

Order ANSERIFORMES

Medium-sized to large aquatic, marine and terrestrial birds. Three families: (1) Anhimidae (screamers), (2) Anseranatidae (Magpie Goose) and (3) Anatidae (true wildfowl); Screamers confined to South America, Magpie Goose confined to Aust. and New Guinea, and rest cosmopolitan. Suggestion that the order is distantly related to Phoenicopteriformes and Ciconiiformes (see Sibley & Ahlquist 1972) now seems unlikely. Claims for some anatomical similarities with gamebirds such as Cracidae, suggesting distant affinity with Galliformes via Anhimidae and Anseranatidae (Simonetta 1963; Johnsgard 1968; Bock 1969), strongly rejected by Olson & Feduccia (1980).

All members of the Anseriformes are web-footed (in some semi-palmate) swimming (some now almost terrestrial) and diving birds that are filter-feeders or are derived from aquatic filter-feeders. They differ from Galliformes in almost every anatomical feature (see Olson & Feduccia 1980). The unique filter-feeding mechanism is diagnostic of the order. Two groups of filter-feeding birds probably evolved from some charadriiform origin; in one, the specialized mechanisms for filtering evolved in the lower mandible (flamingoes); in the other, the upper mandible housed the specialized tongue used to provide the pump-action for filtering. The complex structure of the bill and its operation during filter-feeding in a typical duck has been investigated recently (Zweers 1974; Zweers *et al.* 1977; Kooloos 1986; Kooloos & Zweers 1989; Kooloos *et al.* 1989). Sensory apparatus of the bill associated with this filtering function is likewise complex (Berkhoudt 1980). The typical bill, representing the fundamental apparatus unique to the order, acts as a double-action suction-pump in which fluid is drawn in at the tip and expelled past filter plates at the sides and rear. The tongue and internal shape of the bill provide the elaborate piston effects and the lamellae or fine plates, common to all members of the order, act as the sieves. Lamellae trap the food, which is then brushed free and swallowed by the combined actions of tongue and lamellae. Vestigial lamellae occur in screamers (Olson & Feduccia 1980). Filtering is the original feeding method and departures from it towards adaptations for grazing in geese, serrated edges for catching fish in 'saw-billed' ducks (mergansers and allies) or superficially fowl-like bill of screamers, are all derived features (Olson & Feduccia 1980). Anhimidae, however, being extralimital, are not considered further.

The innovative modern classification of the ducks, geese and swans, and the systematic order proposed by Delacour & Mayr (1945, 1946) and Delacour (1954-64), was modified by Johnsgard (e.g. 1965a, 1968) in the light of further studies, particularly on behaviour and social signals, and new information on little known species. Woolfenden (1961) and Livezey (1986) have prepared phylogenetic analyses of the order based on morphological characters, and the classification by Livezey has been followed by some recent works (e.g. Madge & Burn 1988). Madsen *et al.* (1988) provide important additional information from DNA studies and give a partial classification of the order. We have adopted the classification of Johnsgard in Peters with some modification concerning only those species within our area. Our reasons for these changes are as follows but the arrangement of species fits closely the proposed classification of the order given by Sibley *et al.* (1988) and Madsen *et al.* (1988). The arrangement is consistent with the persuasive argument presented by Olson & Feduccia (1980) concerning the origin and evolution of the order. The fossil *Presbyornis* (Eocene; North America) and the endemic *Stictonetta* (Freckled Duck) and *Malacorhynchus* (Pink-eared Duck) of Aust. have special significance in this respect (see Olson & Feduccia 1980).

Special features of *Stictonetta* are: reticulated anterior face of tarsus; lack of a syringeal bulla; no speculum; unpatterned downy young (see Frith 1964a,b). Structure of the trachea and syrinx described by Ramsey (1878) and in more detail by Campbell (1889) and in Campbell demonstrate the lack of any development of a swollen bulla in drake. Claim by Frith (1964a, 1965, 1967, 1982) that tracheal loop occurs in mature drake is unconfirmed in many hundreds of birds examined (G.F. van Tets). Long neck. Uropygeal wax esters like those of some swans (Edkins & Hansen 1972) but chemotaxonomy difficult to interpret because similarities also shown with *Cereopsis*, *Branta*, *Cairina*, *Tadorna*, *Mergus* and *Melanitta* (Jacob & Glaser 1975). Brush (1976) has shown that the feather-proteins are unique. Verheyen (1953) on skeletal characters (cranial & post-cranial) concluded that it was sufficiently distinct to be separated from other waterfowl. Clearly it shows a large number of 'primitive' characters. Olson & Feduccia (1980) emphasize several features of the cranium that are unique in living ducks: the markedly recurved rostrum and mandible and the expanded lachrymal. Livezey (1986), largely from osteological characters, supports traditional conclusions that it is the last branch of the waterfowl with reticulate tarsi and places it after the geese and swans. Faith (1989) has shown that many of these skeletal characters might be explained on divergence between diving, dabbling and grazing adaptations. Recent DNA studies (Madsen *et al.* 1988) lend some support to an earlier suggestion, based on behaviour and some morphological features, of possible similarity with Oxyurinae (Johnsgard 1965b). Fullagar *et al.* (in press) add support to idea that *Stictonetta* has several behavioural similarities with stiff-tails. The uniqueness of this species has been widely supported, but in the past the absence of information about its behaviour and ecology ensured that it remained doubtful to which other group of

