

Order **PODICIPEDIFORMES**

Family **PODICIPEDIDAE grebes**

Small to medium-large, foot-propelled diving birds. Single family in order. Morphology and egg-white protein suggest no close relationship with any other group of waterbirds (Sibley & Ahlquist 1972). Evidence from DNA hybridization (Sibley *et al.* 1988) implies that grebes diverged from a lineage that gave rise to penguins, petrels, pelicans and storks. Formerly considered closely related to Gaviidae (divers) but similarities due to convergence (Stolpe 1935; Storer 1960, 1971). Twenty species in six genera, worldwide; four species in three genera in our region.

Aquatic specialists, mostly in temperate climates. Main centre of adaptive radiation in New World, especially South America. Generally avoid ice, snow and cold waters. During breeding season, inhabit standing fresh water, particularly shallow eutrophic lakes with muddy, clayey or sandy bottoms and emergent, submerged or floating vegetation. Readily colonize newly flooded or excavated areas. Dispersive, capable of long-distance movements, probably normally at night. In winter, tend to form non-breeding flocks on permanent water, including sheltered bays and estuaries.

Body elongated (in larger fish-eating species) or rotund; feet placed far back, and high on sides of body. Neck rather long. Wings small and narrow; remiges curved; when folded, fitting closely to body, concealed by feathers of flanks and back; 12 primaries, p10 usually longest, p12 minute; 15-22 secondaries; usually diastataxic. Some species have never been seen to fly. Tail-tuft short, downy; lacks stiff rectrices. Shape of bill from long and pointed to short and stout; generally larger in males. Nostrils usually narrow slits. Feet large: used in propulsion and steering. Tarsi strongly laterally compressed. Toes broadly lobed, front three connected by small webs at base; hind toe raised, flattened, with small lobe. Nails broad and flat, those of middle toe pectinate. Joints of tibiotarsus and toe extremely flexible, conferring manoeuvrability while swimming. Clumsy on land but can run for short periods, often falling over. Oil-gland feathered.

Plumage dense and waterproof; looser on upperparts, more downy towards rump. Feathers of underparts directed perpendicularly from body and strongly curved towards tip (Chandler 1916), giving breasts distinctive satiny texture. Before diving, feathers pressed against body, decreasing buoyancy; assumed to be the way in which grebes adjust their level of swimming; often swim with only head and neck above water. Adults are generally dark brown above, white below. Most have a colourful or ornate breeding plumage, often with chestnut markings on neck or crests and head-plumes; also yellowish-green patch of swollen skin on gape and base of lower mandible. Chicks covered by short dense down, usually with longitudinal striping on upperparts and complex patterning on head. Strands of down attached to tips of individual barbs of emergent juvenile feathers and wear off gradually, especially on head. Juveniles, otherwise similar to non-breeding adults, can be recognized for some time, even months, on basis of remnant striped pattern on head.

Moult of remiges simultaneous; flightless period of about 3 weeks. Moult of wings usually follows breeding, but pre-breeding moult in some species, or wing-moult may be inserted between first and second broods. Body-moult (Storer & Nuechterlein 1985; Piersma 1988a,b,c, 1989) extremely complex; some tracts, especially flanks, in almost continuous moult, which may provide continuous source of ingestible feathers used in pellet formation.

Feathers usually found in stomachs of adults and young, especially in fish-eating species. Habitually eat own feathers, preferring those from flanks, while preening; given to young from day of hatching. Eating of feathers believed to assist in formation of pellets, reducing chances of gastric parasites building up (Piersma 1989). Breast-pelts ('grebe fur') were once used for making women's muffs, capes and hats, but now grebes are of no direct commercial use.

Usually monogamous, bonds probably lasting for only one season. Elaborate and complex displays when breeding. Territorial and usually well dispersed, but some species truly colonial nesters. Nest is usually a floating mass of sodden water-weed, attached to submerged or emergent vegetation. Both sexes build. Eggs, white, characteristically pointed at both ends; quickly become stained brown. Clutch-size of 2-6 eggs. Laying at intervals of about 48 h. Lost clutches and perhaps broods replaced. Two or three broods may be raised in one season. Both sexes incubate and rarely leave the nest but cover eggs when they do so. Incubation lasts for 3-4 weeks. Young precocial but depend on parents closely for about 3 weeks; when small often carried on backs of parents. Fledging period in some species 6-7 weeks, in others 10-12. Juveniles may help to feed and tend young of subsequent broods.

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Tachybaptus novaehollandiae Australasian Grebe

COLOUR PLATE FACING PAGE 112

Podiceps novaehollandiae Stephens, 1826, *Shaw's Gen. Zool.* 13: 18 — New South Wales.

The generic name is combined from the Greek *ταχύς* (swift) and *βάπτειν* (to dive), ie. *the fast diver*.

OTHER ENGLISH NAMES Little Grebe, Australian Little Grebe, Dabchick, Black-throated Dabchick or Grebe, Red-necked Grebe and various combinations using **diver** incorrectly.

Because the species was for a long time submerged in **Little Grebe** *T. ruficollis*, the English names are somewhat confused and it is best to break away from all previous usages.

POLYTYPIC Nominate *novaehollandiae* occurs Aust., Tas., s. New Guinea and NZ; *leucosternos* (Mayr 1931) New Hebrides and New Caledonia; *rennellianus* (Mayr 1931) Rennell I., Solomon Is; *javanicus* (Mayr 1943) Java; *timorensis* (Mayr 1943) Timor; *fumosus* (Mayr 1943) Talaud Is; *incola* (Mayr 1943) n. New Guinea.

FIELD IDENTIFICATION Length 23-25 cm; wing-span 39 cm; weight 100-230 g; males probably heavier than females. The smallest A'asian grebe, with short, stout bill, short neck and dumpy, blunt-ended body. No ornamental head-feathers when breeding. Shows broad white patch in wings during flight. When breeding, generally dark plumage above, with conspicuous yellow gape-patch. Trilling call in breeding season and some tawny or buffy plumage, diagnostic. Sexes alike. Marked seasonal differences in plumages. Juvenile, generally pale; distinctive.

DESCRIPTION **ADULT BREEDING.** Forehead, lores, crown and nape, grey-black with chestnut stripe on sides of neck from behind eye to mid-neck. Conspicuous, sharply defined yellow patch of bare skin between base of lower mandible and eye; chin and throat, mainly blackish; rest of upperparts, dark grey-brown. Upper breast, dark brown appearing faintly mottled (from pale tips to feathers) with white; rest of underparts, whitish. Flanks, pale chestnut or tawny with dusky spots; downy rear, pale buffish and white. Iris, large, yellow. Bill, black with cream tip. **ADULT NON-BREEDING, IMMATURE.** Similar to adult breeding but paler, especially on face, neck and bill. Forehead, crown, upper part of lores and nape, dark grey-brown as rest of upperparts; grey-brown cap separated from paler lower-face along a line passing from upper mandible through centre of eye; ear-coverts and sides of neck, light buffish-grey; cheeks and throat, off-white; flanks, buff with diffuse darker spots. Gape-patch, off-white; sides of bill, light yellowish to bluish; upper mandible, dark to below nasal groove. **JUVENILE.** Initially, face boldly striped with black; later, only remnants of one dark diagonal remain on cheeks; some rufous feathering in dark cap and nape; flanks, warm buff with some streaking. Small, creamy gape-patch develops behind irregular dark stripe across base of both mandibles; otherwise bill similar to non-breeding adult. In general, paler than adult.

