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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Poliocephalus poliocephalus Hoary-headed Grebe

COLOUR PLATE FACING PAGE 112

Podiceps poliocephalus Jardine and Selby, 1827, *Ills Orn* 1: Pl. 13 — New South Wales.

The scientific name is a combination of two Greek words: πολιός (grey) and κεφαλή (head).

OTHER ENGLISH NAMES Dabchick, Hoary-headed Dabchick, Tom Pudding.

MONOTYPIC

FIELD IDENTIFICATION Length: 29–30.5 cm, of which body half to two-thirds; wingspan 46 cm; weight: males 260 g, females 220 g. Small grebe with short, fairly stout bill, broad-bodied, in most postures looking dumpy with broad high downy rear; rear often turned towards sun for sunbathing. Generally darkish grey and white plumage; when breeding, white streaking on dark head imparts neat brushed-back appearance of head. Gregarious, sometimes in large flocks. Sexes alike but with experience separable in field by size of bill: shorter in female than in male. Seasonal differences in plumage occur but not fully understood; eclipse and immature breeding plumages may occur but have not been described (see Plumages). Juveniles like non-breeding adults, dull but retaining some stripes of downy young. Generally silent.

DESCRIPTION ADULT BREEDING. Whole of head appears dark streaked white: crown, face, nape and centre of hind neck, black prominently streaked silver white (thus 'hoary-headed'); hindneck, mantle pale grey-brown merging evenly into darker grey-brown back and rump. Downy rear, fluffy and white. Upperwing, mostly dark with white secondaries and webs to innermost primaries forming pale trailing edge to innerwing extending inwards over base of primaries. Chin and lower throat, dark brown-black; neck and breast off-white with varying cinnamon or pinkish buff hue on outer breast; flanks, pale greyish; abdomen, white becoming brownish on vent. Underwing shows dark remiges contrasting with pale white coverts. Bill, black with white tip. Iris, black brown, not obvious against plumage of head. Legs and feet, greyish yellow. ADULT NON-BREEDING. Generally, like adult breeding but pattern of head markedly different, lacking streaked appearance of breeding plumage: crown, dark grey extending to just below eye-level, inconspicuously streaked and becoming black centrally, on nape; forehead, lores and feathers round base of bill, blackish combining with dark crown to form dark cap separated from pale lower face along a line from mandible below eye to nape; conspicuous dark stripe extends down nape. Rest of dorsum, as breeding, mainly grey-brown. Cheeks, throat, breast and abdomen, white; flanks, light greyish; rear end, fluffy, whitish. Bill, light

yellowish or greenish. Iris, inconspicuous, brown, probably paler than breeding but varying (see Bare Parts). JUVENILE. Dependent juvenile retains strongly striped face of downy young but stripes broader; chin and throat, white; hindneck appears mottled brown and white; rest of upperparts like adult non-breeding. Lower neck to upper breast, light grey-brown; breast, abdomen and vent, white.

SIMILAR SPECIES Easily distinguished from **Great Crested Grebe** in all plumages by much smaller size, shorter and stubbier bill and shorter less silky-white neck. Resembles **Australasian Grebe** *Tachybaptus novaehollandiae* and **New Zealand Dabchick** *Poliocephalus rufopectus* in size, build, and proportions of bill, head and neck. In breeding plumage, readily distinguished from both by hoary, brushed-back appearance of head, black throat, pale cinnamon-washed breast and generally grey-white plumage rather than dark brown to black. In juvenile and non-breeding plumages, often hard to tell apart from Australasian Grebe but, in general, Hoary-headed has grey wash on flanks and rear (not buff) and sharp line of separation between dark cap and pale-grey cheeks and throat passes from base of upper mandible below

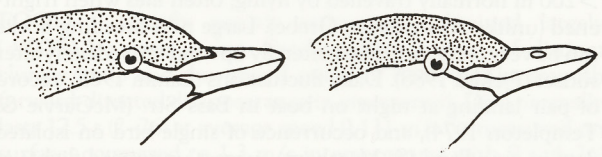


Fig. 1 Hoary-headed Grebe Australasian Grebe

eye (not through centre of eye); Hoary-headed is also slightly bigger, not so short-bodied and less high-sterned; markedly heavier head, more smoothly rounded and less angular contour. With experience, can be distinguished by silhouette: when swimming normally, neck held erect and bill slightly below horizontal whereas Australasian Grebe holds bill horizontal. Hoary-headed usually silent, whereas high-pitched trill of Australasian Grebe diagnostic. Juvenile Australasian Grebe has boldly patterned face (blackish cap, grey-brown pattern on cheeks, white throat) (see D'Andria 1974). Unlikely to be found with New Zealand Dabchick but Dabchick distinctly darker in all plumages and when together, Dabchick is noticeably larger; in breeding plumage, Dabchick is overall dark brown to blackish with obvious yellow eye contrasting markedly with dark head (not streaked with white) and body. In non-breeding plumage, Dabchick (*q.v.*) is much darker dorsally and lacks distinctive dark stripe on nape of Hoary-headed (see Storer 1987).

Typically found well away from shoreline on large open waters, estuarine, brackish or freshwater, often in large dense flocks. Float and swim buoyantly with relaxed plumage. Birds sleek plumage before diving but in cool weather adopt blunt-sterned pose even in shortest pauses between dives. When alarmed and in hot weather, float with sleek plumage and erect neck; during hottest midday temperatures may float partly submerged. Dive with clumsy forward jump and downward swing of neck in contrast to smooth forward disappearance in emergency. After feeding dive, often drain bill by short shake of head. Fly with rapid wing-beats, head and neck extended, protruding feet, giving hump-backed appearance. Apparently more inclined to fly during daytime than any other grebe; usually low above water; on windy days may fly for more than 200 m; often fly when frightened unlike Australasian Grebe.

