by drainage of natural wetlands; also round bore-drains and, occasionally, rubbish tips (Badman 1979; Czechura 1983; Morris *et al.* 1990; Tas. Bird Reps 12, 13, 14). Sometimes occur in polluted water (Hindwood 1953).

DISTRIBUTION AND POPULATION Indonesia, from Borneo and Sulawesi to Flores and Timor, locally widespread in New Guinea, and e. and sw. Aust. Vagrant to NZ.

Aust. Widespread from near Cooktown to e. SA (to 138°E);

mainly in e. Qld, E of w. slopes in NSW, throughout Vic. and e. SA; widespread but sparse records from w. and central Qld, w. plains and w. NSW, Eyre Pen. and L. Eyre drainage basin (Aust. Atlas). **Tas.** First mainland record: about four birds, Queechny Pond, Launceston, late Oct. to early Nov. 1976 (Green 1989; Tas. Bird Rep. 6). Subsequently expanded throughout much of n. and nw. Tas. (Aust. Atlas). Few isolated records in SE, from Oatlands, Gould's Lagoon and Primrose Sands (Tas. Bird Reps 15, 16; Aust. Atlas). Breeding on Flinders I. since 1935 (Green 1969) and King I. since 1960s (Green & McGarvie 1971). **WA** Mainly in SW, from Bremer Bay N to Jurien (Serventy & Whittell 1976; Aust. Atlas); small recently established population round Dampier and Port Hedland (Aust. Atlas). Vagrants recorded round Esperance; Leonora, Apr. 1975; Tom Price area (Serventy & Whittell 1976; Storr 1984, 1986, 1987; Aust. Atlas). **NT** Vagrant. First record: two, Little R., 11 km W of Balbirini Depot, 31 Aug. 1976 (Thompson 1977). Also recorded at Emerald R., Groote Eylandt, Aug. 1978 (Aust. Atlas). Single, Calvert R. (just below Gulf Highway crossing), 29 Sept. 1986; single, near Borroloola, 12 Apr. 1988; single, 10 km S of mouth of Calvert R., 21 Mar. 1990 (M. Fleming).

Lord Howe I. Single, Blinky Beach Swamp, 9 Apr. 1975 (NSW Bird Rep. 1975).

NZ One record: single, L. Hayes, 11 Aug.–9 Oct. 1968 (Barlow 1969).

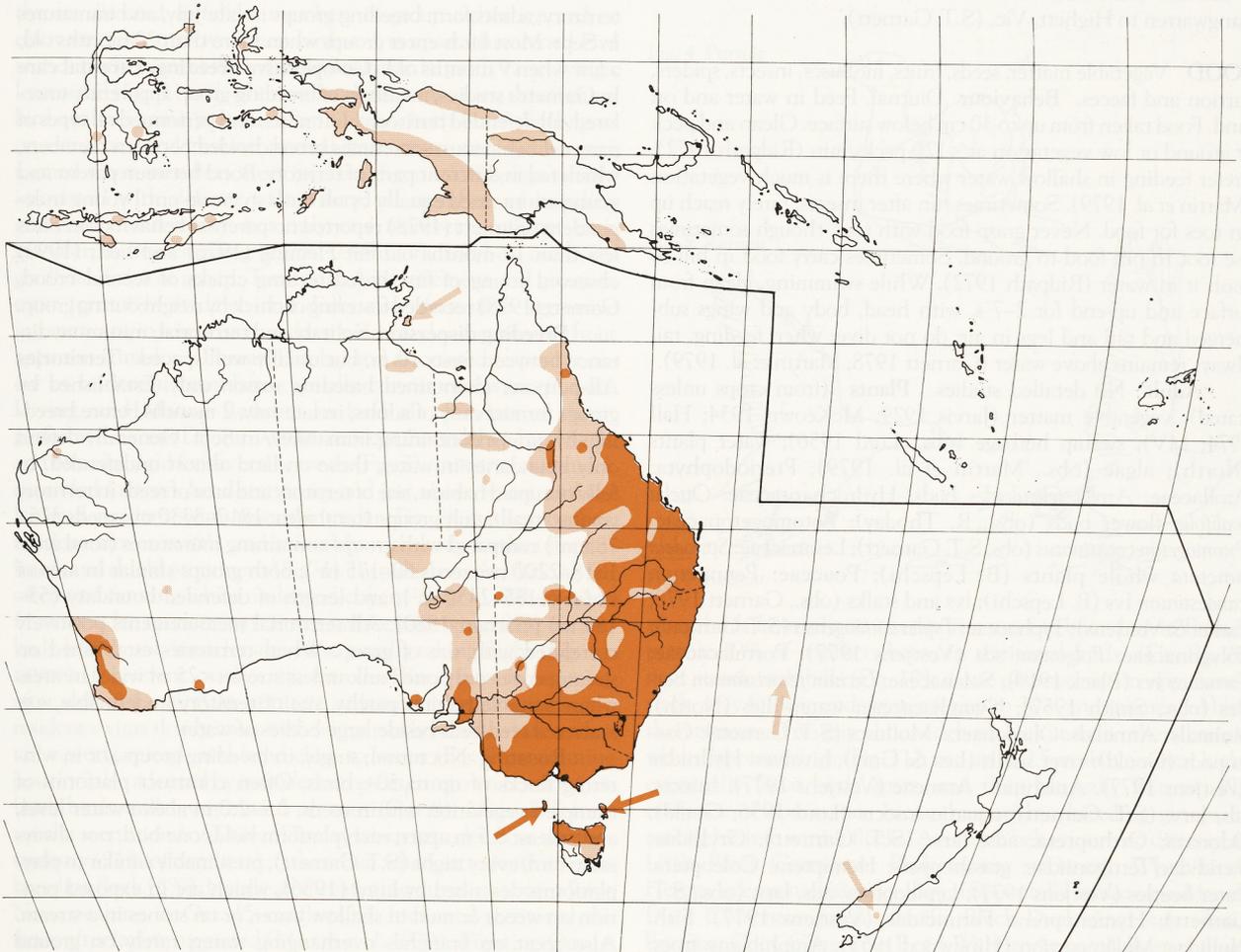
Breeding Through most of main range in e. Aust., from 20°S to e. SA (138°E); also recorded round Cairns, sw. and

central Qld, n. Tas., mid-n. SA, s. Eyre Pen., near Esperance and sw. WA from about Denmark, N to Perth (Aust. NRS; Aust. Atlas).