SIMILAR SPECIES Easily distinguished from **Great Crested Grebe** *Podiceps cristatus* by small size, dumpy appearance, lack of ornamental head-feathers when breeding and short neck. Out-of-breeding plumage and juvenile hard to separate from **Hoary-headed Grebe** *Poliiocephalus poliocephalus*. Line separating dark crown from white face passes through eye in Australasian, but below eye in Hoary-headed Grebe. Australasian in incomplete non-breeding plumage often has dark smudge below eye and some pale rufous on sides of neck. Nostrils oval in Australasian, elongate and pointed posteriorly in Hoary-headed. Borderline between forehead feathers and culmen, convex in Australasian; concave in Hoary-headed. Downy young Hoary-headed have light buff or white mid-dorsal stripe bordered by darker stripes; in Australasian, mid-dorsal stripe, dark brown, bordered by paler stripes; flanks buff-washed, not grey, lack of dark stripe on nape, subtly different silhouette and differences in habitat and gregariousness all useful clues to identity. **New Zealand Dabchick** *Poliiocephalus rufopectus* is slightly, but noticeably larger, blacker above in all plumages, strongly chestnut from chin to chest; lacks rufous stripe on sides of neck and yellow gape-patch; is not so furtive or secretive and is silent.

Found on all sorts of rather shallow freshwaters from small dams to large lakes and marshes; more likely to occur on smaller, weed-covered waters than Hoary-headed Grebe, tending to be found mostly near shore and in fringing vegetation rather than on open water; also less likely on brackish and saline waters. Usually singly or in pairs, not forming large parties. Swim and float buoyantly with compact, high-sterned, blunt-ended, round-headed profile; normally, neck appears short but obviously long in upright and advertising postures and sometimes when threatened. Dive with small forward jump and splash, downward swing of neck. Fly with rapid whirring wingbeats, head and neck extended, feet protruding,

with hump-backed appearance; fly low above water but not often seen to do so except during territorial and courtship encounters. In emergencies, more likely to dive than fly. When alarmed, can disappear completely, even on waters with little or no vegetational cover. Generally, very secretive and wary, much more so than Hoary-headed Grebe and New Zealand Dabchick. Only accidentally on land.

HABITAT Wetlands of all sorts, mainly freshwater, in temperate to tropical, arid to high rainfall zones, and from sea-level to se. uplands; unusual on brackish or saline waters, at least in se. Aust. Equally at home on smallest farm dams and deep permanent or semi-permanent waters or on temporary floodwaters, mostly with some fringing vegetation, especially when breeding.

AUST. Wetlands in varying terrain from open cleared flats and undulating areas to hilly forested areas. In arid zones, on dams and similar artificial or temporary waters (Wilson 1974). In n. coastal NSW, common on: seasonal freshwater swamps, to 1.3 m deep, with low emergents, and submergents; semi-permanent swamps, to 1.5 m deep, with tall emergents, submergents and some open water; permanent open freshwaters with submergents and no emergents; less common on: shallow, seasonally flooded, freshwater meadows, open pools in saltmarshes, and on reed-swamps with dense *Phragmites* or *Scirpus* (Gosper 1981). In inland NSW, common on dams and in semi-permanent swamps (Vestjens 1977; Fjeldså 1988). In Vic., recorded on shallow (<0.5 m) freshwater marshes, dominated by herbs; deep (>1 m) freshwater marshes, dominated by rushes; deep open freshwater marshes without emergents; permanent natural lakes, over 1 m deep; reservoirs, over 1 m deep with some aquatics (Corrick & Norman 1980; Corrick 1982). Surveys in Vic. in two seasons found distribution roughly equal (50–55%) between small (<100 ha) and large waters, having greater proportion of population on small waters than most other species of waterfowl (Martindale 1988; Hewish 1988). In WA, largest numbers on brackish to moderately saline (<30‰) lakes, 0.5–1.5 m deep, with large areas of open water, fringed by dense vegetation, and on large estuarine area (Vasse), 0.5–1.0 m deep, fresh to brackish, non-tidal (Jaensch *et al.* 1988).

NZ. Mainly freshwater pools, small lakes, farm ponds, dams and coastal dune lakes, always reed-fringed, sea-level to 300 m asl. Breeding reported on mountain lakes (Falla *et al.* 1978); reed-fringed ponds in farmland (Lauder 1978).

Probably prefer (from multivariate analysis) rather small open waters with some cover of tall aquatics and banks with herbs or scrub, and fairly deep, permanent clear water. Typically feed where gradient of bottom is steep, near steep banks, and at edges of reed beds with patchy emergents (tufts of *Triglochin*), clumps of submergents, submerged logs, and carpets of *Azolla* or coarse floating vegetation. On open lakes, found away from banks, normally where there are snags, logs, protruding trunks, gradients of depth and at edges of dense reed-beds (Fjeldså 1985, 1988).

Depend for breeding on fringes or patches of emergent vegetation (*Typha*, *Eleocharis*, *Triglochin*, carpets of *Myriophyllum*) for anchoring and concealing nests; usually on fertile, permanent and semi-permanent waterbodies; usually avoid uniform grass-swamps and thick stands of emergents, preferring mosaic of cover and open water but can breed successfully on small dams or ponds, including ornamental lakes (R.P. Jaensch), with no cover except steep grassy edge. Out of

breeding season or in dry times may concentrate in flocks on large lakes with dead or live trees in water (Hobbs 1958; Fjeldså 1988), on exposed lakes and other large waters, dammed salt pans, sewage farms (Gosper 1981).

Since European settlement, probably much habitat lost or modified by drainage, increased salinity, extraction of ground-water, etc. (Riggert 1966; Goodrick 1970; Corrick 1981, 1982; Halse 1987; Jaensch *et al.* 1988), thus leading to loss or depletion of populations in some areas. On the other hand, artificial impoundments have doubtless been of benefit.

DISTRIBUTION AND POPULATION Aust. and NZ; extraliminally Indonesia, from Java to Timor; New Guinea and nearby islands; New Caledonia; New Hebrides. Accidental to Moluccas, Admiralty Is (Peters).