HABITAT Terrestrial to estuarine wetlands of much variety throughout temperate and tropical Aust., including arid and semi-arid zones; from sea level to *c.* 1000 m asl. Apparently prefer large open waterbodies, permanent or semi-permanent, but also frequent small ($\leq$1 ha) waters, and temporary waters after flooding. Common at times on brackish to saline coastal, estuarine and even marine waters.

Coastal wetlands, particularly in winter, flocks recorded on estuaries, inlets, bays, lagoons, saltfields, mangrove swamps and more rarely on inshore waters off unindented shores (North; Wheeler 1947; Burbidge 1982; Corrick 1982; Aust. Atlas; Vic. Atlas). In arid inland: on waterholes, station pumpholes, borrow pits and temporary shallow waters (Wilson 1974; Aust. Atlas). In se., s. and sw. Aust. frequent waters of all sorts and sizes: small dams ($<$1 ha), sluggish rivers, large lakes and reservoirs, and sewage ponds. In Vic., occupied 26 of 953 farm dams (Corrick 1982); but 75–76% of birds counted were on large wetlands (Hewish 1988; Martindale 1988) and in s.NSW associated with extensive lakes and swamps (Fjeldså 1985, 1988). Following habitats recorded in Vic. and NSW: shallow herb-dominated transient freshwater meadows and swamps; open water in deep freshwater marshes; deep permanent reservoirs and natural lakes; shallow turbid floodwater swamps; saltpans; lagoons; saline and hypersaline lakes; coastal inlets; wetlands in cleared river-flats and agricultural land; off ocean beaches (Vestjens 1977; Corrick & Norman 1980; Corrick 1981, 1982; Gosper 1981; Fjeldså 1985). In sw.WA, highest numbers on open lakes and tidal estuaries (Jaensch et al. 1988); also occur on timbered swamps (e.g. *Eucalyptus, Melaleuca, Casuarina*) with little or no open water (R.P. Jaensch).

Probably prefer large (100–500 m wide) sheets of open water, 0.5–3.0 m deep, with submerged vegetation. Avoid water covered by dense weed; sharp division between zones of dense waterweed and open deep water leads to concentrations for feeding, preference probably being for uniform, rather sparse growth mainly of light-green, linear-leaved submergents such as *Ruppia, Vallisneria*, where foliage-gleaning perhaps easier than among other vegetation such as *Myriophyllum*. If small invertebrates plentiful, clarity of water rather unimportant; social behaviour may help to find concentrations of food in muddy water. Thus, at times common on waters without submergents (Fjeldså 1988). If underwater habitat suitable, feed without regard to distance from shore or cover (Sedgwick 1940; Fjeldså 1988) but for roosting prefer to be near grassy banks, low sedges, scattered lignum, flooded trees or shrubs, or areas where submergents reach surface (Fjeldså 1988).

For breeding, prefer permanent waters or climax stages of semi-permanent floodwaters with open marsh and swamp vegetation and widespread waterweed. Colonies among scattered sedges, reeds, saltmarsh vegetation, *Triglochin, Eragrostris* or lignum, or open to view where dense submergents come to surface.

Artificial regulation on floodwaters may prevent breeding in some areas. Artificial constructions (dams, reservoirs, sewage farms) may have allowed spread into naturally unsuitable areas (Corrick 1982), especially in arid inland. Vulnerable to oil-slicks in coastal areas (Pescott 1983).

DISTRIBUTION AND POPULATION Aust. and NZ. Distribution in Aust. Atlas seems to follow distribution of observers but least common N of 20°S.

AUST. In all states; widespread in se. and sw. Aust.

and Tas. Generally absent from central arid regions but probably occurs wherever surface water persists after rain. **Qld**, common in S, becoming less so to N and W (not recorded Torres Str. islands; Draffan *et al.* 1983). **NSW**, **Vic.**, **Tas.**, e. **SA** and sw. **WA**: common throughout, elsewhere sparsely distributed, becoming rarer in drier regions and to N. **NT**: patchy records, less frequent in N.