After first record in 1976, range now includes n. Tas. (Tas. Bird Reps 8, 9; Aust. Atlas). Small population established round Port Hedland where previously vagrant (Aust. Atlas). First breeding in some regions (Rolling Downs, L. Eyre, Eyre Pen.) recorded 1977–81 (Aust. Atlas). Inland expansion possibly assisted by construction of dams, e.g. at Mt Isa (Horton 1975). Do not undergo irruptive movements; numbers in sw. NSW said not to be affected by floods (Hobbs 1961). However, at Murphy's Ck, absent for several months after floods in 1950 (Lord 1956); up to 50 birds recorded round Cabanda in 1971 after good rains (Bell 1971). First records in Tas. and NT, late 1976, coincide.

At Canberra, breeding density of 53–89 birds/ha recorded in lakeside reeds (Garnett 1980). N of Melbourne, 97 birds recorded on 2-ha lake (J.M. Peter). In sw. WA, 16 birds recorded at Joondalup NR (469 ha) and 232 birds recorded in c. 3.3 km of Canning R. (Jaensch *et al.* 1988). Occasionally disturbed by dogs and duck-shooters (Klapste 1975); sometimes shot (Green 1969).

MOVEMENTS Little known. Sedentary or dispersive, possibly partly migratory though reporting rates do not suggest regular long-distance movements (Aust. Atlas; Vic. Atlas). Adults observed to stay in same area for over 8 years (Martin *et al.* 1979; R. Thoday; P.J. Fullagar). Immatures form flocks in winter and disperse in spring (Garnett 1980); near Emerald, Vic., immatures move in



autumn and occur in habitats rarely frequented by adults (Twaits 1982); in Canberra, population peaked Nov., then dropped Dec., leaving only territorial birds (Garnett 1980). Apparently occur seasonally in parts of e. Aust. and possibly migratory in some areas (Green 1989; Gosper *et al.* 1983): Hunter and Richmond Rs, NSW, peak Mar.–Oct., with greatest fluctuations on larger seasonal swamps; Parramatta R., NSW, peak summer; at Ballarat, Vic., peak winter; Canberra, peak in Nov. (Garnett 1980; Gosper 1981; Gosper *et al.* 1983; Wheeler & Wheeler 1983; Morris *et al.* 1990). In sw. Aust. movements possibly regular; arrive in s. swamps after first rains (Serventy & Whittell 1976) but do not flock in non-breeding season. Intermittent occurrence of birds on isolated wetlands (Bell 1971; Garnett 1978), recent extension of range to Tas. (Green 1989) and one record from NZ (Barlow 1969) are evidence of long-distance movement. Possibly move to areas of high rainfall (Black 1919; Bell 1971; Serventy & Whittell 1976) or surface water (McKeown 1923; Masters & Milhinch 1974), to floodwaters (White 1918; Reid 1976; but see Hobbs 1961), to abundant food sources, e.g. fish killed by pollution (Hindwood 1953), temporarily away from floods that have destroyed vegetation (Lord 1956), away from wetlands that have been drained, filled or are covered in water hyacinth (van Tets 1969; Wheeler 1981). Numbers also affected by wetland discharge (Gosper *et al.* 1983). Fly at night (Black 1919; Watson 1955); bird hit roof of Pajingo Stn, near Charters Towers, Qld, probably in Nov. (Black 1919).

Banding One found dead at banding location after 10 years 3 months to (ABBBS). One recovery, 30 km movement from Langwarren to Highett, Vic. (S.T. Garnett).

FOOD Vegetable matter, seeds, fruits, molluscs, insects, spiders, carrion and faeces. **Behaviour** Diurnal. Feed in water and on land. Food taken from up to 30 cm below surface. Glean and peck at ground or low vegetation at <120 pecks/min (Ridpath 1972). Prefer feeding in shallow water where there is much vegetation (Martin *et al.* 1979). Sometimes run after insects, rarely reach up on toes for food. Never grasp food with feet, though sometimes use foot to pin food to ground. Sometimes carry food in bill to wash it in water (Ridpath 1972). While swimming, glean from surface and up-end for 2–7 s, with head, body and wings submerged and tail and legs in air; do not dive; when feeding, tail always remains above water (Garnett 1978; Martin *et al.* 1979).

Adult No detailed studies. **Plants** (from crops unless stated): vegetable matter (Jarvis 1929; McKeown 1934; Hall 1974; MV); swamp herbage (obs., Lord 1956); water plants (North); algae (obs., Martin *et al.* 1979); Pteridophyta: Azollaceae: *Azolla feliculoides* buds; Hydrocharitaceae: *Ottelia ovalifolia* flower buds (obs., R. Thoday); Potamogetonaceae: *Potamogeton tricarinatus* (obs., S.T. Garnett); Lemnaceae: *Spirodela punctata* whole plants (B. Lepschi); Poaceae: *Pennisetum clandestinum* lvs (B. Lepschi); lvs and stalks (obs., Garnett 1978; Barker & Vestjens); Typhaceae: *Typha domingensis* (S.T. Garnett); Polygonaceae: *Polygonum* sds (Vestjens 1977); Portulacaceae: *Portulaca* lvs (Black 1919); Solanaceae: *Lycium ferocissimum* berries (obs., Smith 1957); Nymphaeaceae: water-lilies (North). **Animals** Annelids: Oligochaeta. Molluscs (S.T. Garnett): Gastropods (Gould): river shells (Lea & Gray); bivalves: Hydridae (Vestjens 1977). Arachnids: Araneae (Vestjens 1977). Insects: ads, larv. (S.T. Garnett); aquatic insects (Lord 1956; Gould); Odonata; Orthoptera: ads, larv. (S.T. Garnett); Gryllidae; Acrididae/Tettigoniidae: grasshoppers; Hemiptera; Coleoptera: water beetles (Vestjens 1977); Lepidoptera: ads, larv. (obs., S.T. Garnett); Hymenoptera: Formicidae (Vestjens 1977). Fish: Mullidae: *Mullus* carrion (Hindwood 1953). Amphibians: frogs:

ad., tadpoles (Frith 1969). Bread and vegetable scraps (Fleming 1976). Droppings of Silver Gull *Larus novaehollandiae* (Starks & Peter 1991), ducks (G.F. van Tets). Mud (McKeown 1934); fine sand and mud (Lea & Gray); small pebbles and grit (Garnett 1978).

Young Nidifugous. Intensely fed from hatching until 4 weeks old, less so up to 9 weeks. Make pecking gestures, but take no food themselves till at least 10 days old. Animals for first few weeks: annelids; molluscs; insects. Plants taken increasingly (Garnett 1978). **Intake** No data.

SOCIAL ORGANIZATION Well known; based on contribution by S.T. Garnett; detailed studies in ACT by Garnett (1978, 1980). In breeding season concentrate in territorial breeding groups of 2–7 adults, with young; non-territorial birds remain in flocks and leave breeding grounds in Dec. In non-breeding season most birds gather in loose flocks, sometimes over 100 birds; in ACT, flocks form early autumn as juveniles leave territories, increasing in late autumn when joined by breeding adults, and persist till formation of territories in following season, when breeding birds and immatures disperse; some adults stay in territories through winter but do not defend them.