AUST. Widely distributed except in drier regions but can be found there on water storages or where water persists after good rain. **Qld**; throughout; less common in N and SW; also Torres Str. islands, Dec. to Mar. only (Draffan *et al.* 1983). **NSW, Vic.:** reported all regions. **Tas.:** original status uncertain; small numbers (<10 adults) reported annually (Tas. Bird Rep. 1972–88); first records 1964 and breeding reported Oct. 1965 (Wall 1979); first reported King I., 1972 (McGarvie & Templeton 1974). **SA:** common in se. area but not reported from e. Nullarbor nor Great Victoria Desert, possibly reflecting distribution of observers and surface water (Aust. Atlas). **WA:** reported from w. Nullarbor at Black Ridge Dam, N of Naretha, 8 Feb. 1978 (Brooker *et al.* 1979) and Cocklebidy Tank, N of Eyre Bird Observatory, Feb., Mar. and Apr. 1985 (Dymond 1988); regularly recorded sw. WA and Pilbara and Kimberley regions but reports probably limited again by distribution of observers and water. **NT:** scattered throughout but apparently fewest in desert areas; in Tanami Desert, 1981–84, uncommon, groups of 2 to 20 observed; usually found wherever large waterbodies present (Gibson 1986); scattered records Simpson Desert (Gibson & Cole 1988).

NZ. First records: one, Arrowtown, Otago, Apr. 1968–Jan. 1969 (Chance 1969); a pair, Dargaville, N. Auckland, Aug.–Oct. 1972 (with pre-breeding behaviour Sept.; Miller 1973); one, L. Okareka, near Rotorua, Jan.–Mar. 1973 (Lyle 1973). Now small breeding population established on NI and SI. NI population centred on n. and w. Northland; with occasional records elsewhere e.g. Dargaville district 1980; L. Tarawera 1977; Paraparaumu 1974 (B.D. Heather). SI: a few pairs near Greymouth, Cheviot, and possibly Kaikoura and Southland-Otago; scattered observations from near Collingwood, nw. Nelson, 1976, 1985, 1986; L. Elterwater, Marlborough 1975–77; Charleston, West Coast, 1981–83 (B.D. Heather).

BREEDING Aust.: throughout range, but mostly E of a line from Cairns to Eyre Pen. and SW of line from Jurien Bay to Esperance; Tas., in small numbers, probably now annually (Wall 1979; Tas. Bird Rep. 1972–88). Other, scattered, breeding records mostly inland, from SA, WA and NT (Aust. Atlas). **NZ:** first recorded SI: pair with three young, Diamond L., near L. Wanaka, Otago, Mar. 1977 (CSN 24); near L. Brunner, West Coast, 1978 (Lauder 1978) and 1979; St Anne's Lagoon, near Cheviot, n. Canterbury, 1979–89 (usually one pair but max. six adults and four young 1980); possibly also Southland in late 1970s (B.D. Heather). On NI, pair with chick 1987 and 1988 at L. Kereta, S. Kaipara Head (B.D. Heather); probably breed Ls Rotorua and Rotoiti and, in N. Auckland, on Aupouri and Karikari Pens where recent



non-breeding counts have been largest in NZ.

In Aust., distribution may be modified by flooding and drought and provision of farm dams. Status: in Aust., stable; in NZ, population small and apparently declining (B.D. Heather).

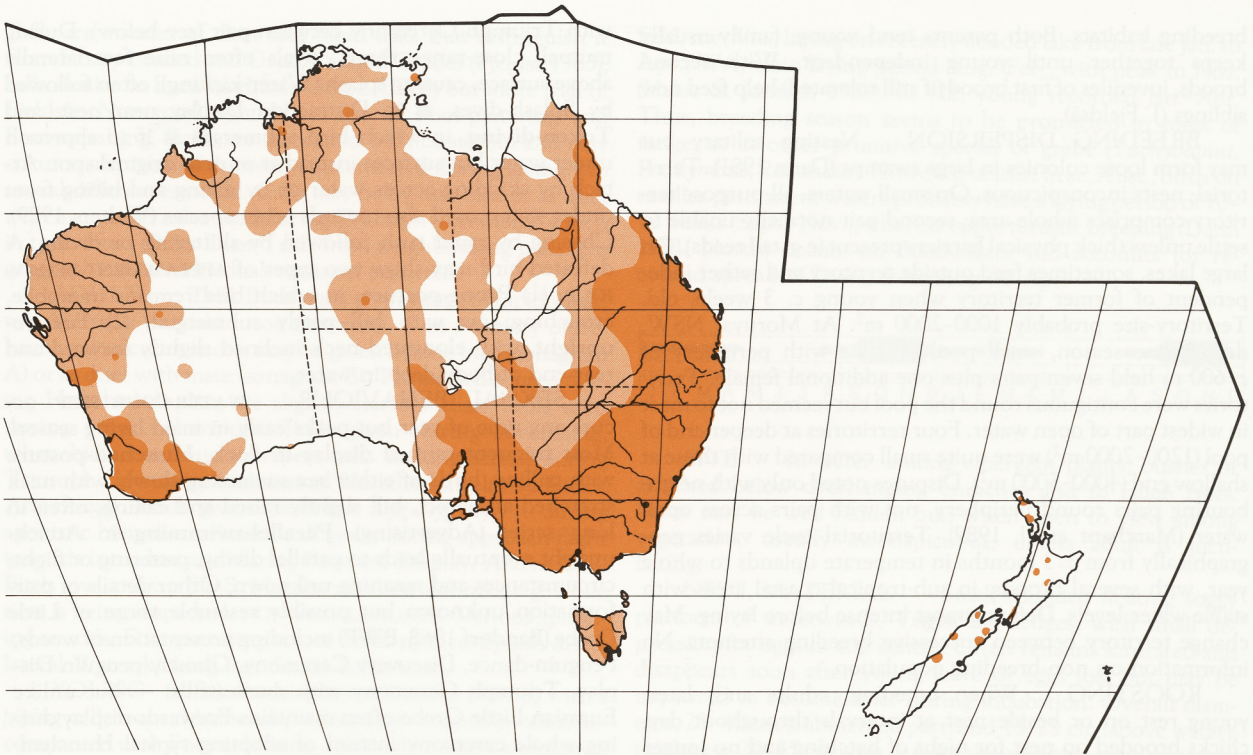
MOVEMENTS Poorly known. Possibly migratory in n., resident in e. and sw. Aust., dispersive inland. Most records from n. Aust. in dry season (Darwin area, NT, May–Jan. [Crawford 1972]; Atherton Tablelands, Qld, Apr.–Nov. [Bravery 1970]; Edward R., Cape York Pen., May–June [Garnett & Bredl 1985]) but breed on ephemeral waters of Torres Str. islands, Qld, Dec.–Apr. (Draffan *et al.* 1983); recorded all year from Booby I., Torres Str. (Ingram *et al.* 1986) and resident at Innisfail (Gill 1970). On n. coast NSW, present all year, numbers peaking Mar.–Sept. (Gosper 1981) but changes in population not correlated with rainfall elsewhere in state (Gosper *et al.* 1983). Similarly, numbers counted in se. Qld every Oct. (1972–83), stable though negative correlation with local and inland rainfall, which indicates some movement towards coast in dry years (Woodall 1985). On New England Tableland, NSW, numbers rise during periods of inland drought (Briggs 1977) and, in winter 1975, numbers decreased with increasing rainfall (Whyte 1981). No evidence of regular long-distance movement in se. or sw. Aust. (Aust. & Vic. Atlas) though flocking regular in autumn (Altona, Vic.; Watson 1955) and winter (sw. NSW [Hobbs 1958, 1961]; L. George, ACT [Lamm 1964]) and regular winter visitor to Middle Swan in sw. Aust. (Heron 1970). Flock of 150 in Aug. at L. Argyle, nw. Aust. (R.P. Jaensch) may indicate similar movement patterns there.