wildfowl it was most closely related. Many of these deficiencies have now been resolved (see text elsewhere) and the argument for a link with stiff-tails has become more compelling. Plumages, social signals and vocalizations are all in some way most readily comparable to *Oxyura* and *Biziura* but specially to *Heteronetta*. A seasonally colourful bill in the male most closely matches the condition found in *Heteronetta* but also in most stiff-tails; sequence of moults follow unusual pattern found in at least some, if not all, stiff-tails but not known in other wildfowl, notably the presence of a post-juvenile moult including wings. Many characteristics of breeding biology (nest-construction and choice of site; small clutch-size; predisposition to dump laying; appearance and quantity of down used in lining nest; unpatterned ducklings) are features shared with most stiff-tails. In particular the unusual copulation involving greatly elongated pseudopenis is most closely comparable with features shown only by stiff-tails.

Major recommended works of reference are: **Comprehensive accounts:** Delacour (1954-64); Todd (1979); Phillips (1922-26) [ducks]; Scott (1972) [swans]; Owen (1980) [geese]. **Regional accounts:** Palmer (1976) [Nearctic]; BWP [w. Palaearctic]; Bauer & Glutz von Blotzheim (1968-69) [Europe]; Frith (1982) [Aust.]. **Field guides:** Scott (1988); Madge & Burn (1988). **Special studies:** Hochbaum (1955, 1973) and SOWLS (1955) [migration and habits]; Johnsgard (1965a) [complete review of behaviour]; Hochbaum (1944); Driver (1974) and Kear & Berger (1980) [species monographs].

REFERENCES

- Bauer, K.M., & U.N. Glutz von Blotzheim. 1968-69. *Handbuch der Vögel Mitteleuropas*. 2,3.
- Berkhoudt, H. 1980. *Neth. J. Zool.* 30: 1-34.
- Bock, W.J. 1969. *Ann. NY Acad. Sci.* 167: 147-55.
- Brush, A. 1976. *J. Zool., Lond.* 179: 467-98.
- Campbell, A.J. 1899. *Ibis* (7) 5: 362-4.
- Delacour, J. 1954-64. *Waterfowl of the World*.
- Delacour, J., & E. Mayr. 1945. *Wilson Bull.* 57: 3-55.
- Delacour, J., & E. Mayr. 1946. *Wilson Bull.* 58: 104-10.
- Driver, P.M. 1974. In *Search of the Eider*.
- Edkins, E., & I.A. Hansen. 1972. *Comp. Biochem. Physiol.* 41B: 105-12.
- Faith, D. 1989. *Cladistics* 5: 235-58.
- Frith, H.J. 1964a. *Nature* 202 (4939): 1352-3.
- Frith, H.J. 1964b. *Emu* 64: 42-7.
- Frith, H.J. 1965. *CSIRO Wildl. Res.* 10: 125-39.
- Frith, H.J. 1967. 1982. *Waterfowl in Australia*.
- Fullagar, P.J., et al. In press. *Wildfowl* 41.
- Hecht, M.K., & F.S. Szalay (Eds) 1977. *Contributions to Vertebrate Evolution*. 3.
- Hochbaum, H.A. 1944. *The Canvasback on a Prairie Marsh*.
- Hochbaum, H.A. 1955. *Travels and Traditions of Waterfowl*.
- Hochbaum, H.A. 1973. *To Ride the Wind*.
- Jacob, J., & A. Glaser. 1975. *Biochem. Syst. Ecol.* 1975 (2): 215-20.
- Johnsgard, P.A. 1965a. *Handbook of Waterfowl Behavior*.
- Johnsgard, P.A. 1965b. *Wildfowl Trust Ann. Rep.* 16: 73-83.
- Johnsgard, P.A. 1968. *Waterfowl. Their Biology and Natural History*.
- Kear, J., & A.J. Berger. 1980. *The Hawaiian Goose. An Experiment in Conservation*.
- Kooloos, J.G.M. 1986. *Neth. J. Zool.* 36: 47-87.
- Kooloos, J.G.M., & G.A. Zweers. 1989. *J. Morph.* 199: 327-47.
- Kooloos, J.G.M., et al. 1989. *Zoomorphol.* 108: 269-90.
- Livezey, B.C. 1986. *Auk* 103: 737-54.
- Madge, S., & H. Burn. 1988. *Wildfowl*.
- Madsen, C.S., et al. 1988. *Auk* 105: 452-9.
- Olson, S.L., & A. Feduccia. 1980. *Smithson. Contr. Zool.* 323.
- Owen, M. 1980. *Wild Geese of the World. Their Life History and Ecology*.
- Palmer, R.S. (Ed.) 1976. *Handbook of North American Birds*. 2,3.
- Phillips, J.C. 1922-26. *A Natural History of the Ducks*.
- Ramsey, E.P. 1878. *Proc. Linn. Soc. NSW* 1878: 154.
- Scott, P. 1972. *The Swans*.
- Scott, P. 1988. *A Coloured Key to the Wildfowl of the World*.
- Sibley, C.G., & J.E. Ahlquist. 1972. *Bull. Peabody Mus. nat. Hist.* 39.
- Sibley, C.G., et al. 1988. *Auk* 105: 409-23.
- Simonetta, A.M. 1963. *Arch. Zool. Ital.* 48: 53-135.
- SOWLS, L.K. 1955. *Prairie Ducks. A Study of Their Behaviour, Ecology and Management*.
- Todd, F.S. 1979. *Waterfowl. Ducks, Geese and Swans of the World*.
- Verheyen, R. 1953. *Gerfaut* 43 (Suppl.): 373-497.
- Woolfenden, G.E. 1961. *Bull. Fla. St. Mus., biol. Sci.* 6: 1-129.
- Zweers, G.A. 1974. *Neth. J. Zool.* 24: 323-467.
- Zweers, G.A., et al. 1977. In: Hecht & Szalay 1977.