Bonds Simultaneously promiscuous; in breeding season, form breeding groups of 2–7 apparently unrelated birds; individuals sometimes switch groups between seasons. Within group, all males copulate with all females; sex-ratio usually favours males, but even ratios (Martin *et al.* 1979; Garnett 1980) and female-biased ratios recorded (R. Thoday). Bonds form with claiming of territory; adults form breeding groups in late July, and immatures in Sept. Most birds enter groups when more than 20 months old, a few when 9 months old. **Co-operative breeding, Parental care** In Garnett's studies, members of breeding group apparently unrelated; all defended territory, built nests, and performed all types of parental behaviour; sometimes brood divided between members, which fed in different parts of territory. Bond between parent and young maintained equally by all birds in group until young independent. Garnett (1978) reported no parental behaviour in birds less than 10 months old but Fleming (1976) and Lenz (1990) observed young of first brood feeding chicks of second brood. Garnett (1978) recorded fostering of chick by neighbouring group.

Breeding dispersion Solitary and territorial; minimum distance between nests 10 m, but usually well spaced. **Territories** All-purpose, maintained breeding season only. Established by groups formed only of adults, in late July, 2 months before breeding; by groups containing immatures, in Sept. Generally defend only boundaries in water, those on land almost undefended. In fully occupied habitat, size of territory and area of reeds in territory greater in all-adult groups (total area: 1810–3330 m²; reeds 375–785 m²) compared with groups containing immatures (total area: 1818–2200 m²; reeds 60–175 m²); both groups similar in area of water (1185–2450 m²), and length of defended boundary (53–185 m) (Garnett 1980). All territorial measurements positively correlated with size of group. When territories established on stream, cover only one bank unless stream <25 m wide. In areas where suitable habitat patchy, size of territory undefinable, e.g. scattered reed beds beside large bodies of water.

Roosting Nocturnal; singly, in breeding groups, or in wintering flocks of up to 50+ birds. Often construct platforms of trampled vegetation within reeds, 0.5–2.0 m above water level, and at least 0.5 m apart; each platform holds one bird, not always same bird, every night (S.T. Garnett); presumably similar to play-platforms described by Lord (1936), which are in exposed position on weeds or mud in shallow water, or on stones in a stream. Also roost on branches overhanging water; rarely on ground

among reeds. Chicks and attendant adult often roost in incubation- or brood-nest; after 4 weeks old, young sleep alone, first on low platforms, later on raised roosting platforms. Birds assemble at roost 10–20 min before dark. Rest at roosting sites during day; also on banks, floating vegetation, logs and stones emerging from water, or in shallow water (S.T. Garnett); on hot days in WA, perch high in paperbarks (Masters & Milhinch 1974). Sleep on two legs; head tucked over back. Sunbathe on platform when cold, with wings partly opened and drooped.

SOCIAL BEHAVIOUR Well known; based on contribution by S.T. Garnett; detailed studies in ACT by Garnett (1978, 1980). Generally wary and secretive, but easy to observe behaviour where artificially fed (Fleming 1976). Displays conspicuous; identical to those of Common Moorhen *G. chloropus* but with differences in social structure; similar to Eurasian Coot *Fulica atra* and Purple Swamphen *Porphyrio porphyrio* with differences in morphology and habitat. Behaviour similar to Tasmanian Nativehen *G. mortierii*, though agonistic and predator-response behaviours simpler. Birds often jostle and call when climbing to roost-platforms. Lord (1937) recorded unusual diving behaviour by breeding female who was found submerged and stationary with tail down; said to remain submerged for up to 4 min (NPIAW 1985).

Agonistic behaviour Aggression well developed and usually occurs on water. Apparent in non-breeding flocks, particularly in spring and autumn, but no pattern detected. Rarely occurs within breeding group though, when territory being established, threats directed at fellow members of group either ignored or elicit **MEETING DISPLAY**: when birds c. 1 m apart, threatened bird arches neck, points bill vertically downwards, partly raises wings, lowers tail (Fig. 1) and, when on land, rises onto toes; threatening bird assumes same posture; after ≤ 1 min, both birds slowly pass one another and resume normal behaviour; display also performed when members meet face on. Agonistic displays mainly associated with defence of territory; all members of breeding group defend territory, but only one member confronts each intruder; during breeding season, 0.45 conflicts/h/bird occur, regardless of size of group. Territorial Advertisement call given in most territories at dawn and dusk; also often after aggressive interactions, in response to sudden noise, and sometimes without apparent stimulus. **Threat** Display and associated responses occur at territorial boundaries; usually consist of Aware, Pursuit, Diving, and Mutual Retreat; on land all elements of threat performed, except Diving. **AWARE**: resident extends head and neck, and remains rigid for several seconds (Fig. 2). **PURSUIT**: with neck extended forward, head stationary and just above water, and tail lowered, resident swims toward intruder (Fig. 3); as it approaches, resident moves swiftly and smoothly with body further streamlined, and shield prominent (Fig. 4). Intruder retreats, flicking tail often and fanning white under-tail coverts (Fig. 5). When < 2 m from intruder, resident runs across surface with wings flapping and body horizontal; intruder also runs, usually taking flight (Fig. 6). **DIVING**: if resident catches up, intruder dives, pursuit resuming after surfacing. **MUTUAL RETREAT**: at boundary, pursuit stops and resident swims slowly away with wings partly raised, white under-tail coverts spread, and head close to water (Fig. 7); swimming position also adopted by intruder on re-entering own territory; on land, birds walk away raised on toes (Fig. 8). Mutual Retreat usually seen at end of Threat Display when intruder from another territory (91% of conflicts), rather than when intruder from non-breeding flock (5%). Nearly all threatening intrusions occur July–Nov., peaking in Oct. (5 conflicts/h). Increased territorial defence after laying suggested (Martin *et al.* 1979). **Fighting** Occurs