Movements must be extensive as indicated by recent colonization of NZ (Kinsky 1980) and appearance on temporary ponds far inland soon after their formation (Frith 1984). Before build-up of invertebrates on floodwater swamps, sometimes congregates in hundreds on permanent swamps; then may be restless immediately after sunset. Probably undertakes long-distance flights at night.

BANDING Longest recorded movement 338 km, Lucindale to L. Murdeduke, Vic.

37S 140E 12 1+ U 3 339 113 ABBBS

FOOD Fish, snails and aquatic arthropods. **BEHAVIOUR.** Feeding methods vary more than in most other grebes and include diving (55% observations), swimming with head and neck immersed and turned rhythmically from side to side, sometimes interspersed with brief pursuit-diving (0.5–4.0 s; Fjeldså 1988) including also approaching food from underwater (England 1974); floating in one position, peering through carpets of surface vegetation, often in sunbathing pose; stealing in crouched pose upon insects perched on floating vegetation; picking from water surface; snatching insects from emergents, from banks or from overhead, sometimes by leaping. Feeding dives consist of small jump, splash, and downward swing of neck. Normally last 8–20 s (up to 66 s) at average speed 0.13 m/s (as measured on surface; compared to 1.0 m/s in emergency; Fjeldså 1988) with 7–8 s between dives (Serventy & Whittell 1976) when swims only 0.05 m/s (n=74). Bimodal distribution of dive times suggests two different types of feeding dives. Small prey swallowed unnoticed underwater; prey that are hard to swallow (e.g. fish >3 cm long) eaten at surface. Mates feeding side by side often use different techniques. Feeding methods and prey selection usually require a certain privacy and spacing, based on avoidance of close company rather than intolerance over food. Sometimes many birds congregate where arthropods abundant, where they circle or move parallel in mild Attack-upright postures 0.5–1.0 m apart (Fjeldså 1988). Sometimes follow Eurasian Coots *Fulica atra*, Dusky Moorhens *Gallinula tenebrosa* (Hobbs 1958) and Pacific Black Duck *Anas superciliosa* (Hobbs 1959) in weedy areas, apparently eating arthropods disturbed by the larger birds. Feed intensely during morning and evening twilight, more sporadically during day, with minor peaks 09:00–11:30 and 14:30–16:00 (Oct.–Nov., NSW; Fjeldså 1988). Do not feed in darkness; first feed about half-hour after sunrise (Marchant *et al.* 1989).



ADULTS Dominant food NSW (nine stomachs, 1226 items; % weight; Fjeldså 1988) fish 84% wt., snails 7, bugs 4, beetles larv. 2, imagines 2. Numerical analysis: snails 6.2%: *Glyptophysa* 3.8, *Isidorella* 1.5, *Thiara* 0.1; arachnids Hydracarinae *Piona* 0.1; crustaceans 0.7: cladocerans *Daphnia* 0.1, ostracods 0.1, amphipods 0.3; insects 77.0: odonatan larv. 0.5 (Coenagrionidae 0.2, Libellulidae 0.2, imm. 0.6: Coenagrionidae 0.3, Libellulidae 0.2, Aeshnidae 0.1); mayfly nymph 0.1; stonefly nymph 0.1; bugs (adults 45.4, nymphs 5.8: *Sigara* 0.3, *Agraptocorixa* 5.5, Homoptera 0.1, imm. 31.0: *Sigara* 9.0, *Agraptocorixa* 22.0) ads.: *Limnogonus* 0.1, *Ranatra* 0.1, *Naucoris* 0.2, *Notonecta* 6.7, *Anisops* 0.3, large Belostomatidae 0.2, *Plea* 0.7, Lygaeidae 0.3; beetle larv. 18.1: Hydrophorinae 16.6, *Homeodytes scutellaris* 0.1, other Dytiscidae 0.5, Hydrophilidae 0.8, imagines 4.8: *Haliphus* 0.6, Hydrophorinae 0.6, *Nectorosoma regulare* 0.1, *Megaporus howitti* 0.6, Dytiscinae small 0.2, 1.0–1.5 cm 0.3, *Dineutes neohollandiae* 0.1, Hydrophilidae small 0.3, 1.2–1.4 cm 0.5, 25 cm 0.2, Hydrobiinae 0.4, Staphylinidae 0.2, Helmidae 0.2, Curculionidae 0.1, unident. terrestrial 0.2; caddisfly eruciform larv 0.7; lepidopterans Nymphalidae larv. 0.1, pupa 0.1; fly larv./pupa 5.1: Chironomidae 4.6, other Nematocera 0.1, Brachycera 0.1, imm. 2.4: Chironomidae 0.1, other Nematocera 0.1, Ephydriidae 2.0; hymenopterans 0.5: Formicidae 0.4; fish (*Philypnodon grandiceps* 1.5, *Gambusia affinis/Hypseleotris klunzingeri* 9.3, unident. fry 3.9), unident. plant seed 0.1. Benthic corixids, nektonic notonectids, diving beetles and fish taken selectively, which suggests preference for free-swimming prey. Snails probably taken when nekton scarce.

Other records: vegetable matter 18% freq., fragment of mollusc 9, crustaceans (decapods *Paratya australiensis* 27, *Cherax albidus* 9), insects (dragonfly nymph 9, damselflies 18; cockroaches 9; bugs Corixidae 46, Notonectidae 9, unident. 9; beetles Dytiscidae 9, Hydrophilidae 27, Curculionidae 9, unident. 9; flies nematoceran larv. 9, Stratiomyidae larv. 9,

blowfly 9; hymenopteran Formicidae 9), fish *Gambusia affinis* 9, unident. 9 (11 stomachs, w. NSW; Vestjens 1977; Barker & Vestjens 1989); beetles *Lancetes lanceolatus*, *Cybister tripunctatus*, fibrous vegetable matter (one stomach, Penola, SA), small aquatic insects, incl. beetle *Eretes australis*, mostly larvae (three stomachs, Mannum, SA; Lea & Gray 1935); beetles and other insects, water snail, vegetable matter (five stomachs; Hall 1974); freshwater mussel, water beetles, water bugs, Poaceae seed (three stomachs; Cleland *et al.* 1918); small beetles and other insects (one stomach, n. NT; White 1916); small water beetles (Carter 1923); insects, shellfish (Mathews 1909); fish (Hobbs 1958); full-sized frog (Lyle 1973); vegetable matter (McKeown 1934). Suggestions that weeds eaten deliberately (Walters 1979) possibly mistaken. Feathers swallowed to aid formation of pellets for ejecting fish-bones and other roughage.