Family **ANATIDAE** wildfowl

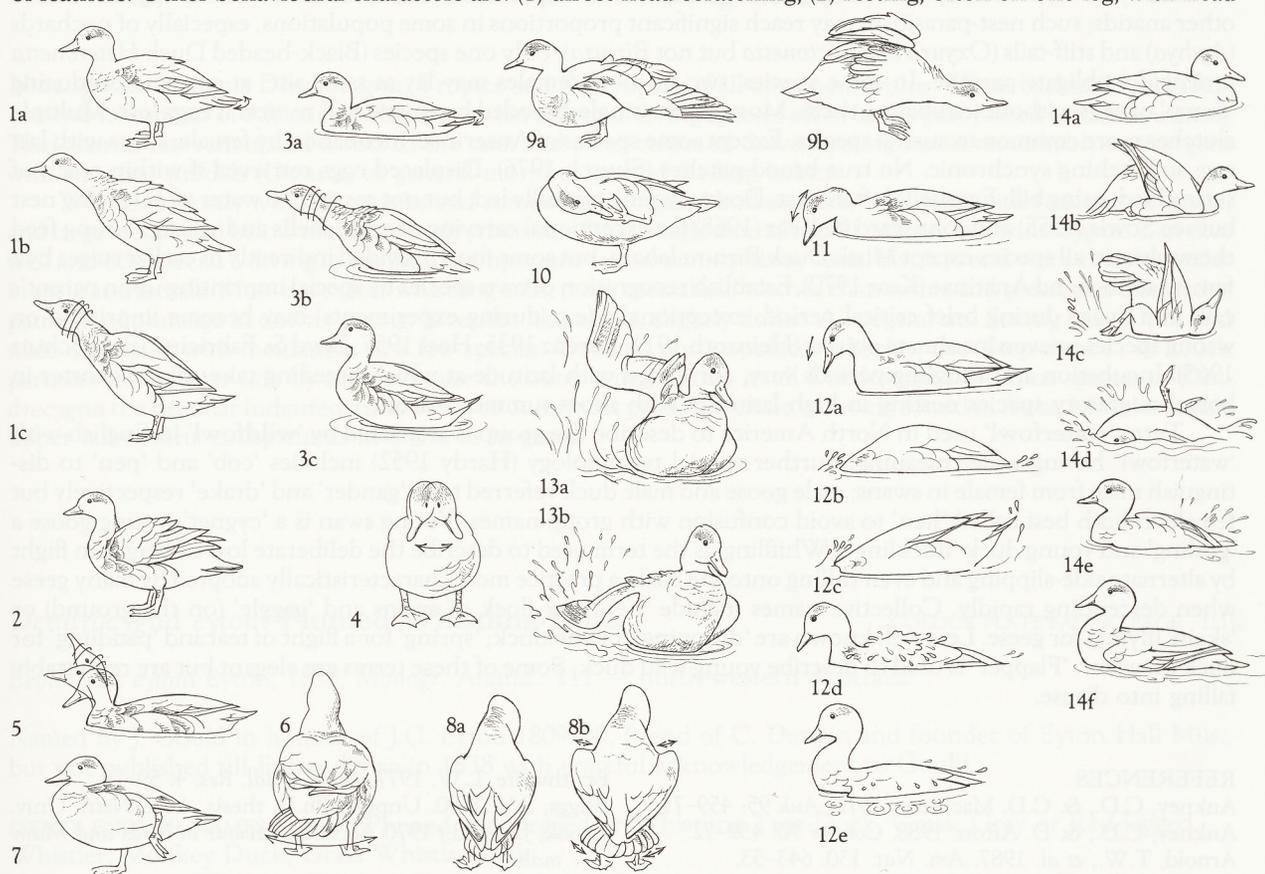
Waterbirds (some more or less terrestrial) with rather short legs and front toes connected by webs; hallux elevated and reduced. Though considerable adaptive diversity in outward appearance, size, colours of plumage, behaviour, and ecology, homogeneous in many characters, as attested by numerous, often fertile, interspecific hybrids reported, chiefly in captivity (see Gray 1958). About 160 species in six sub-families: (1) Dendrocygnae (whistling-ducks); (2) Oxyurinae (stiff-tails and Freckled Duck); (3) Anserinae (swans and geese); (4) Tadorninae (shelducks, sheldgeese and steamer-ducks); (5) Anatinae (dabbling ducks and allies); (6) Merginae (eiders, scoters, mergansers and allies).