Fig. 1 Meeting Display

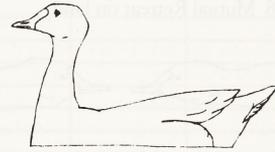


Fig. 2 Aware/Alert

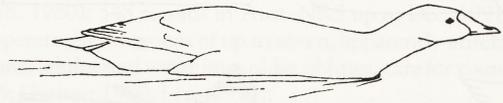


Fig. 3 Pursuit



Fig. 4 Pursuit

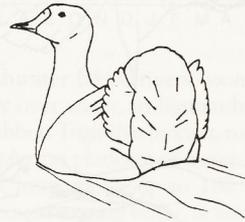


Fig. 5 Retreat



Fig. 6 Retreat

when birds from adjacent territories meet at boundary in Pursuit posture (9% of conflicts between territorial birds) (Fig. 9). At first, attack with bills (Fig. 10); if one obtains grip on opponent's neck, may force it underwater for up to 30 s, and submerged bird then retreats. If no grip obtained, both kick at each other's breasts while flapping wings (Fig. 11); rise up to 0.5 m above water; kicks eventually force birds apart, and they Mutually Retreat. No evidence of dominance hierarchies within breeding groups or among birds in winter flocks. Agonistic behaviour also directed at Little Black Cormorant *Phalacrocorax sulcirostris*, White-faced Heron *Ardea novaehollandiae*, Royal Spoonbill *Platalea regia*, Maned Duck *Chenonetta jubata*, Pacific Black Duck *Anas superciliosa*, Eurasian Coot, Clamorous Reed-Warbler *Acrocephalus stentoreus*,

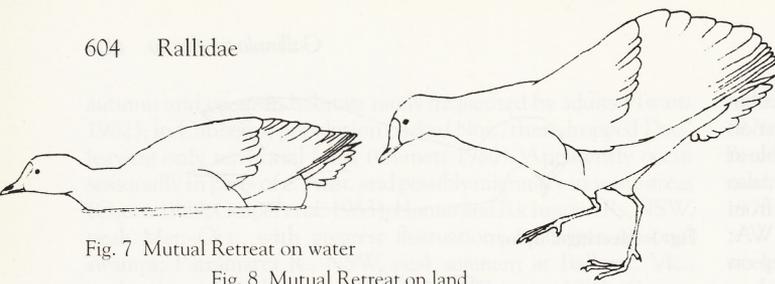


Fig. 7 Mutual Retreat on water

Fig. 8 Mutual Retreat on land

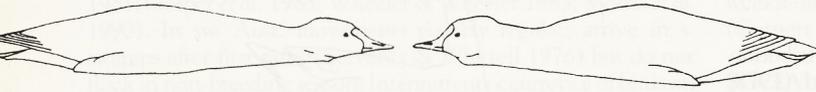


Fig. 9

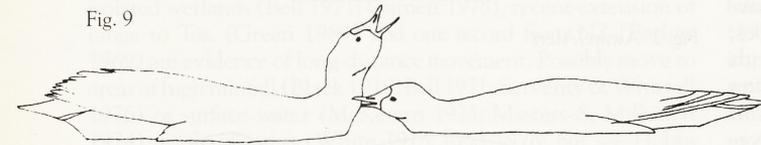


Fig. 10

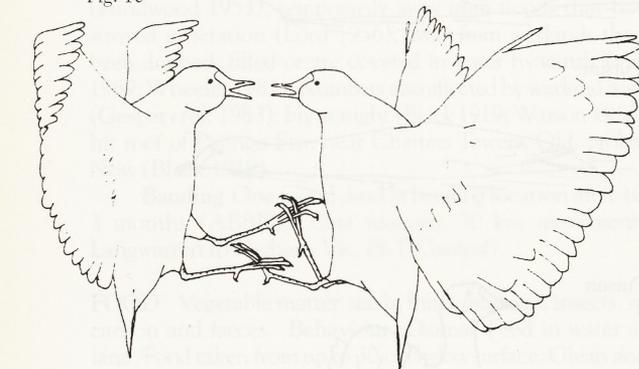


Fig. 11



Fig. 13 Males chasing female during Pre-copulatory Display

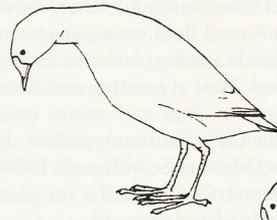


Fig. 14 Female posture before copulation

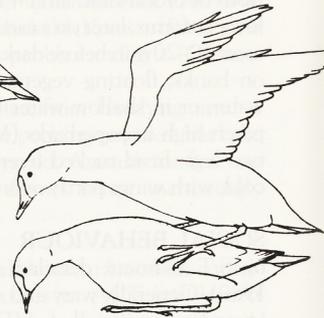


Fig. 15 Copulation

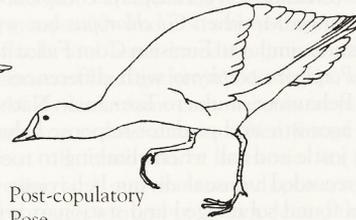
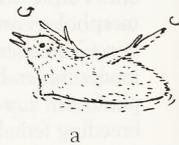


Fig. 16 Post-copulatory Pose



a

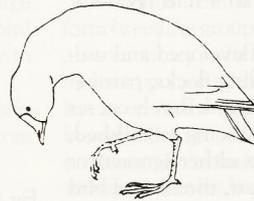


Fig. 12 Allopreening

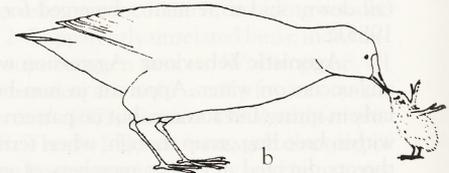


Fig. 17 Begging

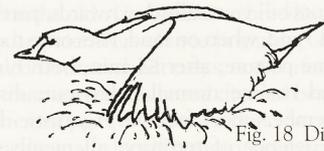


Fig. 18 Distraction Display



Fig. 19 distraction Display

and Australian Magpie-Lark *Grallina cyanoleuca*. **Alarm** Among non-breeding birds, predators elicit following responses: Alert (same as Aware) with **TAIL-FLICK** (rapid raising of tail, fanning of under-tail coverts, then slow lowering of tail) indicates general alarm; often perform for duration of feeding on land; frequency increases with proximity of threat. Increase in threat, or sudden appearance of potential predator results in Alarm Walk, Run, or Flight; if on land, move to water where Alarm Swim or Flight to Cover occurs. In cover, hide and watch predator; if cover violated, climb, often to roosting site. Give Alarm Calls when attacking or being attacked by predators.