Diet fed to young similar to that of adults (J. Fjeldså).

SOCIAL ORGANIZATION Based mainly on observations by J. Fjeldså. Solitary or in pairs, often in parties of two to seven (possibly family groups) but sometimes flocks may number several hundred. Dense flocks form only when loafing; disperse to feed. In NSW and ACT in Nov.–Dec. 1979, 38% of Grebes were <5 m from conspecifics (with 35% feeding), 8% were 5–10m apart (53% feeding), 14% were 10–20 m apart (65% feeding), 40% farther away (87% feeding) (n=367). When disturbed, often disappear, even on ponds lacking vegetational cover. Sometimes seen crouching among floating plants with only top of head visible; during low passage of raptor or pelican, may crash-dive and water-kick.

BONDS Monogamous. Fragmentary data suggest similar pattern as in better known Little Grebe (Bandorf 1968, 1970). Pair-bond maintained for one breeding cycle or for several successive cycles; may be life-long in case of permanent territories. Unstable bonds probably initiated in non-

breeding habitats. Both parents tend young; family usually keeps together until young independent. With second broods, juveniles of first brood (if still tolerated) help feed new siblings (J. Fjeldså).

BREEDING DISPERSION Nesting solitary but may form loose colonies in large swamps (Dann 1981). Territorial; nests inconspicuous. On small waters, all-purpose territory comprises whole area; second pair normally unable to settle unless thick physical barriers present (e.g. tall reeds). On large lakes, sometimes feed outside territory and rather independent of former territory when young c. 3 weeks old. Territory-size probably 1000–2000 m². At Moruya, NSW, during one season, small pool of 1 ha with periphery of c. 600 m held seven pairs plus one additional female. Territories were contiguous round the pool but seemed not to meet in widest part of open water. Four territories at deeper end of pool (1200–2000 m²) were quite small compared with those at shallow end (4000–5000 m²). Disputes noted only with neighbouring pairs round periphery, not with pairs across open water (Marchant *et al.* 1989). Territorial cycle varies geographically from c. 3 months in temperate uplands to whole year, with several broods, in sub-tropical coastal areas with stable water levels. Defence most intense before laying. May change territory between successive breeding attempts. No information on non-breeding population.

ROOSTING When breeding, adults and, later, young rest on or beside nest at intervals throughout day; chicks brooded on nest for night of hatching and no longer (Marchant *et al.* 1989). Otherwise, roost on water in pairs, families or small flocks, in or near vegetation, below steep banks and near trunks or logs in water. Active on moonlit nights; duets suggest nocturnal courtship.

SOCIAL BEHAVIOUR Poorly studied; possibly as in Little Grebe (Bandorf 1968, 1970; BWP). Information supplied by J. Fjeldså. More vocal than Hoary-headed and Great Crested Grebe, characteristically giving distinct trill, singly or in duet with mate. Sexual behaviour simple, mostly mutual or with reversible roles.

AGONISTIC BEHAVIOUR Intruders into territories driven off by one or both of pair together, often with initial approach flight accompanied by Attack-calls. Three types of **THREAT DISPLAY**: **Attack-upright**, with erect neck, ruffled head-feathers, bill sometimes lowered slightly and tail-tuft cocked; **Forwards-display**, with head and neck stretched low over water, usually with Attack-calls (Fig. 1); **Hunched-display**, with neck in, sometimes deeply into shoulders, plumage ruffled, wings folded and lifted on back, or tilted forward somewhat during intense display; usually accompanied by Threat-trills (Fig. 2). Hunched-display less likely to lead to attack than other displays, and may alternate

with Triumph Ceremony between pair (see below). During mutual, close-range threat, rivals often raise feet laterally above surface, causing splash (Water-kicking); often followed by Splash-dives, as in Distraction Display near nest, and **Token-diving**, in which bird submerges as if to approach under water but surfaces instead at or near original spot. Attack by skidding across water or by diving and biting from under water; used also towards other species (Walters 1979). Chasing by rapid rush followed by skittering or diving. A defeated bird may show two types of **APPEASEMENT BEHAVIOUR**: (1) **Prone-posture**, in which bird remains immobile, crouching low with bill partly submerged; (2) **Furtive-upright**, with elongated neck inclined slightly forward and rear-end of body deep in water.

SEXUAL BEHAVIOUR **WATER-COURTSHIP** occurs any time of year but peaks early in main laying season. Most frequent mutual display in flock, **Hunched-posture** with trilling: birds of either sex swimming slowly with neck stretched and erect, bill slightly raised and calling, often in long series (Advertising). **Parallel-swimming** in Attack-upright eventually leads to parallel diving, pattering or flight; circumstances and meaning unknown. Other details of pair-formation unknown but possibly resemble those of Little Grebe (Bandorf 1968; BWP) including presentation of weeds, Penguin-dance, Discovery Ceremony, Ghostly-penguin Display, Triumph Ceremony with duets (trills) — but unlike Eurasian Little Grebe often maintains Forwards-display during whole ceremony instead of adopting typical Hunched-posture; ceremony may elicit duets (trills) from neighbouring territories) and Platform-courtship.

RELATIONS WITHIN FAMILY GROUP Young carried under wings of adults. Usually carried by one bird while mate brings food; as chicks develop, brood may be divided between male and female or left on water while both adults bring food. Brood uses nest and auxiliary platforms more often than other grebes and carrying phase probably shorter. Although young may swim from first day, broods stay most of first week on nest alone or with an adult. When young more than 1 month old try to board, adults often avoid them by swimming, pattering away or showing aggression. Small young beg by piping and stretching neck forward; bigger young peep intensely while drawing in neck and lifting bill, body partly submerged, and foot-splashing. When attacked, adopt Prone-posture with Foot-splashing. Bare skin of chick's lores flush red both when begging and when subject to aggression. Juveniles show large repertoire of adult behaviour, including feeding of smaller siblings.

VOICE No detailed studies; information supplied by J. Fjeldså. Generally silent when not breeding or courting; more vocal than other grebes (Serventy & Whittell 1976; J. Fjeldså).