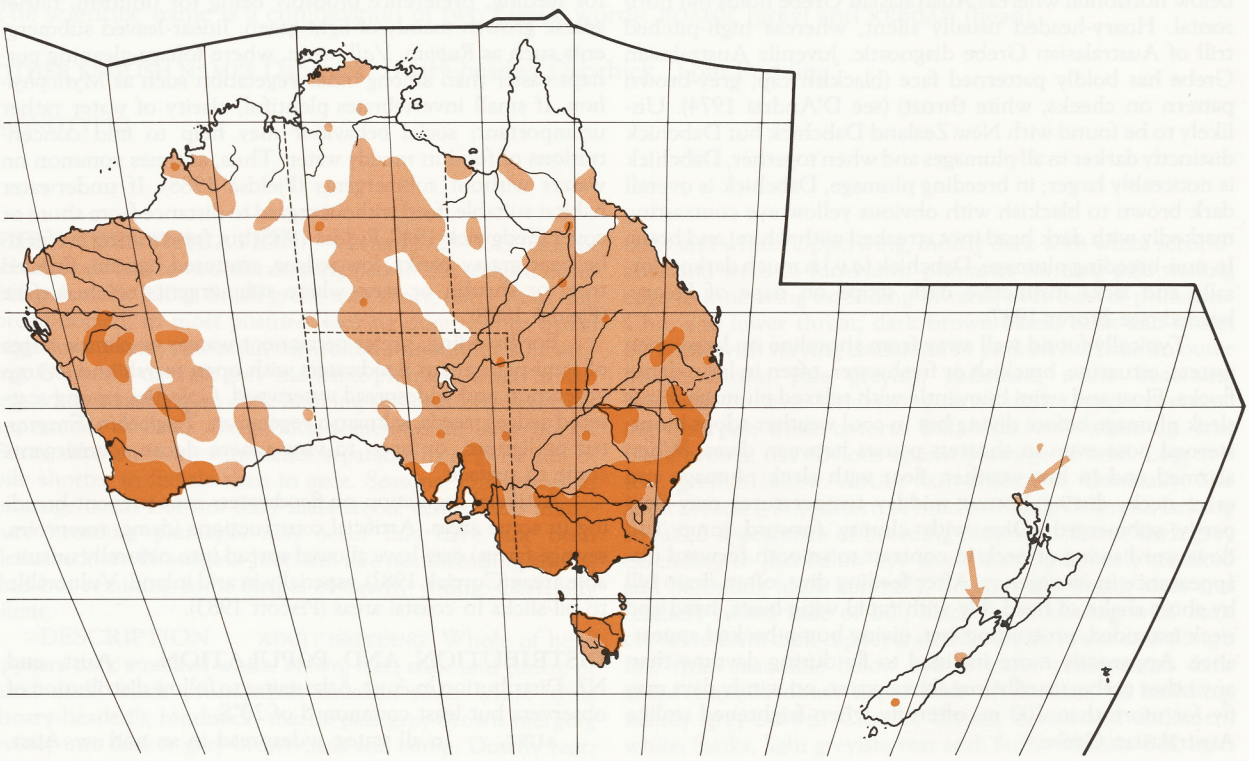
NZ. First reports: one, Snares Is, Feb. 1975; on mainland at L. Horowhenua, NI, June–July 1975 (Best 1976) and pair that bred, Te Anau district, SI, Nov. 1975–Mar. 1976 (CSN 25). Elsewhere, one, occasionally two, birds reported at widely scattered localities; probably same birds moving widely because seldom seen in same place twice. Few records after 1978 (CSN unless indicated): e.g. NI: Aupouri Pen., two, Jan. 1978; one, Jan. 1987; L. Purimu, one, Dec. 1977; Pukepuke Lagoon, one, June 1976; L. Horowhenua, one, Sept. 1977. SI: L. Elterwater, one, Feb. 1978, one, June 1987; near Farewell Spit, one, May 1989; L. McGregor, one, July 1978; L. Ohau, one, Dec. 1977–Mar. 1978; Redcliff Wetland Reserve, two, Feb.–Mar. 1980; Christchurch Sewage Ponds, one, most years 1980–85, two in 1983.

Assumed to breed throughout se. Aust., S and E of a line from Fraser I. to Birdsville and Eyre Pen.; and in sw. Aust., S and W of a line from Shark Bay to Wiluna to Esperance, wherever habitat and conditions suitable. Breeding reported less frequently in Tas. than Vic. (Aust. Atlas). Elsewhere breeding recorded near Cloncurry and Boulia (Qld), Broome (WA), Finke Gorge NP and Tanami Desert (NT), but perhaps no breeding likely in arid regions from Nullarbor to Gibson and Great Sandy Deserts in absence of surface water. In NZ, pair at L. Te Anau, Nov. 1975–Mar. 1976, bred: first nest destroyed; second nest produced two chicks, one of which survived; re-nested Dec. 1976, and raised three young; second nest seen Mar. 1977 with five birds present (Barlow 1976). In 1977–78, two pairs bred, each raising one young (CSN 25). Pair seen building nest, Aug. 1978 Redcliff Wetland Reserve (CSN 26). Breeding not recorded after 1978.

Can form large, non-breeding flocks: NSW: 1400, L. Illawarra, Aug. 1980; 2000–3000 at Fletcher's L. in summer (Hobbs 1961); Vic.: 400, Rotamah I. in winter; SA: 500, Adelaide, Mar. 1978 (Aust. Atlas); sw. WA (1981–88): 4900, Bibra L., Mar.; 3000, Guraga L., Oct.; 1890, Forrestdale L., Jan.; 1500, Thomsons L., Nov. (R.P. Jaensch). Colonies of 400 nests reported L. Bathurst, NSW (Frith 1976); 100 nests s. Murray–Darling region (Hobbs 1958); and 10 breeding pairs/ha reported near Clunes, Vic. (Aust. NRS); colonies 25–50 nests in wheatbelt, sw. WA (R.P. Jaensch).

Status, stable in Aust. In NZ, apparently few remain from small influx in mid-1970s and breeding not recorded there since 1978.

MOVEMENTS Poorly known; highly dispersive in drier parts of range, some regular movement in coastal areas. Diurnal flights apparently more frequent than any other grebe (Fjeldså 1983); on moderately windy days distances of >200 m normally travelled by flying; often flies when frightened (unlike Australasian Grebe). Large non-breeding flocks can be very restless; groups often fly upwind immediately after sunset (Fjeldså 1988). Daily fluctuations (Lamm 1965), record of pair landing at night on boat in Bass Str. (McGarvie & Templeton 1974), and occurrence of single bird on isolated dam in woodland (S. Marchant) suggest unnoticed flights at night. Long distance dispersal suggested by recent arrival in NZ (see Distribution) and appearance on isolated lakes throughout normal range (Aust. Atlas). Flocks of thousands arrive at some inland swamps shortly after rise in water level (Hobbs 1956; L.W. Braithwaite). On n. coast NSW (Gosper 1981) and in se. Qld (Woodall 1985) a scarce visitor during



times of low rainfall inland.

More regular movement occurs in better-watered parts of se. Aust. where flocks of hundreds or thousands assemble in bays and estuaries during winter (Wheeler 1947; Vic. Atlas). Flocks also on perennial inland lakes during winter (Hobbs 1958) which, in dry years, may persist through summer (Hobbs 1961). In Oct.–Nov., assemblies of a few to many hundreds occur on productive flood-water swamps, sewage farms etc., most of which appear to be of moulting immatures and sub-adults (Fjeldså 1988). Extent of possible moult migration and participation by breeding adults not known. At Avon R., sw. Aust., absent winter, in small flocks Nov. then dispersed on small waterbodies summer and autumn (Masters & Milhinch 1974). Over most of SW, however, largest flocks form late spring-early autumn as most small wetlands dry out quickly in summer (R.P. Jaensch). Apparently same individual returned May–Nov. to a dam on Atherton Tableland, n. Qld, in 3 successive years (Bravery 1970).