Body, broad and rather elongated in many, though more rotund in some, especially diving species. Plumage, thick and waterproof; contour-feathers distributed over distinct feather-tracts with underlying coat of down. Neck, medium to long. Wings generally rather small; mostly pointed, fairly broad in many, but narrower in some highly migratory species. Small claws on first and second digits occur in most. Spurs—horny sheathed bones—occur in several species as projections near carpal joint; attached either to radial carpal or the metacarpal. Wing-spurs are found in the Tadorninae and *Sarkidiornis*, *Plectopterus* and *Merganetta* in the Anatinae. Eleven primaries; p9 nearly always longest, p11 minute. Wide range in number of secondaries, from 12 to 24, innermost (tertials) often long and brightly coloured; diastatic. Many species, particularly in Tadorninae, Anatinae and Merginae have a specialized, contrastingly coloured patch (speculum) on upper surface of inner wing, important for sexual and social signalling. Most fly fast and have large, high-keeled sternum. Tail, short and square or slightly rounded in most; long in some diving species (serving as rudder), pointed or with elongated central feathers in some others. Tail-feathers, 14–24 but varying even in single species. Bills show much adaptive variation but typically of medium length, broad, often flattened centrally and distally but high at base, and rounded at tip with horny nail at tip, producing slight terminal hook; covered with soft skin. Edges of mandibles with rows of lamellae, showing different development in various ecological types and taxonomic groups; most highly specialized in surface plankton-feeders, least so in species (such as scoters *Melanitta*) that swallow molluscs whole. Tongue, thick and fleshy; epithelium covered with papillae and horny spines. Lower part of tibia and tarsus bare; front toes connected by webs (reduced in a few species), hind toe elevated. Gait, striding or waddling. Oil gland, feathered. Aftershaft, reduced or absent. Special intromittent copulatory organ present in males; vascularized sac everted from wall of cloaca, protruded by muscular action; facilitates sexing by examination (Hochbaum 1942), even of small young. Salt-secreting nasal glands subject to adaptive variation in size, even in same species; enlarged in forms inhabiting saltwater or brackish habitats, modifying profile of head considerably. In many species, males have remarkably lengthened, bent, or locally widened trachea forming resonating tubes; also syngo-bronchial sound-boxes (bullae), either fully ossified or with membranous fenestrae. These vocal structures highly characteristic of species or larger taxonomic units (see Eyton 1838 and, especially, Johnsgard 1961, 1971). Considerable diversity in types of plumage: male and female similar, nearly similar, or show extreme sexual dimorphism. In all species, except some sheldgeese, flight-feathers moulted simultaneously, producing period of flightlessness lasting 3–4 weeks. Two body-moult per cycle. Young precocial and nidifugous, covered with thick down; pattern often cryptic and characteristic of taxonomic groups within sub-families. Able to swim soon after hatching.

Cosmopolitan, but absent from continental Antarctica and some islands. Usually on or close to water. Highly vulnerable to human pressures on habitats. Labrador duck *Camptorhynchus labradorius* extinct during last century, and three more (Crested Shelduck *Tadorna cristata*, Pink-headed Duck *Rhodonessa caryophyllacea*, Auckland Merganser *Mergus australis*) probably so this century. A few species domesticated: Swan Goose *Anser cygnoides*, Greylag Goose *A. anser*, Muscovy Duck *Cairina moschata*, and Mallard *Anas platyrhynchos* (Goodwin 1965); some populations of a few more (Mute Swan *Cygnus olor*, Canada Goose *Branta canadensis*, Egyptian Goose *Alopochen aegyptiacus*) kept in semi-domesticated or feral conditions.

N. forms often highly migratory and tied to Arctic or high latitudes for breeding, exploiting brief but productive period each year to raise young; for many of these species autumn movements preceded by marked moult-migrations by males to special areas for period of flightlessness. More sedentary in warmer latitudes, specially in equatorial regions. The term 'boreal' for these n. wildfowl is useful to draw attention to the marked differences between the breeding ecology of n. high-latitude wildfowl compared with many s. hemisphere species for which the term 'austral' has been used (Fullagar *et al.* 1988). In general, most austral species are more sedentary and certainly lack spectacular migrations. Regular movements in most s. hemisphere species are at best only local. Occasional much wider dispersal is often initiated by factors such as flooding rains and drought (specially in Aust.). Many austral ducks exploit seasonally persistent or occasional, extremely propitious conditions by responding with an extended breeding season. In reality, most are seasonal breeders but productivity of some will vary greatly according to rainfall and flooding; most notable with many species in Aust. For further details see Fullagar *et al.* (1988).

Wide range in diet, from totally vegetable to totally animal, and in feeding habits, from terrestrial grazing to bottom diving; correlated with conspicuous adaptations in structure of bill, musculature of head, length of neck, and in general proportions of body. Terminology of feeding methods in species accounts mainly after Szijj (1965) and Bauer & Glutz (1968, 1969); see also Olney (1963). Typical filtering action of most members of the order, described earlier, best termed 'suzzling'. Most species gregarious, feeding, loafing, roosting, and travelling in cohesive flocks, integrated by calls and special pre-flight signals. Generally solitary breeders nesting in concealed sites, though some species colonial, either habitually or, more often, as alternative to dispersed nesting, usually in protected areas such as islands. Degree of territorialism when breeding and relation between territory and nest-site vary between species and larger taxa; some strictly territorial; others occupy wholly or largely undefended home-ranges. Monogamous pair-bond in most species but much variation between taxonomic groups in duration of bond and degree of male promiscuity (if any). Social systems and displays correlated with formation and maintenance of pairs; complex (see classic work of Lorenz 1951-53) and largely dissimilar in six sub-families (see below). Copulation on water in all species (except some Anserinae and Tadorninae), typically with male grasping female's nape in bill. Vocalizations varied but generally simple (mainly honks, grunts, quacks, coos, and whistles); often different between sexes when linked with anatomical differences in vocal apparatuses (syringeal bullae). Non-vocal sound-signals produced in some species. Calls of downy young are: (1) Contact or Greeting Call (also termed Pleasure and Contentment Call) and (2) Distress Call (see Kear 1968). Comfort-behaviour well known. Bathing frequent and elaborate. Typically performed while swimming in water too deep for standing; involves head-dipping, wing-thrashing, somersaulting, and diving. Followed by oiling (with use of bill and head) and preening. Full description of comfort movements, the behaviour patterns of shaking, stretching, preening, bathing and related activities given by McKinney (1965). The diagrams (Figs 1 to 14) based on those from McKinney illustrate most of these actions, all of which are common to all wildfowl. Some essentially aquatic species (genera *Thalassornis*, *Oxyura* and *Biziura*) have other, slightly specialized, preening and shaking actions peculiar to them because they are performed on water. No elaborate thermoregulatory responses except erection of feathers. Other behavioural characters are: (1) direct head-scratching; (2) resting, often on one leg, with head