Fig. 1 Forwards-display

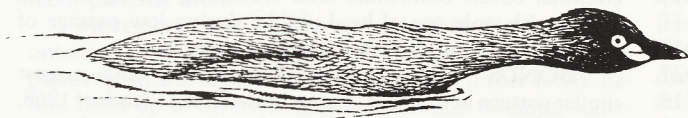
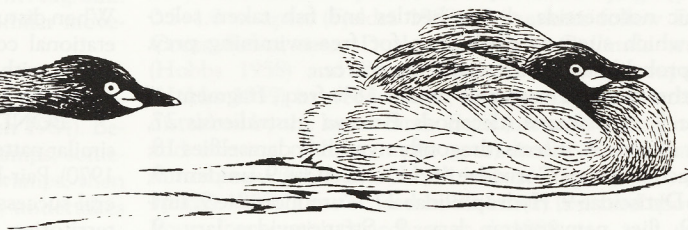


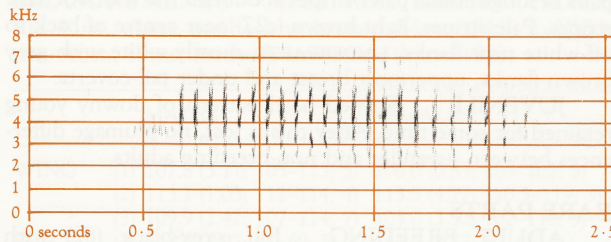
Fig. 2 Hunched-display



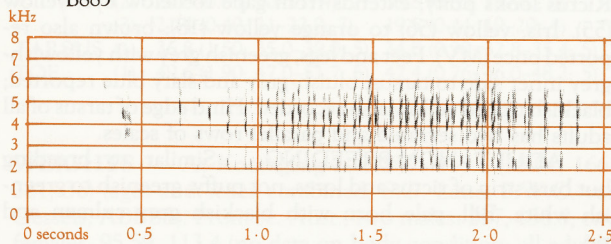
Calls are a series of clear and rapid trills that distinguish it from Hoary-headed and Great Crested Grebes (Fjelds  1983); calls similar to Eurasian Little Grebe (BWP) but more frail (J. Fjelds ). Non-vocal sounds consist of Foot-pattering and Foot-splashing. Trills are associated with courtship and may occur at any time of the year; concentrated during laying. No sexual differences noted. Calls may be by one bird or as duet with mate; duet most used during Triumph Ceremony, which in turn often elicits Duet-Trills from neighbouring pairs. No geographical or individual variation reported.

ADULT Trill. Both sexes give a range of rapid, clear, metallic trills *titititititi* . . . or *zizizizizizi* . . . in a variety of behavioural circumstances; may be given by one bird (sonagram A) or as duet with mate (sonagram B). **Threat-trills**, used during Hunched-display, are slightly harsher than Trills used during other behaviours. Trills given during advertising, when birds continue to repeat calls in long series; during Triumph Ceremony and mutual Hunched-display in flocks. **Attack-call.** Birds give a resonant *diygy-diygy-diygy* . . . during agonistic behaviour; Attack-call given during approach flight towards intruders and during Forward Display. **Alarm Call.** Birds give a sharp *pit* (S. Marchant) when alarmed, e.g. while nest is being inspected. **NON-VOCAL SOUNDS.** Various splashing sounds: Foot-pattering across water surface; Splash dives; lateral Water-kicking (see Social Behaviour).

YOUNG Small young (up to 2 weeks old) beg with a piping call; from third week, young *peep* intensely, often accompanied with Foot-splashing, which also used when young threatened.



A C.C. Davey & P.J. Fullagar; Booligal, NSW, Sept. 1980; B885

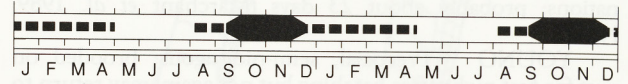


B R. Buckingham; Melbourne, Vic., Sept. 1979; P26

BREEDING Poorly known. Based mainly on Ashby (1933), Walters (1979) in Tas., Marchant *et al.* (1989) at Moruya, NSW, Dann (1981) at Wyperfield NP, Vic., and J. Fjelds , who provided information. Indefinite aspects may be as in Eurasian Little Grebe (Ahl n 1966; Bandorf 1970; BWP). Breeds in simple pairs, territorially.

SEASON Nesting recorded: tropical Aust., Feb. (Lavery *et al.* 1968); coastal and inland NSW, peak laying Nov., but eggs recorded Aug. (J. Fjelds ), Oct., Feb., Mar. (Gosper 1981), Apr. (North); at Moruya, se. NSW, in one season, first eggs about 4 Sept., last about 11 Nov.; at Wyper-

field, nw. Vic., laying on recently flooded lake from late Jan. to Apr.; WA, main laying period Aug.-Feb., with peak in Nov. (Halse & Jaensch 1989). In NZ, young recorded Jan.-Apr. Thus, breeding season seems to be protracted in most of range, as in other primitive species of grebe (*Tachybaptus*, *Podilymbus*, *Rollandia*). However, at least in se. Aust., birds on smaller permanent waters probably have a laying period of 10-12 weeks (Sept.-Nov.), whereas opportunistic breeding (Dann 1981; North) occurs on floodwaters and accounts for recorded spread of laying from Aug. to Apr.



SITE In water, among emergent plants, bushes or attached below overhanging branches and to fallen trees. Nests may be well hidden but, when open to view among vegetation, usually inconspicuous, unless adult is incubating.

NEST, MATERIAL Small rounded floating soggy platform of waterweeds, *Triglochin*, sedges, with small depression for eggs in top centre. Often remains saturated and disappears soon after young leave or eggs lost but may be improved to become drier during incubation. Overall diameter, 25-40 cm (submerged part) and 15-25 cm (above water); thickness, 20-35 cm with 3-6 cm above water; egg-depression 4-7 cm across and 3-6 cm deep. Usually in shallow water: 1.3 m (0.45; 0.5-2.5; 55) or 0.9 m (0.75-1.1) and not far from shore, 39.3 m (30.2; 10-150; 55) or 11 m (5-25) (Dann 1981; Marchant *et al.* 1989 respectively). Same nest (site) may be used for second brood but nest needs rebuilding. Several platforms may be built in territory. Both sexes build, usually taking about a week to complete nest but sometimes much less (North).

EGGS Pointed oval; smooth, not glossy; bluish white, becoming stained to pale or reddish brown within 24-48 h of laying (Marchant *et al.* 1989). **MEASUREMENTS:** 36.0 (33-38; 40) x 25.2 (23.4-26.9) (Sch nwetter 1967).

CLUTCH-SIZE Difficult to establish because two females may lay in same nest and because laying routine is uncertain (Marchant *et al.* 1989). Records of 94 clutches (Dann 1981; Marchant *et al.* 1989; Aust. NRS) range from one to nine, average 4.3 but C/1 were almost surely incomplete or were sightings of single egg not yet hatched after other eggs had hatched, and all clutches above six, and perhaps of six also, were probably the product of two females laying in the same nest. There remain, as acceptably complete clutches laid by one female, 15 x C/2, 10 x C/3, 21 x C/4, 21 x C/5 (and 13 x C/6), which gives an average of 4.1 (or 3.7 excluding all C/6). Second clutches started when young of previous brood c. 3 weeks old and starting to feed independently. Up to six replacements after loss of eggs recorded (North). Perhaps more broods and replacements attempted in stable subtropical coastal areas (c.f. 24 fledgelings from 35 eggs in one year by Least Grebe *T. dominicus*; Gross 1949). Wing-moult, normally post-breeding, can be inserted between successive clutches.

LAYING Probably at intervals of up to 48 h or irregular (Marchant *et al.* 1989).