BANDING Longest recorded movement of a banded bird 572 km (ABBBS).
34S145E 01 J U 6 584 225 ABBBS.

FOOD Chiefly aquatic arthropods, obtained largely (±90%) by deep diving. Feeding dives consist of distinct clumsy jump and downward swing of neck (unlike smooth forward-directed disappearance in emergency). Dive normally lasts 17.5 s (2–26) at average speed 0.121 m/s (as measured on surface; compared to 1.3 m/s in emergency) with 9 s (4–26) between dives swimming 0.1 m/s. On 12 timed dives spent 5–8 s on surface, 16–24 s underwater (Barlow 1976). Underwater descent at 45°–90°, moving slowly with rear elevated and feet waving vigorously, pecking incessantly towards water-weeds or sediment (Fjeldså 1988) over small area of bottom; feeds less on surface than other small grebes (J. Fjeldså). Periods of swimming with head and neck immersed and turned from side to side followed by brief, shallow dives for large prey. Immersion of head occasionally associated with rotation of body, which may stir up prey. Sometimes pick from water surface but rarely chase prey. Stationary between most dives. Feeding apparatus primitive and generalized with some adaptations for taking very small items of food. Eject pellets of arthropod chitin but without previously drinking. Congregate when feeding, particularly in turbid waters (Fjeldså 1983). Diving sometimes associated with feeding herbivorous waterbirds, possibly taking prey displaced as other birds disturb vegetation. Feed throughout daylight, with no clear maxima; when light poor, feed mostly at surface.

In **NSW** (19 stomachs, 7056 items; % weight; Fjeldså 1988) chironomid larvae 34% wt., bugs 21, water beetles 15, moth larv. 10, caddisfly larv. 5, dragonfly larv. 3, midges 3, fish 3. Numerical analysis: earthworms <0.1; snails *Glyptophysa* <0.1; arachnids 4.1 (water mites *Arrenurus* 2.7, *Eylais* <0.1, *Piona* 1.3); crustaceans 30.8 (cladocerans *Daphnia* 28.7; ostracods 1.2, *Mytilocypris henriciae* 1.0; amphipods 0.8, decapods *Paratya australiensis* 0.1), insects 12.2 (mayflies <0.1, odonatans Zygoptera nymphs 1.7, imagines 0.1, Anisoptera Aeshnidae <0.1; bugs Saldidae <0.1, Corixidae 24.4 *Sigara* nymph 4.6, imm. 5.8, *Agraptocorixa* nymph 2.9, imm. 10.9, *Naucoris* 0.1, Notonectidae 3.0 *Notonecta* <0.1, *Anisops* 3.0, *Enthares* <0.1, *Plea* 0.1, Tingidae <0.1, Lygaeidae <0.1; thrips <0.1; beetle larv. 0.7: *Haliplus* <0.1, Hydroporinae 0.5, large *Homeodytes scutellaris* <0.1, imagines. 15% wt: Carabidae <0.1% no., *Megaporus howitti* 4–6 mm 0.2, Hydrophilidae 8–11 mm 5.6, Melolonthinae <0.1, Helmidae 0.1; caddisfly larv. 1.0: Leptoceridae 0.9, campodeiform 0.1, pupa <0.1; lepidopterans Nymphulidae larv. 2.0; flies Tipulidae larv. <0.1, Chironomidae larv. 17.8, imm. 5.1, Stratiomyidae larv. 0.8, Ephydridae larv. <0.1, imm. 0.1, *Eristalis* <0.1; hymenopterans Formicoidea 0.1); fish *Gambusia affinis* <0.1, amphibians <0.1, plant fragments 0.3. Corixid bugs, especially rather big *Agraptocorixa*, damselfly nymphs, caddisfly larvae, big *Chironomus* larvae and dytiscid larvae, amphipods and nymphulid larvae probably taken selectively. Data suggest preference for foliage-gleaning arthropods when food plentiful and efficient use of *Daphnia* and other tiny prey when food scarce. In captivity, small-billed female fed most efficiently on zooplankton, damselflys, corixid nymphs and midge larvae; large-billed male on beetles and probably small fish.

Other records: freshwater snail 9% freq., crustaceans (ostracods 9, decapods shrimps 27, yabbies 9); insects (dragonflies 9, bugs Corixidae 46, Notonectidae, beetles Dytiscidae 46, unident. 18, various larvae and pupae 18, terrestrial and aerial species 18 incl. short-horned grasshopper, beetles Hydrophilidae, Curculionidae, moths, hymenopterans *Iridomyrmex*), fish *Gambusia affinis* 18 (9 stomachs, w. NSW; R. Barker & W.J.M. Vestjens); beetles *Necterosoma penicillatus*, *Heteronyx*, and water weeds (1, Glenelg R., Vic.), small crustaceans, small spiders, insects (bugs Corixidae, Notonectidae; beetles *Haliplus testudo*, *Cybister tripunctatus*, *Hyphydrus elegans*; *Bagous*; caddisfly larvae), water plants, 2 feathers (1, Muswellbrook, NSW; Lea & Gray 1935); seeds of dicots *Chenopodium*, *Heliotropium supinum* (Barker & Vestjens 1989). As with NZ Dabchick, but unlike other grebes, does not normally eat feathers (Fjeldså 1983).

CHICKS Fed 7 times/min soon after being hatched (n=4 min; Barlow 1976).