Figs 1-14. Comfort movements of Anatidae (based on Grey Teal): (1a-c) Body-shake; (2) Wing-shake; (3a-c) Swimming-shake; (4) Head-shake; (5) Head-flick; (6) Tail-wag; (7) Foot-shake; (8a,b) Wing-shuffle and tail-fan; (9a) Wing-and-leg Stretch; (9b) Both-wing Stretch; (10) Foot-pecking; (11) Bill-cleaning; (12a-e) Head-dipping; (13a,b) Wing-thrashing (14a-f) Somersaulting.

turned back and bill inserted in scapulars on same side as lifted leg (Heinroth & Heinroth 1954), latter being characteristically stowed away in waterproof flank 'pocket'.

Breeding strictly seasonal in boreal, migratory species and populations; less so or opportunistic at warmer latitudes. For most wildfowl, censuses of breeding numbers extremely difficult. Although breeding habitat and nest-sites show considerable diversity, nests usually placed over water or on or near ground. Well hidden in vegetation or sometimes concealed in other dark places such as burrows and tree holes (or nest-boxes); some species also use old nests of other birds or cliff ledges. Often near water but some species may at times nest far away from it. Nests made only of vegetation, or other materials, within reach of sitting bird, using side-building method (see Harrison 1967). In spite of limited scope of this method materials are often collected from large area by repeated movements of this form. Nest usually lined with down plucked from female's belly (often cryptic and grown specially for this purpose). Value of down for insulation and for concealing nest examined for arctic geese by Thompson & Raveling (1988). Eggs, large, immaculate; surfaces greasy. Clutches often large. Regulation of clutch-size in Anatidae has been the subject of much investigation in n. hemisphere (Rohwer 1984, 1988), but has received little attention in s. Proximate (physiological and psychological [Lack 1974]) factors that may regulate clutch-size include availability of food, condition of birds, weather, age or experience of the breeding birds, ability to incubate, and, of the female, to acquire resources for production of eggs, time of breeding, hormonal levels and interactions between two or more of these (Bengston 1971; Johnsgard 1973; Braithwaite 1977; Ankney & MacInnes 1978; Drent & Daan 1980; Duncan 1987; Ankney & Afton 1988; Kingsford 1989; Briggs 1990). Ultimate (evolutionary [Lack 1974]) factors that may regulate clutch-size are availability of food, condition of birds, length of breeding season, weather, predation and viability of eggs, ability to incubate and rear brood, time of breeding, trade-offs between annual reproductive effort and residual reproductive value, and interactions between two or more of these (Williams 1966; Lack 1967; Ryder 1970; Johnsgard 1973; Braithwaite 1977; Pellis & Pellis 1982; Toft *et al.* 1984; Lessells 1986; Arnold *et al.* 1987; Briggs 1990). Both proximate and ultimate factors can act together to influence clutch-size. Eggs laid at intervals of 24 h in most species but longer in some. Clutch covered by down in most species during recess of adult. Some species may lay some or all of their eggs in nests of other anatids; such nest-parasitism may reach significant proportions in some populations, especially of pochards (*Aythya*) and stiff-tails (*Oxyura* and *Stictonetta* but not *Biziura*); only one species (Black-headed Duck *Heteronetta atricapilla*) obligate parasite. In some species, two or more females may lay at same site, at extreme producing 'dump' of eggs without incubating them. Most species single-brooded but many will re-nest if eggs lost. Multiple clutches more common in austral species. Except some species of Anserinae, incubation by female; starts with last egg; so hatching synchronic. No true brood-patches (Skutch 1976). Displaced eggs retrieved if within reach of sitting bird, using bill. Eggshells left in nest. Downy young typically led, but not carried, to water after leaving nest but see SOWLS (1955) and Johnsgard & Kear (1968) for exceptional carrying of eggs, shells and young. Young feed themselves in all species except Musk Duck *Biziura lobata*, but some food provided indirectly in earlier stages by a few Anserinae and Anatinae (Kear 1970). Establish recognition of own species by special imprinting upon parent's calls and image during brief critical period; exceptionally (e.g. during experiments) may become imprinted on wrong species or even inanimate objects (Heinroth 1911; Lorenz 1935; Hess 1957; Boyd & Fabricius 1965; Schutz 1965). Incubation and fledgling periods vary, correlated with latitude at which breeding takes place; shorter in boreal migratory species nesting in high latitudes with short summer season.