INCUBATION By both sexes, from laying of first or second egg; hatching asynchronous. Change-overs made very quickly and eggs not exposed for long; do not take place at night. Eggs covered with nest material by adult when leav-

ing nest voluntarily or otherwise. Temperatures of eggs and of egg-depression feel decidedly higher than that of water and remains remarkably uniform at c. 34 °C except when ambient shade temperature exceeds 34 °C and incubating bird cannot apparently maintain an even temperature; otherwise temperature of eggs is 1–6 °C higher than water temperature. No evidence to support idea that decomposition of nesting material may enhance temperature of incubation (Marchant *et al.* 1989). Adults usually disappear when observer visits nest; sometimes surface hastily to make fold-in-middle crash-dive with water-kicking. INCUBATION PERIOD: no exact determinations; probably about 23 days (Marchant *et al.* 1989; North).

YOUNG Precocial, semi-nidifugous; brooded on nest for first night after hatching but not again; may return to old nest-platform during day. Cared for by both parents; perhaps brood splits as young grow, each parent tending 1–2 young (S. Marchant). Young carried on back under wings. Fed bill to bill (*cf* Ahlén 1966 for Eurasian Little Grebe).

FLEDGING TO MATURITY Young independent at 8 weeks old; age at first flight not known. Adults often aggressive to older young, which may stay unobtrusively in or near territory and may help to feed younger siblings.

SUCCESS No quantitative data. Losses probably high, caused by fluctuating water-levels, weather and predation.

PLUMAGES

ADULT BREEDING Definitive, alternate. Unknown if found on birds too young to breed. **HEAD AND NECK.** Chin and throat, black (c82), bordered on sides by chestnut (32) stripe running from eye, where narrow, to sides of midneck, where broad. Crown, forehead and hindneck, dark grey (c83); centre of lower throat, grey brown (greyish 119a). **UPPERPARTS.** Mantle, dark greyish; feathers at sides have white tips, occasionally giving appearance of white mottling. Rest of upperparts, dark brown-grey. Flank feathers can protrude into area of upper tail-coverts, making region look white with buffish tinge. **UNDERPARTS.** Upper breast, mixed dark brown (21) and white; feathers, dark brown (21) with open pennaceous white tips. Flanks and sides of breast, dusky grey-brown, sometimes with pale-cinnamon trace; feathers, dusky merging to pale cinnamon at base. Lower breast and belly, white, indistinctly streaked darker. Feathers, white, with ill-defined dark greyish-brown (c20) shaft streaks to all feathers but those in centre of breast and belly. **UPPERWING.** Upper wing-coverts as back. Primaries, dark grey-brown (greyish 119a) with white bases, broadest on inner primaries, concealed in outer three primaries. Secondaries, white with small dark grey-brown marking at distal corner of outer web; outer secondaries also have dark grey-brown marking on distal corner of inner web. **UNDERWING** Humeral, dark grey-brown (greyish 119a) with concealed white bases. Under wing-coverts, white.

ADULT AUTUMNAL Supplemental. Similar to adult breeding. Neck-stripe, pale chestnut-brown (c35), narrower than in breeding adults. Chin and throat, white mottled black; feathers, white, with partly concealed black bases. This plumage has previously been described as 'transitional' but consists of a distinct feather generation, at least in head. Unknown whether this plumage also occurs in the spring; a bird collected Feb. 1875 (HLW) in autumnal plumage but with chestnut feathers emerging on neck. Possibility that this is an immature plumage cannot be excluded but all skins

examined have adult tarsus and claws.

NON-BREEDING Basic. Crown and hindneck, dark brown-grey (c83). Upper throat, chin and face below centre of eye, white. Most birds have smudge of grey-brown (brownish 84) below eye, perhaps retained from little-known autumnal plumage. Lower throat and foreneck, light grey-brown (119C). Underparts, mostly clean white, with no trace of streaking. Grey (84) tinge to region of under tail-coverts. Other areas as breeding adult.

DOWNY YOUNG **HEAD AND NECK.** Forehead, crown and nape, black-brown (119) with silvery grey (c86) stripe above bare lores. A vaguely heart-shaped rufous (136) spot in crown is small or absent in some (usually smaller) birds. Lateral crown stripes converge between eye and culmen; pale rufous-brown (38) anteriorly, merging to white posteriorly. Three small spots in nape mostly white but pale rufous anteriorly. Black-brown (119) supercilium broad; runs into nape. Neck, mostly dark brown (21) with three longitudinal white stripes on each side. These white stripes irregular in shape, lobe-shaped projections sometimes breaking the broader dark brown stripes. Uppermost white stripe runs into centre of eye. Below this, a thick dark-brown (21) marking runs from mid-neck to bottom of eye. A narrow dark-brown (21) stripe, following line of rictus, joins the dark-brown (21) mid-ventral neck-stripe at base of lower mandible. Rest of lower face, white with small dark-brown (21) blotches; shape varies between individuals. In some birds, mid-ventral stripe is broken by white patch on upper throat. **UPPERPARTS.** Dark brown (21), including mid-dorsal stripe, with three parallel pairs of longitudinal paler stripes about half the width of dark stripes. Pale stripes, light brown (c27) near centre of back to off-white near flanks. **UNDERPARTS,** mostly white with grey brown flanks, uppermost breast and under tail-coverts.

JUVENILE Striped head pattern of downy young retained for some time. After this is lost, no plumage differences between juveniles and non-breeding adults.

BARE PARTS

ADULT BREEDING Bill, grey-black (82) with small white tip, slightly more extensive on lower mandible. Rictus looks puffy; extends from gape to below eye; yellow (55). Iris, yellow (56) to orange yellow (18); brown also reported once (MV). Feet and legs, greenish grey with yellowish-grey inner side to tarsus; bluish-grey and slaty blue reported; blackish tinged yellow also recorded. Hind edge of tarsus of all adults has two serrated and parallel rows of scales.

ADULT NON-BREEDING Similar to breeding but bare strip of rictus and lores, not puffy; greenish to greenish white. Bill, pale horn with blackish grey culmen and tip.

DOWNY YOUNG Bill, pink (3) to salmon (6) with narrow dark-brown (119) band across upper mandible. Egg-tooth, white. Iris, blackish brown; eye-ring and bare lores, pink (3) to salmon (6). Outer side of tarsus and toes, grey (84) to blackish (82). Soles and inner side of tarsus, brown grey (1198). Tarsus, rounded; laterally flattened in older birds.

JUVENILE Iris, cinnamon (c39). Bare skin from rictus to eye, not puffy; pale lime-green (c59). Culmen, blackish (c82); rest of bill, buff (c53) with faint reddish tinge. No information on feet and legs; in skins, adults discolour to blackish and juveniles to yellowish. Double row of scales on hind edge of tarsus fused, and serrations slight or absent.

MOULTS Based on Fjeldså (1988).