SOCIAL ORGANIZATION Based mainly on Fjeldså (1983) and information supplied by J. Fjeldså. Highly gregarious. In breeding season, in colonies up to 400 nests (Frith 1976); otherwise, in small parties to flocks of several thousands. Flocks usually dispersed with clumping of groups within flocks; on dense rafts of vegetation when nesting. Two or more birds often in physical contact when preening or resting. Single birds and small parties may be seen with Australasian Grebes. Usually move offshore and cluster together when alarmed. In presence of low-swooping raptors, may show synchronized crash-diving, characterized by fold-in-middle dive and water-kicking in which bird moves under water kicking rapidly with both feet. Based on data from Oct.–Nov. in NSW (867 observations), 24% of Grebes less than 1 m from conspecific (23% feeding), 40%, 1–5 m (51% feeding), 17%, 5–10 m (52% feeding) and 21% more than 10 m away (70% feeding). Clumping of feeding birds mainly associated with turbid water, which suggests clumping may function in location of prey.

BONDS Poorly studied. Monogamous pair-bond but no direct evidence of maintenance of bonds over more than one cycle. Paired associations in non-breeding flocks appear to be short-lived. Pair-bond apparently not secure on arrival at breeding locality because promiscuous mating can occur in early building phase.

BREEDING DISPERSION Colonial, often densely in more or less exposed sites, that remain inaccessible to predators. Defends only immediate vicinity of nest; several nests sometimes join to form a large raft.

ROOSTING When breeding, probably on or near nest. Otherwise in flocks on open water where dense water-

weeds rise to surface and prevent sleeping birds drifting. Some birds heap together weeds to make flimsy platform on which they sleep. Arrive at roost area one hour before sunset. Clusters of 20–30 birds may form within roosts of c. 1000 birds, each cluster occupying 2–3 m^2 and each bird maybe in physical contact with 3–4 others. Normally do not roost with other species.

SOCIAL BEHAVIOUR Based mainly on Fjeldså (1983) and information supplied by J. Fjeldså. Aggressive behaviour most noticeable during courtship and when birds crowd round nest on which another is soliciting.

AGONISTIC BEHAVIOUR In flocks, birds occasionally **Bill-thrust**: mostly short dashes with body raised slightly, mantle and head-feathers partly ruffled; ritualized threat; rare. In **Forwards-threat**, swims rapidly towards another bird with neck extended just above water, hyoid region bulging. Attacked bird shows **Hunched-threat**, with neck in, bill pointing slightly down, plumage expanded and partly lifted and wings spread, or flees by skidding away one to several metres with sleeked plumage. Brief adoption of vertical position with breast puffed out suggests that bird may rarely use vertical fight similar to that of other grebes. **Crouch-and-dive Display** (see below) may be associated with aggression. Incipient or established pairs perform **Triumph Ceremony**, where partners face, turn, and mill round each other with heads directed forwards, plumages expanded and wings partly lifted and spread; often associated with aggression near nests.

SEXUAL BEHAVIOUR **Water-courtship** observed in spring, in birds with breeding or non-breeding plumage on breeding lakes or localities where birds assemble for moult in spring; suggests that sub-adults may be involved. When **Advertising** (Fig. 2), often swim fast with long, thin neck extended and held erect and crown feathers ruffled, making head look laterally compressed. At intervals, jerk head upwards and may give rolling, guttural call (Hobbs 1958). Advertising birds usually avoid contact with other birds except birds also advertising. When approaching potential partner, may suddenly crouch very low, retracting neck and lifting wings slightly on back (**Crouch**) and then crash-dives. Other bird may also show Crouch-and-dive. In subsequent **Diving-ceremony**, partners face each other, 0.1–0.5 m apart, with neck held high and head-turning; one lowers bill and other repeats thrust or makes clumsy dive with splash, towards partner, emerging beside or behind partner, 1–3 s later. Sequence repeated 2–4 times, sometimes with roles alternating, before birds depart or start **Head-turning Ceremony**: partners face each other and gradually extend necks as in Advertising, but show more rounded head, which is jerked from side to side in irregular tempo; feet used to turn entire body from side to side during intense displays, suggesting ritualized intention to turn away. In **Penguin-dance** (Fig. 3), starting spontaneously or by gradual intensification of Head-turning, partners rise slightly in water for 5–10 s by treading water and expanding body-plumage, the swollen white breasts making birds conspicuous from long distance. Sometimes one or both birds dive to fetch water-weeds shortly after other displays. **Platform-courtship** normally occurs about time of laying; associated with mating, but also as promiscuous behaviour round early weed-platforms. At least early in season, roles reversible, and partners may be of same sex. On platform or nest, shows **Rearing** (Fig. 4): freezing in highly raised posture with mantle feathers ruffled, neck curved with head pointing down and then neck extended forwards. Bird then settles and lies down, **Inviting** with throat resting on rim of nest, neck kinked in middle. Inviting may also be adopted directly without preceding Rearing; sometimes performed on water. During COPULATION on platform, active bird sits on back of partner with wings folded, neck outstretched and sleeked head pointing forwards; passive bird maintains Inviting posture, or turns head or retracts it towards end of copulation. Terminated as active bird dismounts hurriedly over partner's head, which is raised very suddenly. Both then extend necks as in Head-turning Ceremony, passive bird showing measured lateral head-jerks, active bird vigorous head-flingings. Preening and nest-building may follow.