Sexual behaviour Allopreening Occurs within breeding group, and possibly among pre-breeding immatures (S.T. Garnett). One bird approaches another with head and neck depressed, and pauses (Fig. 12); approached bird runs bill through feathers of other's head and neck; not immediately reciprocated; mainly occurs Aug.–Mar.; probably not ritualized but serves to remove ectoparasites. Copulation often occurs on play-platform (Lord 1936). **PRE-COPULATORY DISPLAY:** female usually initiates by passing in front of male or by calling briefly; then she runs or swims away with neck extended forward, and under tail-coverts fanned beneath lowered tail; 1–3 males follow, often with their bills on

female's back (Fig. 13); after ≤ 3 min only one male remains in chase, which ends on land or matted vegetation. With bill pointed vertically down, female depresses tail and crouches (Fig. 14). Pre-copulatory behaviour observed between Moorhen and Coot (J.R. Starks). **Copulation** Male climbs on back of female, maintaining balance by flapping wings and moving feet (Fig. 15); lowers tail beside laterally displaced tail of female and wags it as cloacae contact. After coition, male raises tail, and dismounts over head or side of female. Female may copulate with another male immediately; if not, she relaxes, ruffles feathers, preens, and pecks ground as if feeding. Male often adopts **POST-COPULATORY POSE** (Fig. 16): moving slowly on raised toes, lowers head, arches wings high over back, and raises tail with under tail-coverts fanned; after several paces relaxes, ruffles feathers, then resumes routine activities; more often seen after successful coition (118 of 126 observations) than unsuccessful mounting (59 of 78) or chasing (5 of 67). Sexual activity higher in later-formed groups (1.98 sexual activities/h, Sept.–Dec.; peaks 2.89 in Sept.) compared to earlier-formed groups (1.17/h, Aug.–Dec.; peaks 1.60 in Oct.), but unsuccessful mounting more frequent. Reversed copulation and homosexual mounting between males rare.

Relations within family group In first 4 weeks, close con-

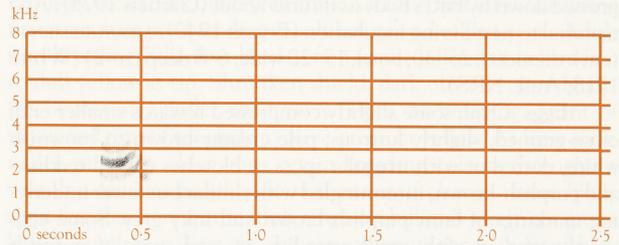
tact maintained between adults and chicks; chicks brooded at night in brood-nests, and during inclement weather. At any one time, 1–2 adults bring chicks every item of food they find; other adults bring food occasionally; when chicks brooded on nest, adults pass food to bill of brooding adult, which feeds chicks. After chick has left nest, approaches adults **BEGGING** (Fig. 17a,b): extends neck towards adult (elevation 30° in water, 60° on land), waves wings, which have conspicuous orange-yellow patches on leading-edge, and emits high piping call. Adult lowers bill, and chick pecks at yellow tip. Fed intensely until 4 weeks old, then fed with decreasing frequency until 9 weeks old. Favalaro (1926) observed chicks being fed by Eurasian Coot. Chicks may peck at ground or water surface when 3 days old, but do not feed using these motions until 10 days old. Contact Call given by adult when separated from chicks, and chicks give responding call.

Anti-predator response of young Newly hatched young capable of swimming then climbing to cover. Young remain flattened and motionless on mud; dive, travelling up to 10 m underwater, or run to cover (Lord 1936; S.T. Garnett). Breeding groups attack predators using bills. **Parental anti-predator strategies** Adults reach nest by indirect, concealed route, when direct route available (Bryant 1940); hiss if eggs handled (R. Thoday). Group attacks some predators, including cats, Water Rat *Hydromys leucogaster*, Brown Goshawk *Accipiter fasciatus*, Collared Sparrowhawk *A. cirrhocephalus*, and Australian Raven *Corvus coronoides*; closest birds try to use bills but not feet; predator sometimes pursued across water or up tree but never onto land. Only attack predator if it threatens chicks, not if threatening eggs. Adults have two **DISTRACTION DISPLAYS**: (1) with body held low, bird beats half-open wings on water and Alarm Calls, while alternately approaching and retreating from predator (Fig. 18); (2) if first not successful, while facing predator with head lowered, half raises wings and tail, then shakes them (Fig. 19). When threatened, adults give Parental Call and chicks move toward adult giving Contact Call. Purple Swamphens near nest elicit full threat display including Pursuit, Mutual Retreat and fighting; Swamphens frequently respond with similar displays. Young tended till 3–4 weeks old; remain in territory for 5–8 months, then independent; immatures leave territory Feb.–Apr.

VOICE Quite well known from work of Garnett (1978); no detailed studies. This account from contribution by S.T. Garnett and from Garnett (1978). Variety of harsh sounds from adult; communication between adults and chicks more sibilant. Main calls made all year, with increased frequency during early breeding season. Sexual and individual differences and regional variation, not known. **Non-vocal sounds** Beat water with wings during defence of chicks.

Adult TERRITORIAL ADVERTISEMENT CALL: raucous crowing *kark* (sonagram A), sometimes repeated or run together as *krrruk-uk*. Most familiar call. First call made in morning; may occur at any time of day without evident stimulus. When made by birds in one territory, taken up by those in neighbouring territories, and responses can be heard over 2 km from original call. **SEXUAL CALL:** soft mewling made by either sex during or immediately before sexual pursuit. Also short soft *kook* repeated two or three times (Garnett 1978). **ALARM CALL:** variety of short sharp utterances in response to sudden noises or movements, predators or handling, or by birds being expelled from a territory. Soft hissing call made when eggs handled (R. Thoday). **PARENTAL CALL:** short click when separated from chicks. Not heard to make calls when approaching chicks with food (Ridpath 1972). **Other calls** Wide-spaced staccato call made by birds swimming or preening within a territory; no stimulus evident, no apparent response from other birds.

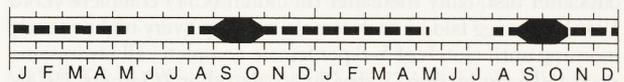
Young CONTACT CALL: series of descending whistles in reply to clicks of adult. **FEEDING CALL:** repeated shrill piping at approach of adult with food, reaching climax just before feeding; also used when separated; call made until 3 months old.



L. Gilliard; P 43

BREEDING Fairly well known; studied in ACT by Garnett (1978, 1980); 348 records in Aust. NRS up to Dec. 1991. Breed co-operatively, in groups of up to seven, apparently unrelated; up to three adults, and sometimes older siblings, care for young (Lord 1936; Garnett 1980; Lenz 1990).

Season Laying, Aug.–Mar., little variation throughout range (Bedgood 1980; Czechura 1983; Jaensch *et al.* 1988; Aust. NRS); may lay twice in a season in some areas. In ne. Qld: clutches begun, Sept.–Feb., May (Lavery *et al.* 1968; Lavery 1986). In sw. WA, lay Aug.–Dec., mostly Sept. and Oct.; laying correlates with peak rainfall plus 3 months (Halse & Jaensch 1989).