ADULT POST-BREEDING Pre-basic. Remiges simultaneous, usually between Jan. and Apr. A male with young from a winter clutch in wing-moult in Nov.; all birds collected in May have completed moult. This suggests that wing-moult occurs just after breeding and may be inserted between two broods if more than one is raised (Fjelds  1988). Loss of breeding plumage can start as early as Jan. or as late as Apr.; this body-moult presumably complete. Presence of autumnal plumage shows head feathers replaced at least three times a year; in absence of direct data on body-moult it is not possible to identify a pre-supplemental moult.

ADULT PRE-BREEDING Pre-alternate. Only specimen observed in pre-alternate moult into breeding plumage collected late May; it showed no trace of a transitional plumage. This probably unusually early, because most adults collected between June and Aug. in full non-breeding plumage.

All above information on body moult pertains to se. Aust. Pattern of body-moult obscure in n. Aust., where non-breeding plumage seldom reported. Autumnal plumage observed June-Aug. and twice in Nov.

POST-JUVENILE Body-feathers probably all replaced in first winter, because all birds collected in spring and summer in breeding plumage. Feathers forming striped head pattern of juveniles do not appear downy, suggesting some head-moult before 'pre-alternate 1'. Note that distinction between down and juvenal plumage difficult in grebes (Fjelds  1977).

MEASUREMENTS 1. SE. Aust., skins (MV, HLW) 2. SE. Aust., skins; methods unknown (Mayr 1943). 3. Qld to nw. Aust., skins; methods unknown (Mayr 1943).

	MALES	FEMALES
WING	(1) 107.8 (3.11; 105-113; 5) (2) 113.1 (1.03; 112-114; 4) (3) 109.9 (2.42; 107-114; 7)	106.0 (0.63; 105-107; 5) 113.5 (4.77; 110.5-119; 3) 105.0 (3.32; 102-110; 5)
8TH P	(1) 65.6 (2.97; 61-69; 5)	63.4 (2.33; 60-66; 5)
BILL	(1) 21.4 (0.53; 21.0-22.3; 5) (2) 20.8 (0.65; 20-21; 4) (3) 21.4 (0.40; 21-22.0; 7)	19.1 (0.81; 18.0-20.0; 5)** 18.8 (0.85; 18-20; 4) ** 19.5 (0.44; 19-20; 4) **
TARSUS	(1) 36.8 (1.50; 35.0-39.0; 5)	34.0 (0.90; 32.8-35.4; 5)**
TOE	(1) 49.6 (1.90; 47.0-51.7; 5)	47.4 (0.76; 46.0-48.2; 5)

WEIGHTS At Kooragang I., NSW: 218.6 (25.01; 166-281; 36) (ages and sexes combined; S.G. Lane, F.W.C. van Gessels; ABBBS). From se. Aust., two males: 227, 158.5; two females: 95.59, 113.4 (no data on body condition; all adults). Four unsexed adults collected 6 Feb. 1959 at Kerang, Vic.: 222.2 (10.03; 214.4-235.9; 4).

STRUCTURE Wing, short and narrow. Twelve primaries; p10 longest, p11 0-3.5 shorter, p9 0-3 shorter, p8 2-10, p7 8-15, p6 13-19, p5 17-22, p4 21-26, p3 24-32, p2 27-34, p1 29-38; p12 minute. Emarginations, small on outer web of p9 and p10, larger on inner web of p10 and p11. Eighteen secondaries, including five tertials. Bill, short and stout; deepest at base. Nostrils, oval. Borderline between forehead feathers and culmen, convex. Strip of skin between eye and gape, bare; puffy in breeding adults. Tarsus, flattened; hind edge of tarsus has two serrated rows of scales in adults; fused and less serrated in younger birds. Toes, lobed; claws, flattened and not

protruding past skin. Middle and outer toes, approximately equal; inner c. 73%, hind c. 25%.

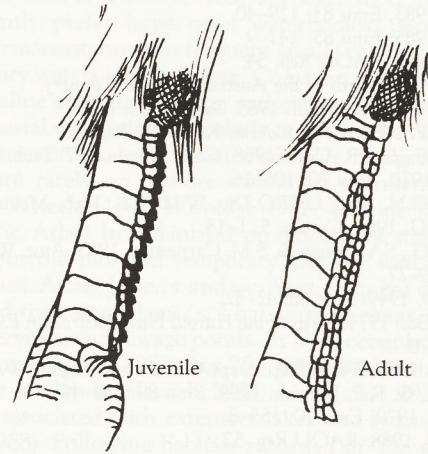


Fig. 3 Tarsi (hind-edge facing up)

AGEING Adult-non breeding plumage similar to that of juveniles that have lost striped head-pattern. At least some of these juveniles have two rows of almost fused, slightly serrated scales on hind edge of tarsus; in adults these rows of scales diverge and are strongly serrated. Claws slightly pectinate in adults, less commonly in juveniles.

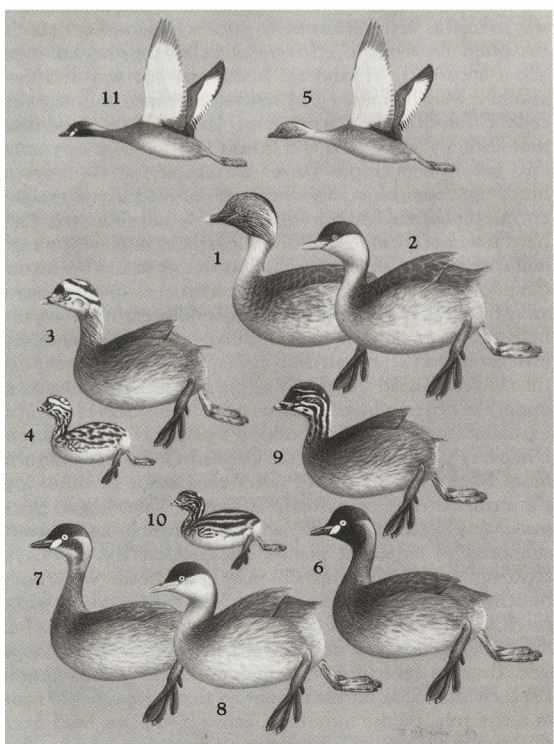
GEOGRAPHICAL VARIATION Mayr (1943) suggests clinal variation in Aust. with tropical populations tending to have larger bills and shorter wings than those in se. Aust. No differences in colour known in Aust. (those noted by Mathews [1910-27] not widely accepted), but non-breeding plumage seldom recorded in tropics. *T. novaehollandiae* considered a superspecies with *T. ruficollis* from which separated because breeding ranges overlap (Rand 1942).

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Volume 1 (Part A), Plate 5

Hoary-headed Grebe
Poliiocephalus poliocephalus
 1. Adult breeding
 2. Adult non-breeding
 3. Juvenile
 4. Downy young
 5. Adult breeding, flight

Australasian Grebe
Tachybaptus novaehollandiae
 6. Adult breeding
 7. Adult autumnal
 8. Adult non-breeding
 9. Juvenile
 10. Downy young
 11. Adult breeding

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