Fig. 2 Advertising and calling

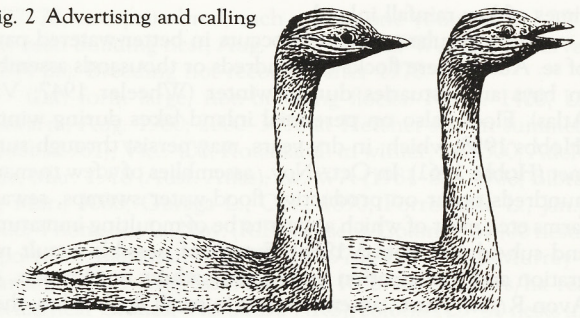
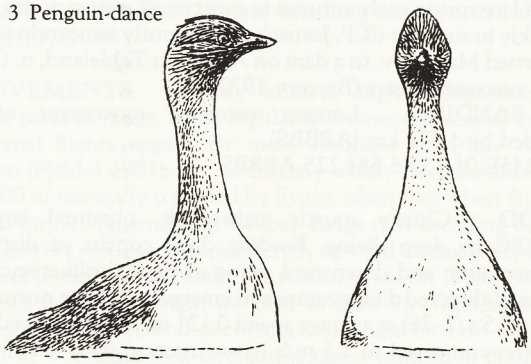


Fig. 3 Penguin-dance



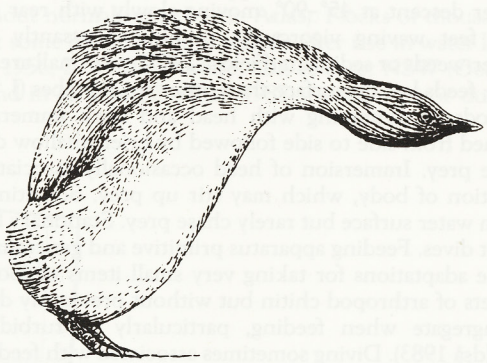


Fig. 4 Rearing

RELATIONS WITHIN FAMILY GROUP Largely unrecorded; probably much the same as other grebes (BWP). Both sexes probably tend young but may sometimes abandon nest before young ready to leave.

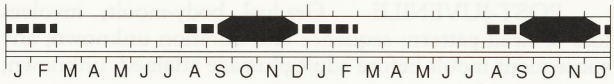
VOICE No detailed studies of vocalizations but behaviour examined by Fjeldså (1983). Information supplied by J. Fjeldså. Almost silent throughout year; have small range of usually soft guttural calls. Non-vocal sounds consist of Foot Pattering across surface of water during Forwards-threat; other splashes, as for other grebes. Possibly birds duet during Hunched-threat, Triumph Ceremony and copulation; however calls not reported and probably audible only over very short distances (J. Fjeldså). No sexual differences reported. No geographical or individual variation reported.

ADULT Few reports of calls. In sw. WA, commonly make peculiar, one-syllable *hrrow* (as in 'cow') when birds dispersed in flooded wetlands (typically in inland) when breeding imminent or in progress (R.P. Jaensch). Loud rolling guttural call reported from lone bird, audible up to 200 m; called frequently as it swam *c.* 1.6 km along length of lake (Hobbs 1958); probably advertising (Fjeldså 1983). Very soft guttural calls reported from calm birds in flocks and near nest. **Alarm Call**. A captured bird emitted *eeow* when handled (Fjeldså 1983).

YOUNG During tending of young, *squeaks* reported (Serventy & Whittell 1976); these probably given by young (J. Fjeldså).

BREEDING No detailed studies; based on material supplied by J. Fjeldså, with data from Aust. NRS (209 records; supplied by J.R. Starks). Breed in simple pairs, often colonially or semi-colonially; colonies up to 300 pairs (Aust. NRS).

SEASON No adequate data. Generally said to be Oct. to Jan.; breeding records in Vic. from Sept. to Jan. inclusive (Vic. Atlas); but North quotes record of young with adults, Lake Way, WA in Aug.; in sw. Aust., laying Aug.–Feb., most clutches started in Nov. (Halse & Jaensch 1989). Eggs recorded Sept. to Mar., most clutches in Oct. (Aust. NRS); all Mar. records from inland NSW. Young recorded Oct. to Feb.



SITE In water, usually in shallows well offshore with floating waterweeds or with scattered, rather open lignum, sedges, canegrass. Records of nest moored inside hollow tree (Sharland 1958), on top of bush standing in water (North) and anchored to tree in water (Aust. NRS).

NEST, MATERIALS Small rounded flattened floating platform of waterweeds, loosely attached to submergents, sedges, fallen branches; with small saucer-shaped depression in top, <5 mm above water-level; diameter of whole 25–30 cm. At first both sexes collect material and heap it on submergent vegetation; later one bird brings shorter items, partner sits on platform and arranges it by sideways pulling. Material added and re-arranged throughout incubation.

EGGS Elongated or pointed oval; chalky, often with somewhat irregular surface, not glossy; white, with the blue inner part of the shell showing through when fresh; soon becoming polished and stained to yellowish or dark brown. MEASUREMENTS: 40.1 (38.0–41.9; 19) x 27.4 (26.2–28.8) (Schönwetter 1967); 40 (36–43; 40) x 28 (25–29) (Serventy & Whittell 1976). WEIGHT: 16 g (n=40; Serventy & Whittell 1976).

CLUTCH-SIZE No quantitative data for definitely complete clutches. Four to five eggs usually recorded in nests, three and six occasional. No evidence of second or multiple broods; replacement clutches after failure probable as in all other grebes. Aust. NRS: mostly 3–4; average 3.4 (1–6; 46, not necessarily complete clutches). Evidence of two females laying in same nest: four eggs laid in 3 days in two nests (Aust. NRS) and white egg appearing once in apparently complete clutch. Replacements after failure of first clutch.

LAYING Routine not established and confused by likelihood of two females laying in same nest; probably daily or irregularly for later eggs of clutch (Aust. NRS).

INCUBATION By both sexes, from laying of first or second egg; hatching asynchronic. Eggs covered with nest material when leaving nest voluntarily or otherwise. INCUBATION PERIOD: said to be 21–25 days but no exact determinations. Aust. NRS: probably 20–24 days.

YOUNG Precocial and semi-nidifugous. Cared for by both parents; carried on parents' backs, under wings; fed bill to bill. Anti-predator reaction probably includes crash-diving with water-kicking.