Term 'waterfowl' used in North America to describe the group is restricted by 'wildfowl' in English with 'waterfowl' having wider meaning. Further special terminology (Hardy 1952) includes 'cob' and 'pen' to distinguish male from female in swans; male goose and male duck referred to as 'gander' and 'drake' respectively but female in both best called 'hen' to avoid confusion with group names. Young swan is a 'cygnet'; young goose a 'gosling' and young duck 'duckling'. 'Whiffling' is the term used to describe the deliberate loss of height in flight by alternate side-slipping and even rolling onto the back; a practice most characteristically adopted by many geese when descending rapidly. Collective names include 'herd' for flock of swans and 'gaggle' (on the ground) or 'skein' (flying) for geese. Less well known are 'dropping' for shelduck; 'spring' for a flight of teal and 'padding' for duck on water. 'Flapper' is used to describe young wild duck. Some of these terms are elegant but are regrettably falling into disuse.

REFERENCES

- Ankney, C.D., & C.D. MacInnes. 1978. *Auk* 95: 459-71.
 Ankney, C.D., & D. Afton. 1988. *Condor* 90: 459-72.
 Arnold, T.W., *et al.* 1987. *Am. Nat.* 130: 643-53.
 Bauer, K.M., & U.N. Glutz von Blotzheim. 1968-69. *Handbuch der Vögel Mitteleuropas*. 2,3.
 Bengston, S.A. 1971. *Ibis* 113: 523-6.
 Boyd, H., & E. Fabricius. 1965. *Behaviour* 25: 1-15.
 Braithwaite, L.W. 1977. *Aust. Wildl. Res.* 4: 59-79.
 Briggs, S.V. 1990. Unpubl. Ph.D. thesis, Aust. Natn. Univ.
 Crook, J.H. (Ed.) 1970. *Social Behaviour in Birds and Mammals*.
 Drent, R.H., & S. Daan. 1980. *Ardea* 97: 480-90.
 Duncan, D.C. 1987. *Can. J. Zool.* 65: 234-46.
 Eyton, T.C. 1838. *A Monograph on the Anatidae, or Duck Tribe*.

- Fullagar, P.J., et al. 1988. *Proc. Int. Symp. Wetlands, 1986. Shortlands Centre, Newcastle*: 81-98.
- Goodwin, D. 1965. *Domestic Birds*.
- Gray, A.P. 1958. *Bird Hybrids. A Checklist with Bibliography*. Tech. Comm. No. 13, Cwealth Bur. Animal Breed.Genet, Edinburgh, Cwealth Agric. Bur.
- Hardy, E. 1952. *The Bird Lovers Week-end Book*.
- Harrison, C.J.O. 1967. *Ibis* 109: 539-51.
- Heinroth, O. 1911. *Proc. Int. orn. Congr. V*: 589-702.
- Heinroth, O., & K. Heinroth. 1954. *Aus dem Leben der Vögel*.
- Hess, E.H. 1957. *Ann. NY Acad. Sci.* 67: 724-32.
- Hochbaum, H.A. 1942. *Trans. 7th N. Am. Wildl. Conf.*: 299-307.
- Johnsgard, P.A. 1961. *Wildfowl Trust Ann. Rep.* 12: 58-69.
- Johnsgard, P.A. 1971. *Wildfowl* 22: 46-59.
- Johnsgard, P.A. 1973. *Wildfowl* 24: 144-9.
- Johnsgard, P.A., & J. Kear. 1968. *Living Bird* 7: 89-102.
- Kear, J. 1968. *Beihefte der Vogelwelt* 1: 93-133.
- Kear, J. 1970. Pp. 357-92. *In*: Crook 1970.
- Kingsford, R.T. 1989. *Aust. Wildl. Res.* 61: 405-12.
- Lack, D. 1967. *Wildfowl Trust Ann. Rep.* 18: 125-8.
- Lack, D. 1974. *Evolution Illustrated by Waterfowl*.
- Lessells, C.M. 1986. *J. Anim. Ecol.* 55: 669-89.
- Lorenz, K. 1935. *J. Orn., Lpz.*, 83: 137-213, 289-413.
- Lorenz, K. 1951-53. *Comparative Ecology of the Behaviour of the Anatinae*.
- McKinney, F. 1965. *Behaviour* 25: 120-220.
- Olney, P.J.S. 1963. *Proc. zool. Soc. Lond.* 140: 169-210.
- Pellis, S.M., & V.C. Pellis. 1982. *Aust. Wildl. Res.* 9: 145-50.
- Rohwer, F.C. 1984. *Auk* 101: 603-605.
- Rohwer, F.C. 1988. *Auk* 105: 161-76.
- Ryder, J.P. 1970. *Wilson Bull.* 81: 5-13.
- Schutz, F. 1965. *Z. Tierpsychol.* 22: 50-103.
- Skutch, A. 1976. *Parent Birds and Their Young*.
- Sowls, L.K. 1955. *Prairie Ducks. A Study of their Behaviour, Ecology and Management*.
- Sziji, K.M. 1965. *Vogelwarte* 23: 24-71.
- Thompson, S.C., & D.G. Raveling. 1988. *Wildfowl* 39: 124-32.
- Toft, C.A., et al. 1984. *J. Anim. Ecol.* 53: 75-92.
- Williams, G.C. 1966. *Adaptation and Natural Selection: A Critique of Some Current Evolutionary Thought*.