Site In freshwater lakes, rivers, swamps, artificial ponds, farm dams; usually over water, in lignum bushes, grass tussocks, canegrass, water ribbon *Triglochin procerum*, rushes *Juncus* and reeds *Phragmites* and *Typha*; on platform of water-lilies, floating nest in clear water, 20 m from shore; up to 180 cm above water; on branch of tea-tree overhanging water, at base of willow tree *Salix*, in low fork of Hawthorn *Crataegus*, butt of large tea-tree, cavity in dead stump, inside hollow log; occasionally on ground under Fog Grass *Agrostis*; in mud on bottom of drained pond, one nest a hollow in dirt at base of fallen *Melaleuca* (Morgan 1918; White 1918; Lord 1936; Bryant 1940; Aust. NRS; S.T. Garnett). Recorded using nest of other species, in tree, 3 m above ground (Klapste 1975); recorded nesting in open-ended metal drum, inside wire netting lying in water (Aust. NRS). Will prepare nests up to 1 month before, in readiness for nesting; if conditions not suitable may move up to 1.6 km away and build hasty nest in suboptimal location (Lord 1937). Nests in reeds may have passageways through growth leading to nest (Bryant 1940). Often build resting platforms or nests nearby (Lord 1936). Most nests have a runway leading from nest to water (Bryant 1940). One pair nested at base of tree in egret colony, in cavity of dead stump with Pacific Black Duck in top of same stump (Aust. NRS).

Nest, Materials Garnett (1978) identified three types of nests built by Moorhens. False nest: up to two built by some groups before egg-nest but not used for display and abandoned after completion. Egg-nest: nest in which eggs laid. Nursery nest: one or two nests, similar to egg-nests, are built after eggs hatch and used as brooding nests at night and during day in bad weather after chicks leave egg-nest. Nest in which eggs laid: bulky platform or shallow cup, loosely constructed of reeds, rushes, lignum shoots, bark, twigs, leaves and waterweed (White 1918; Lord 1936; Aust. NRS). Nests in reeds may have foundation of pressed

down reeds (Aust. NRS). All members of group help build nest; material collected from surrounding vegetation although some material carried from up to 30 m away. Building bird will pull down vegetation and push it round and under itself; material pressed down by bird's body as it turns about (Garnett 1978). Add material to nest during incubation (Bryant 1940). **MEASUREMENTS** (cm): diameter, 25–30; bowl, 15–20 wide, 6–8 deep (n=2) (White 1918; Aust. NRS).

Eggs Oval; some slightly compressed towards smaller end; close-grained, slightly lustrous; pale creamy-brown to brownish white, dotted or with irregular spots or blotches of dull reddish and purplish-brown, intermingled with similar but fewer underlying markings of faint purplish-brown and inky grey. Some eggs evenly marked with small roundish or oval spots of purplish brown and dull violet-grey, latter appearing as if beneath shell (North). **MEASUREMENTS**: 52.8 (2.40; 48.8–58.4; 19) × 35.6 (1.27; 33.8–37.8) (North), 47.3 (1.79; 45.0–49.5; 7) × 33.6 (0.54; 32.8–34.0) (Aust. NRS).

Clutch-size From Aust. NRS: 7.8 (5–18; 85); larger clutches probably result from laying by two or more females. In ACT, for early breeding groups: mean number of eggs per nest (n=36), 8.5; mean number of eggs laid per female, 6.7; if one group contains two females, both lay in same nest (Garnett 1980); one nest of 18 eggs contained three differently coloured groups of five, six and seven eggs (Aust. NRS).

Laying Irregular for first few eggs then daily thereafter; at one nest: first egg laid 4 days after nest complete; second egg, 9 days after first, daily thereafter till clutch (C/7) complete (Lord 1936). One egg laid by each female in group every night or early morning until clutch of 5–8 per female complete; all lay in same nest and start within 3 days of each other (Garnett 1978). Hatching asynchronous but usually within 48 h (Lord 1936), within 1–5 days (Garnett 1978). Will lay again within 2 weeks of failure; three eggs in nest 13 days after eggs collected; same nest used for second brood (Lord 1936). One nest found to contain egg of Musk Duck *Biziura lobata* (Lashmar 1937); twice, eggs of Eurasian Coot found in nest of Moorhen (Campbell).

Incubation Usually begins after laying of last or second last egg (Garnett 1978), though said to begin after laying of second egg (Lord 1936). All members of group are thought to incubate (Garnett 1978). Incubating bird may leave eggs for 2–3 h if sun warm, incubate longer on cooler days (Bryant 1940). **INCUBATION PERIOD**: from laying of last egg to hatching complete: 21 days (Lord 1936), 22 days, 23 days, 24 days (Aust. NRS).

Young Semi-precocial, nidifugous. At hatching: down, black tipped silver; bill, red with yellow basal half; skin on crown, orange-brown or red; skin round eye, bright blue; skin on leading-edge of wing, orange-yellow; at 1 month: fully feathered, brown with light-grey streaks on cheeks (Lord 1936; Bryant 1940; Garnett 1978). **Parental care, Role of sexes** Remain in nest for up to 3–4 days; fed in nest after hatching, fed and guarded by up to three adults till c. 4 weeks old, begin to feed independently after 3–4 weeks (Garnett 1978, 1980; Aust. NRS). Chicks fed bill to bill; adults will pass food to brooding bird, which passes it on to chicks; older siblings will take food from adults and pass it to newly hatched young (Fleming 1976; Garnett 1978, 1980). If nest approached during incubation, sitting bird leaves nest and tries to distract intruder with actions and calls (White 1918; Garnett 1978). Chicks drop into water, swim to branches in water, climb them and hide in foliage, or lie in mud at edge of water and remain still (Lord 1936); in open water, chicks dive and swim underwater towards cover where they hide or approach another Moorhen (Garnett 1978).

Success In ACT: mean productivity per female: in early

groups: 6.72 eggs laid, 5.59 hatched, 1.97 young fledged per group; in late groups: 6.10 eggs laid, 2.65 hatched, 0.5 fledged per group. Size of group does not effect productivity; loss of eggs higher in groups with two females (16.6%) than in those with one female (8.1%); of those eggs that hatched, only 25.2% fledged. Early nesting groups have higher success than late groups; mortality from early groups mainly occurred after hatching: of 307 eggs laid, 13.4% eggs lost. For late groups: 38.5% eggs lost. Only one brood raised per group (Garnett 1980). From Aust. NRS: from 182 eggs laid, 101 (55.5%) hatched. In ACT: nests with least cover suffered greatest predation (Garnett 1978). Mortality of young high; Water Rats take eggs and young; harriers probably take young (Bryant 1940; Campbell); nests flooded by rising water (Aust. NRS).