FLEDGING TO MATURITY Ages of fledging, independence from parents, rates of growth, not known. Commonness of drab-coloured birds on breeding lakes and elsewhere suggests delayed sexual maturity.

SUCCESS No data.

PLUMAGES An eclipse plumage may occur, but, if so, similar to adult non-breeding; further study required, based on live birds (see Structure).

ADULT BREEDING Age at first breeding unknown. HEAD AND NECK. Forehead, crown and nape, black (89), black-brown (119) at side of head. Lores and auricular area, dark olive-brown (129). Chin, dark-brown (119A) merging to black-brown (119) at lower throat. Distal rami of head-feathers, long and white; profuse on crown, hindcrown, cheeks and outer throat; white rami impart streaked appearance to head. Thin oblique narrow line of dull-white feathers extend from base of lower mandible to beneath eye. Upper neck to lower neck, dull white with pale light-brown (223D) shade; hindneck, light grey-brown (119C). UPPERPARTS. Mantle and scapulars, pale dark-brown (c121), narrowly fringed light grey-brown (119C). Back and rump, dark-brown (119A). Concealed bases of feather of mantle, back and rump, light grey-brown (119D). TAIL-TUFT, short and dark-brown (121), surrounded by white hair-like feathers. UPPERWING. All remiges, dark-brown (121) with varying amounts of white on webs. All coverts, including alula, dark brown (121); median to marginal coverts become progressively lighter in colour and narrowly fringed light grey-brown (119C). Inner webs of primaries, become progressively whiter distally, from p11 to p8. Outer webs of primaries whiter distally, from p7 to p1; dark-brown (121) tips become progressively smaller; inner webs entirely white from p3–p1. Rachis, dark-brown (119A) merging to white. Secondaries white with narrow dark-brown (121) edge at tip of outer webs; s11, with most of outer web dark brown (121); inner web, with dark-brown (121) patch near tip (see illustration in Storer 1987). UNDERPARTS. Upper breast to outer breast margins, dull white with pink-buff (121D) shade. Rest of breast to upper abdomen, white; feathers glossy. Abdomen, vent and thighs, pale dark-brown (*c.*121). Flanks white; feathers, open pennaceous; rachis, dark-brown (121), distal rami, brown (119B), most having pink-buff (121D) shade. Axillaries white. UNDERWING. All coverts, white.

ADULT NON-BREEDING HEAD AND NECK. Crown and nape, dark-brown (121), narrowly fringed light grey-brown (119D); black along middle of nape. Side of head, dull white oblique narrow line of dull-white feathers from lower mandible to beneath eye, inconspicuous. Long white distal rami of head feathers, almost absent; some at hindcrown and few on forehead and sides of throat; may be partially retained or lost entirely. UPPERPARTS. Mantle and scapulars, fringed light grey-brown (119D). Rest of plumage, similar to adult breeding.

DOWNY YOUNG Entire down, short, longest on back. HEAD AND NECK. Down on crown to nape, white or light-brown (39), interspersed with longitudinal or concentric black-brown (119) stripes; pattern varies (Storer 1987; R. O'Brien). Down at side of head, striped longitudinally; more spotted at lower hindneck. Chin to lower throat, white with narrow black-brown (119) stripe centrally, extending to lower foreneck; two wider stripes extend from outer margin of chin to outer margin of throat. Lower foreneck, orange-buff (118), with few or no stripes. UPPERPARTS. Down from mantle to rump, light brown (223D); prominent longitudinal black-brown (119) stripes, narrowly spaced towards flanks. Stripes often discontinuous and broken, giving spotted appearance. Upper breast to abdomen, white. Flanks, vent and thighs, light grey-brown (119C), interspersed with black-brown (119) streaks. UPPERWING, black-brown (119). UNDERWING. light brown (223D).

JUVENILE Head pattern of downy young largely retained; stripes, broader. HEAD AND NECK. Forehead dark-brown (121). Small patch of white feathers at either side of base of lower mandible. Lores, light brown (223D). Crown dark-brown (121); two broad single patches of light-brown (223D) feathers on crown and hindcrown, separated by broad stripe of dark-brown (121) feathers. Narrow white supra-orbital streak extends from above eye to ear; other small dark-brown (121) stripes over supra-orbital streak and at gape. Auricular area, dark brown (121). Chin and throat, white. Hindneck, mixture of dark-brown (121) and white feathers, appearing mottled. Lower foreneck, light grey-brown (119D) with pink-buff (121D) shade. UPPERPARTS, TAIL, WING. Similar to adult non-breeding. UNDERPARTS. Upper breast, similar to lower foreneck. Breast to abdomen, white. Flanks, vent and thighs, dull white; rami, pale dark-brown (c121). Plumage probably held for short period, but duration unknown; involves gradual loss of head pattern. An immature plumage may occur but confused with non-breeding plumage; possibly birds lacking black on mid-nape and with few white 'hairs' are immatures (J. Fjeldså); juvenile plumage requires further study.

ABERRANT PLUMAGES Underparts of adult breeding and non-breeding, prone to ferrous oxide staining, and staining from vegetation.

BARE PARTS

ADULT BREEDING Iris, black-brown (119) with irregularly scattered cream (54) specks, progressively becoming larger distally from pupil. Narrow cream (54) iridal ring adjoins pupil; similar larger ring round outer edge of iris. Bill, grey-black (82); distal tip of tomia, pearl grey (81). In female, straw yellow at base recorded (J. Fjeldså). Legs and feet, greyish yellow (-) or greenish grey on inner margins; outer margins, dark olive (48), with black-brown (119) shade.