Sub-family ANATINAE ducks

Small to fairly large wildfowl. Tarsi scutellate in front. Marked sexual dimorphism in plumage and structure of syrinx in most species; correlated with sexual differences in visual displays and voice. About 70 species, composing four main groups: (1) so called 'perching ducks' and allies; (2) Torrent Duck (polytypic species in genus *Merganetta*, South America); (3) typical dabbling ducks (very large genus *Anas* and monotypic *Marmaronetta*) and (4) pochards (*Netta*, *Aythya* and extinct *Rhodonessa*).

Trachea of male usually with bony, asymmetrical bulla on left side of syrinx. Double annual moult in both sexes, resulting in two recognizable plumages. These usually closely similar and cryptic in females, though non-breeding plumage usually duller. Breeding plumage of male of many species in temperate regions elaborate and colourful ('bright'), contrasting with sombre and cryptic non-breeding plumage (eclipse) usually worn for short period in boreal species, during and following flightless period and post-breeding moult and resembling plumages of females and juveniles. Loss of bright plumage in some austral species much more complex. Wing typically brightly coloured in both sexes, often with metallic speculum on greater coverts and secondaries, which contrasts with colourful median and lesser wing-coverts or tertials; this pattern maintained all year, wing being moulted only once. As a rule, juvenile plumage resembles female plumage, but juveniles separable by tail-feathers (notched tip with bare shaft protruding) and by narrower, shorter, and more pointed body-feathers and wing coverts. Juvenile body-plumage moulted within a few months of hatching (3–4 months). In some species breeding in first year, this plumage involves growth of only a few new feathers and is quickly replaced by breeding plumage; in others that defer breeding until second year, immature plumage more complete and retained longer, being only gradually replaced by breeding plumage during whole first year of life. In all, juvenile wing retained until first complete moult in summer of second calendar year, although tertials often and some wing-coverts sometimes replaced earlier.

TERMINOLOGY OF PLUMAGES. Bright (breeding) male plumage of most duck species (often termed 'nuptial' in ornithological literature and more accurately 'alternate'; see Humphrey & Parkes 1959; Humphrey & Clark 1964) usually worn for much of year when birds not actually breeding, including autumn and winter when pair-bonds initiated and maintained until nesting in spring (see below). Thus, males often attain non-breeding plumage (basic) soon after start of nesting when their reproductive activities (but not those of females) are over. In females, though timing of both moults tends to correspond roughly with those of males, also subject to adaptive variation. In many species, post-breeding moult of females more protracted, with greater individual variation in timing, particularly in successfully breeding females; moult usually inhibited during nesting, starting 1–2 months later than in males. Females of some species (e.g. some dabbling ducks) start moult shortly before nesting and therefore incubate and rear young in basic plumage. Although such females in fact nest in 'non-breeding' plumage, terminology sometimes maintained for reasons of homology.

Perching ducks and aberrant species

Small to fairly large wildfowl, usually living in well-wooded areas, most freely perch in trees, and often nest in holes high above ground. Some semi-terrestrial. Highly diversified group of 19 species in 15 mainly monotypic genera, often showing striking convergences with other Anatidae and some regarded now as more properly assigned to other sub-families, specially Tadorninae. Most are here retained in Anatinae following Johnsgard (1965) and Peters. Two groups: (1) more generalized genera *Plectropterus* (Spur-winged Goose in Ethiopian Africa), *Cairina* (Muscovy Duck of neotropical America; White-winged Wood Duck of se. Asia), *Pteronetta* (Hartlaub's Duck of Africa), and *Sarkidiornis* (Comb Duck of South America, Ethiopian Africa, s. Asia); (2) more specialized genera *Nettapus* (three pygmy-geese of central Africa, India to Aust.), *Callonetta* (Ringed Teal of South America), *Aix* (Carolina Duck *A. sponsa* of North America and Mandarin *A. galericulata* of e. Asia), *Chenonetta* (Maned Duck of Aust.), and *Amazonetta* (Brazilian Teal of South America). Also considered here are two very specialized A'sian genera *Malacorhynchus* (Pink-eared Duck of Aust.) and *Hymenolaimus* (Blue Duck of NZ) and *Merganetta* (Torrent Duck of South America) and *Salvadorina* (Salvadori's Duck of New Guinea). Five species in our region.

Wings, often wide and rounded; bony, spur-like knob on metacarpal joint in some. Tails, fairly broad and elongated; slightly graduated but not pointed. Bill, rather thick and goose-like, not depressed, often heavy; large nail; highly specialized structures in *Malacorhynchus* and *Hymenolaimus*. Hind toe well developed, not lobed, and claws strong and sharp at all ages; legs set far forward, tarsus usually short (especially in *Nettapus*), but longer in some (especially semi-terrestrial *Plectropterus*). Usually do not dive, but *Hymenolaimus* specialized river duck. Male noticeably larger than female in some species. Sexes differ in tracheal structure to varying degrees; except in *Nettapus*, *Malacorhynchus* and *Hymenolaimus*, males with bony enlarged bullae; in *Aix*, rather large and rounded, somewhat resembling a dabbling duck. Plumage bright in many; often iridescent, especially in more

generalized genera. Patterns more complex in other genera, particularly *Aix*. No real speculum in most species but tertials and wing-coverts often bright and metallic. Sexual dimorphism slight in some, considerable in others, especially *Aix*. Eclipse plumage in *Aix*, *Nettapus* and *Chenonetta*. Juveniles, like adult females. Downy young, patterned dark brown and white or yellow, most like those of dabbling ducks; in some species remarkable for long stiff tails and capacity for climbing.