PLUMAGES Prepared by D.J. James. Sexes similar throughout life. Hatch in natal down; pre-juvenile moult begins in a few days, producing distinct juvenile plumage; post-juvenile moult, partial, producing first immature non-breeding plumage, which similar to, but duller than, adult, with distinctly duller bare parts; partial immature pre-breeding moult produces immature breeding plumage, which similar to immature non-breeding; thereafter complete post-breeding and partial pre-breeding moults produce alternating though indistinguishable non-breeding and breeding plumages. Sequences very similar to extralimital Common Moorhen *G. chloropus* (cf. Grant 1914; Karhu 1973; BWP).

Adult breeding Definitive basic. Fairly sombre, uniform dusky grey with olive tinge on upperparts and black-and-white under tail-coverts. **Head and neck** Uniform grey-black (c82); fades to duller sooty-grey (dull 82) with wear; feathers have concealed whitish shafts basally. When fresh, many have thin whitish fringes on feathers of chin and throat producing slightly paler area, but generally lost with wear. **Upperparts** Mantle, dark grey (c83), slightly paler than hindneck; becomes duller sooty-grey with wear; lower central feathers have dark-olive tinge, like scapulars; feathers have concealed light-grey (c86) centres grading to grey (84) edges at base. Scapulars, and back to upper tail-coverts, uniform dark brownish-olive (between 129 and 49); slight tinge of very dark rufous when fresh becomes more olive with wear; feathers have concealed grey-black (82) bases with short whitish shaft-streak. **Underparts** Breast, belly and flanks, uniform dark grey (c83) when fresh; slightly duller and paler with wear and fringes fade to light grey-brown (c119C). About 10–15% (skins; Eskell & Garnett 1979) have short narrow (<3 mm) white streaks along shafts (mostly on outer web) of about five central flank-feathers; these sometimes align as one continuous stripe along side (when feathers folded over wing) (Cox 1973) but more often form broken stripe. A few have thin white fringes on feathers of belly when fresh. Vent, grey (84) with varying white tips to feathers, that may give faintly scaled to strongly mottled appearance; in many, fringes lost through wear; feathers, dense and loosely knit; no consistent difference between sexes, unlike Common Moorhen (BWP). Under tail-coverts, black in centre, white at edges in sharply delineated and contrasting pattern; feathers in lateral columns (one-quarter of feather, c. 10 mm wide each side), wholly white; central half (c. 20 mm wide), wholly black; longest feathers of flank wrap round to conceal white basal lateral coverts, giving impression that black central coverts extend farther toward vent. **Tail** Black; very slight greenish gloss when fresh, quickly lost. **Upperwing** Remiges, primary coverts and alula, black-brown (19), fading to dark greyish-brown (c119A) when very worn; leading-edge of p10, whitish, but inconspicuous and only visible edge-on, extending to neither dorsal nor ventral surface of web. Tertiaries and inner wing-coverts, as scapulars. Few have single row of white marginals on leading-edge of wing; this

apparently correlated with development of white stripes on flank. **Underwing** Uniform dark grey-brown (grey 219); palest birds may have faint thin white fringes at tips of coverts.

Adult non-breeding Definitive alternate. Identical to adult breeding; number of new contour-feathers varies but typically head, neck and under tail-coverts, usually mantle and sides of breast, sometimes breast and flanks, new; these faintly contrast with retained, faded non-breeding feathers.

Downy young Down, very sparse and wispy with much bare skin showing on head and wing, thin and wispy above, and dense and woolly below. Head, neck, upperparts and tail, black, with long silver-white tips to down on throat and neck. Underparts, black-brown (119).

Juvenile Duller and slightly paler than adult, with paler throat, browner upperparts and more mottled underparts. **Head and neck** Top of head, dark brown (121), sometimes with narrow light grey-brown (119D) fringes to feathers, which, if present, are soon lost. Chin, throat and neck, dark grey-brown (grey 129); feathers of chin and throat have varying white bases (half to full width of base on central feathers, becoming narrower on feathers laterally and towards neck); palest birds have white bases showing as faint mottling on lower sides of face. **Upperparts** Feathers, dark brown (c21) grading to concealed grey-black (82) bases; have less olive or rufous tinge than adult. Feathers strongly prone to fade patchily to grey-brown (c91), producing slightly untidy appearance. **Underparts** Mostly brownish grey (brown 79) fading slightly (to brown 80) with wear. Central breast often has fine white speckling at tip of feathers when fresh; with wear, broad light grey-brown (c27) fringes develop at tip of feathers. White stripes on flanks like those of adult present in probably same proportion of juveniles as adults. Vent, like adult but often whiter, more mottled, feathers having slightly broader white tips. Under tail-coverts, similar to adult, but some have very thin white tips to black feathers when fresh. **Tail** Like adult. Rectrices, pointed and frayed (not rounded and tightly knit) at tips. **Upperwing** Like adult. Coverts and tertials, browner, like upperparts; tertials have pointed, frayed tips often with clinging down. Some have very thin white fringes to greater and median coverts. Some have thin white leading-edge like adult. **Underwing** As adult.

First immature Feathers of head, neck and varying area of body (usually mantle, breast, flanks and under tail-coverts), replaced, appearing very similar to adult. Retained juvenile feathers, by now faded and conspicuously browner or grey-brown by comparison. If breast and belly replaced, new feathers typically have light grey-brown (c27) fringes but not clear if these most prominent when fresh or worn. Juvenile tertials and remiges retained but wear tends to reduce pointedness and fray tip, making detection difficult in some cases. Best distinguished from adult by bare parts.

Second immature Juvenile wing retained and by now rather worn. Replace feathers head, neck and probably most of body, which are very similar to adult.

BARE PARTS Based on literature and field notes (Alexander 1919; Hall 1974; Garnett 1978; Eskill & Garnett 1979; S.T. Garnett; D.J. James) supplemented by museum labels (AM, HLW, MV) and photos (NPIAW 1985; Aust. RD; unpubl.: D.J. James).