ADULT NON-BREEDING Irides, similar to adult breeding. In males, pale outer iridal ring, golden-yellow; in females, ivory. Colour of iris varies, from brown, grey, yellow to white; males may have yellower eyes than females; needs investigation (Storer 1987) but J. Fjeldså says there are no sexual differences. Upper mandible, grey-black (82); cutting edge, cream (54). Colour of bill, varies seasonally; change in colour starts basally and moves distally; dark spots near bill base recorded (Storer 1987). Legs and feet, vary from light greyish yellow to pale buff with greenish grey edges (gradual transition); some dark spots round joints (Storer 1987). Underside of legs blackish olive. For range of colours, see Storer (1987). Extensive yellow colour (orange-yellow on inner tarsus and feet of female), possibly due to seasonal or sexual difference (Storer 1987).

DOWNY YOUNG (Data from label; SAM): Ground colour of bill, very pale violet-pink with white egg-tooth on each mandible. Dark markings on bill, dark brownish-grey near base, paler mid-grey surrounding egg-tooth. Skin of face, very pale pink, tinged with pale blue-grey just before eye. Legs and toes, elephant grey, tinged violet on inner sides of tarsi, palmations and nails, pale cream-olive (Storer 1987).

JUVENILE (Data from label; SAM). Iris: outer ring, cream; rest, whitish grey. Cutting edge of upper mandible, whitish horn; culmen, dark grey. Lower mandible, whitish horn with diagonal black mark midway. Legs, greenish gold; thinner parts and webbing, very golden. Underside of webs, blackish green with gold edges.

MOULTS Few data. Breeding season protracted; no definite moult period can be ascribed.

ADULT POST-BREEDING Complete; remiges simultaneous. Body moult presumably gradual; involves loss of feathers with conspicuous white rami.

ADULT PRE-BREEDING Probably partial; involves acquisition of profuse white rami on head; in se. Aust., *c.* Oct.–Jan. (Fjeldså 1988). Moult assemblages occur, though not all birds moult at this time (Fjeldså 1988).

POST-JUVENILE Gradual body-moult; involves loss of head pattern; sequence and duration unknown; any subsequent moult before adult plumage attained, unknown; requires study.

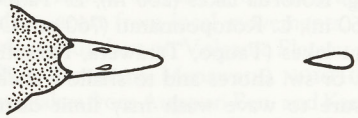
MEASUREMENTS Adult skins from various museums; wing, minimum chord: (1) E. Aust. (2) W. Aust. (Storer 1987).

		MALES	FEMALES
WING	(1)	115.0 (3.41; 107–121; 38)	111.4 (3.54; 104–117; 23) *
	(2)	113.6 (2.97; 109–118; 12)	111.3 (2.95; 106–116; 13)
BILL	(1)	21.2 (1.26; 18.5–23.7; 39)	17.4 (1.35; 15.5–20.2; 23)*
	(2)	21.5 (1.60; 18.5–24.6; 12)	17.2 (0.63; 16.0–17.9; 11)*
TARSUS	(1)	37.8 (1.12; 35.9–40.1; 39)	37.0 (1.18; 34.9–39.3; 23)*
	(2)	38.3 (1.03; 37.2–40.3; 10)	36.7 (1.20; 35.2–40.0; 13)*

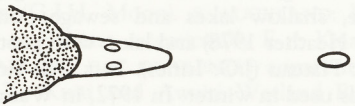
WEIGHTS Aust., label data from adult skins: males 257.9 (30.2; 202–311; 14), females 223.1 (27.6; 190–276; 14); significantly different ($P<0.05$) (Storer 1987). No data on seasonal changes in weight.

STRUCTURE Wing, short and narrow. Twelve primaries: p10 longest, p11 0–1 mm shorter, p9 1–2, p8 7–8, p7 13–15, p6 16–18, p5 20–23, p4 24–27, p3 28–31, p2 32–35, p1

36–38, p12 minute. P11 emarginated on inner web. P10 emarginated on outer web; slight on inner web. P9 slightly emarginated on outer web. Fifteen secondaries, four of tertial form. Short hair-like tail tuft. Bill, short, deep at base, pointed; deep nasal groove. Nares, elongate-oval in shape. Feathered borderline of culmen and frons, concave (D'Andria 1974). Tarsus, laterally compressed; less so in downy young. Feet lobed. Middle claw, slightly pectinate. Outer and middle toes about equal, inner *c.* 78% of middle, hind *c.* 27%.



Hoary-headed Grebe



Australasian Grebe

Fig. 5 Bill, from above

Fig. 6 Nostrils

SEXING, AGEING Double row of separated scutes on hind edge of tarsus, serrated; possibly fused in juvenile, difficult to determine in skins. It may be possible to identify eclipse plumage, if it occurs, in live birds, using this character; see criteria given in Kop (1971).

GEOGRAPHICAL VARIATION Variation slight.

RMO

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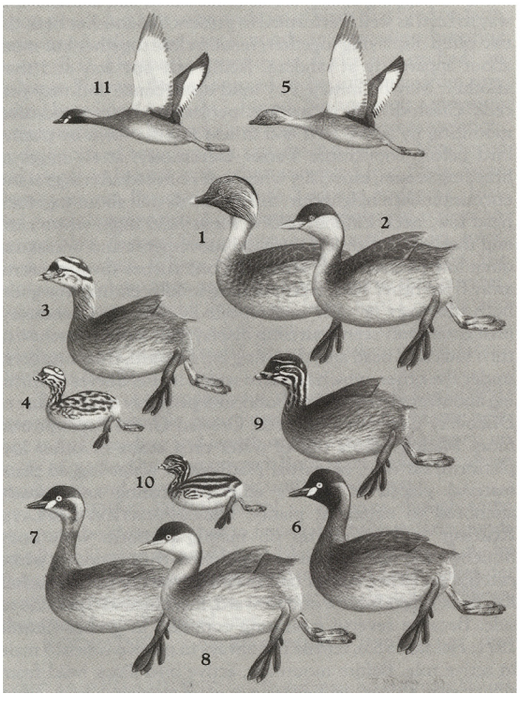

Volume 1 (Part A), Plate 5

Hoary-headed Grebe
Poliocephalus 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