Adult breeding Bill, bright red to crimson with sharply delineated yellow distal quarter to upper mandible and yellow distal third to lower mandible. Slightly swollen frontal shield, orange-red to orange, colour extending broadly onto base of culmen and very narrowly round base of rest of bill. Mouth, light pinkish-grey. Iris, red-brown. Front of tarsus and top of toes, orange-red to orange (similar to bill but duller; toes slightly duller than tarsus)

narrowly edged light olive-yellow or lime-green along sides; rear of tarsus, sole and joints, dark olive-grey, latter broad, forming conspicuous banding. Tibia, completely encircled, dark red to orange-red, a little darker than front of tarsus and separated from tarsus by broad dark olive-grey ankle. Colours first attained during first immature pre-breeding moult before end of first year. **Adult non-breeding** Bill, olive-black (often retain dull-red tinge) grading to dull yellow at tip. Shrunken shield, dark olive to olive-black. Iris, sometimes duller red-brown. Tibia, as breeding. Front of tarsus and tops of toes fade to olive-green or yellow. At least some males, probably older ones, retain breeding colours throughout year, but females possibly do not; males, if change, more likely than females to retain reddish tinge on bill and rarely get green legs. Complete colour change can occur in three to four days. **Downy young** At hatching, frontal shield, rictus and basal third of upper mandible, red; tip of upper mandible, yellow, with white egg-tooth; lower mandible, pink-orange fading to pale yellow at tip. Black ring quickly develops between yellow tip and red base. Over first 10 days or so, red of shield and bill fades to pale red or pink. Iris, dark brown. Legs, black. Bare skin on head orange-pink to orange, with pale blue-grey above eye; skin on wing-tips, orange-yellow. Wing-claw, ivory-white. **Juvenile** Bill and shrunken shield remain pale red until post-natal moult almost complete; then dark olive-brown patches develop along sides of bill and quickly spread until bill and shield all dark. Iris, dark brown. Legs and feet, dark olive-green or olive-brown. **Immature** Bill, shield and tibia, olive-black or dark olive-brown, similar to juvenile; this colouring of tibia, diagnostic of young. Iris, dark brown. Tarsus, olive-green.

MOULTS Little information; 40 skins (AM, HLW, MV) from se. Aust., none of which is moulting flight-feathers; moults apparently very similar to those of Common Moorhen (see BWP) but few details available. Evidently, shy, retiring and elusive when moulting. **Adult post-breeding** (Pre-basic). Flight-feathers, simultaneous. Primary coverts moult with remiges (Carins & Draffan 1976). Moult of head and body begins more or less anteriorly; protracted, but not known if interrupted during wing-moult. Specimens in body-moult, Nov.–Jan. and Apr. **Adult pre-breeding** (Pre-alternate). Partial; restricted to head and body, but varies in extent. Skins in moult, June–Sept. **Pre-juvenile** Begins second to third week. Feathers of head and body develop before wings. Wings sufficiently developed to enable flight from c. 8 weeks (Garnett 1978). **Post-juvenile** (First pre-basic). Partial; juvenile flight-feathers retained. Extent of moult varies. Usually replace head, neck and under tail-coverts, often mantle and upper breast, rarely all of underparts. Possibly occurs during autumn of first year. **Immature pre-breeding** (First pre-alternate). Partial. Like adult pre-breeding and probably executed at similar time.

MEASUREMENTS Nominate *tenebrosa*: (1) Aust., adults and immatures combined, skins; BILL F = from back of frontal shield (feathers) and likely to vary seasonally; BILL L = from loreal point (AM, HLW, MV).

	MALES	FEMALES	
WING	(1) 208.5 (7.12; 197–223; 19)	199.6 (7.01; 189–213; 16)	*
STH P	(1) 138.3 (3.17; 133–144; 12)	133.0 (2.38; 128–135; 7)	*
TAIL	(1) 73.9 (4.16; 64–82; 16)	70.6 (3.96; 63–77; 16)	ns
BILL F	(1) 46.2 (3.63; 40.0–52.0; 17)	43.1 (3.19; 39.0–47.9; 16)	ns
BILL L	(1) 38.0 (0.99; 28.1–32.0; 16)	28.6 (1.08; 26.9–30.1; 16)	*
TARSUS	(1) 63.3 (3.14; 57.6–69.9; 19)	60.2 (2.95; 54.5–67.8; 16)	*
TOE	(1) 71.4 (4.08; 63.0–77.5; 17)	67.8 (3.63; 62.7–73.8; 13)	ns

WEIGHTS Nominate *tenebrosa*: (1) adults and immatures, combined; museum labels (AM, HLW, MV).

	MALES	FEMALES	
(1)	570 (73.6; 490–720; 5)	493 (121; 336–684; 7)	ns

STRUCTURE Wing, broad, rather long for rallid. Eleven primaries; p8 longest; p10 16–22 mm shorter, p9 0–4, p7 1–9, p6 7–14, p5 14–22, p4 23–30, p3 35–41, p2 45–51, p1 54–64, p11 minute. Tail, short, rounded; rectrices rounded at tip in adults but pointed and frayed in juveniles. Large, smooth, elliptical frontal shield (up to 13 mm wide) continuous with base of bill, enlarges slightly in breeding season. Bill, laterally compressed, comparatively shallow and straight at base with gently decurved, tapering tip. Nostril, horizontally elliptical, elongate, set in large nasal groove. Legs, heavy. Tarsus, laterally compressed, rounded at front and sharply keeled behind. Toes, long and slender; front toes, narrowly lobed; hind-toe, laterally compressed, keeled. Tarsus and lower 25 mm or so of tibia, bare; scales, mostly enlarged, scutellate but smaller, reticulate at joints and down sides of tarsus. Outer toe 85–89% of middle, inner 73–80%, hind 30–35%. Claws, long, sharp, slightly downcurved, strongly laterally compressed.

GEOGRAPHICAL VARIATION Nominate *tenebrosa* confined to Aust., mostly E of 135°E. and in sw. WA, with scattered records from n. and nw. Aust. (Aust. Atlas); no geographical variation described. Two extralimital subspecies: *frontata* of se. Borneo, Wallacea and se. New Guinea (White & Bruce 1986; Rand & Gilliard 1967), differs mostly in bright red front of tarsus and top of toes in adults; White (1976) suggested leg-colour not reliable for differentiating these subspecies, citing two skins of *tenebrosa* in AMNH labelled as having 'red' legs; furthermore, details of seasonal change not described for *frontata*; however, 'bright' red tarsus and toes, if occurring in nominate, exceptional; further investigation needed. Possibly also differs in slightly smaller size: White (1976) gives wing 187–206 for *frontata*. Subspecies *neumanni* of n. New Guinea, darker with blackish mantle lacking olive tinge, and smaller: wing 161–198 (White 1976). Additional detail on bare parts of all subspecies in Eskell & Garnett (1979).

Closely related to and sometimes thought conspecific with widely distributed Common Moorhen (see Eskell & Garnett 1979), which is much smaller (wing: 156–194 mm; weight: 146–493; Vaurie 1965; BWP) with different colours of bare parts and juvenile plumage (BWP). White flank-stripes always present, long, broad and aligning as single continuous stripe in adult *chloropus* but rarely present and seemingly vestigial in *tenebrosa*; suggests *tenebrosa* recently derived from *chloropus* stock. *G. tenebrosa* and *G. chloropus* apparently sympatric in parts of Wallacea and se. Borneo though details not well described and sympatric breeding not recorded; temporal disparities in distribution suggest *chloropus* replacing *tenebrosa* in areas of overlap (see White & Bruce 1986 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