Cosmopolitan but most species tropical or subtropical. Most species surface-feeders, some very specialized, though others (notably *Plectropterus* and *Chenonetta*) terrestrial grazers. Often in flocks. **Pre-flight** signals diverse; include **Neck-craning**, **Chin-lifting**, and **Head-thrusting** movements, also lateral **Head-shaking**. Social patterns and behaviour of *Chenonetta* most like those of typical dabbling ducks. **Inciting** display of female also much as in *Anas*. In more generalized genera, however, pair-bonds weak or absent (Johnsgard 1965). Pre-copulatory behaviour varies; includes **Head-pumping** (as in *Anas*), **Head-dipping**, and **Bill-dipping**. Post-copulatory behaviour also varies, but little studied. Voice characteristics vary; sexually differentiated to greater or lesser extent. Male calls mostly whistles; female calls honking, quacking, or squeaking (characteristic **Decrescendo** calls of *Anas* lacking). Some species more or less silent. Torrent Ducks are specialized river-ducks inhabiting rapids and fast-flowing rivers of the Andes of South America; very noisy. *Salvadorina* is similarly specialized but is not necessarily closely allied to the Torrent Ducks. Little is known of its social behaviour and ecology.

Dabbling ducks (known also as surface-feeding, puddle, or river ducks)

Fairly small to medium-sized wildfowl. About 40 species in two genera, *Anas* and *Marmaronetta* (Marbled Teal of Mediterranean and w. Asia; has also been placed with pochards but not considered further here). More than 40 species in *Anas*, including following main species-groups, mostly in Holarctic, some or all formerly treated as separate genera: (1) wigeons, three species including *A. sibilatrix* vagrant to S. Georgia; (2) gadwalls, all Holarctic; (3) true teals, including several s. hemisphere species (about ten) typified by Grey Teal *A. gracilis* of Aust.; (4) pintails, including *A. eatoni* and *A. georgica* in our region; (5) mallards, including *A. superciliosa* of Aust. and NZ; and (6) blue-winged ducks, including Australasian Shoveler *A. rhynchotis*. Term 'teal' used loosely in ornithological literature to indicate small ducks generally, not only in different species-groups of *Anas*. Bodies fairly slender. No marked difference in size between sexes (males somewhat larger). Wings, long and pointed; in flight, wing-beats less rapid than in pochards and other diving ducks. Tails, usually fairly short, pointed; central feathers elongated in some species. Bills, fairly long in most species; flattened, with distinct lamellae. Legs, quite short and inserted centrally giving horizontal stance; hind toe much reduced, not lobed. Take-off from water and land with facility. Walk easily but with waddling gait; able to perch well, though only a few species regularly perch in trees. Dive rather poorly, submerging briefly with use of wings. Sexes differ in tracheal anatomy, males having enlarged rounded bony bullae on left side of syrinx. Plumage of both sexes usually with bright speculum. In many species, sexes alike also in other plumage characters; most of these rather sombre or wholly cryptic but some quite bright; in both types, non-breeding plumage differs little from breeding. In many species of *Anas*, particularly migrants within temperate parts of n. hemisphere, males only with bright plumage worn for much of year; alternates with eclipse plumage during flightless period at post-breeding moult. Females of these species highly cryptic at all times. Colour of bill or foot, or both, sometimes bright. Juveniles resemble adults in non-breeding plumage. Downy young, typically brown and buff or yellow, often with dark and light streaks on sides of head and light spot on each wing and on each side of back or rump.

Cosmopolitan and predominantly continental in distribution, though some island forms. Adapted for living in shallow, biologically productive waters. Many species prefer plenty of vegetation, marginal, submerged, and often emergent and floating. Range widely through mid-latitudes, penetrating into Arctic tundra or even taiga zones only slightly. Widespread and often the dominant genus in s. hemisphere. Faster streams and unsheltered or offshore marine waters normally avoided. Though some species enter wooded habitats (especially flooded or swamp forests) and others tolerate and even prefer wide-open spaces, most occupy sites with more or less dense fringing vegetation at chosen waters, latter being either standing or slow-flowing with ready access to secure and sheltered resting and breeding places. Need for concealment when breeding or in flightless stage of post-breeding moult may force them, more or less deeply, into dense marginal or emergent vegetation and swamps with little open water; some species nest, at least at times, far from water. As main habitats unstable in many areas, exceptional powers of flight enable reconnaissance of wide range of waters and rapid shift when necessary. Vulnerable to reclamation of wetlands, especially when these few and scattered, but readily accept artificially created waters if they provide suitable feeding areas. Little information on breeding numbers because accurate counts of nests impossible but large-scale ground and aerial counts now sufficiently comprehensive to provide reasonable estimates of wintering numbers and main locations, and, sometimes, tentative indication of trends. Some species migrate over considerable distances, especially in n. hemisphere. Males moult during late summer and early autumn on or near breeding grounds. All large-scale movements mainly nocturnal, sometimes at high altitudes, often in irregular wavy lines.

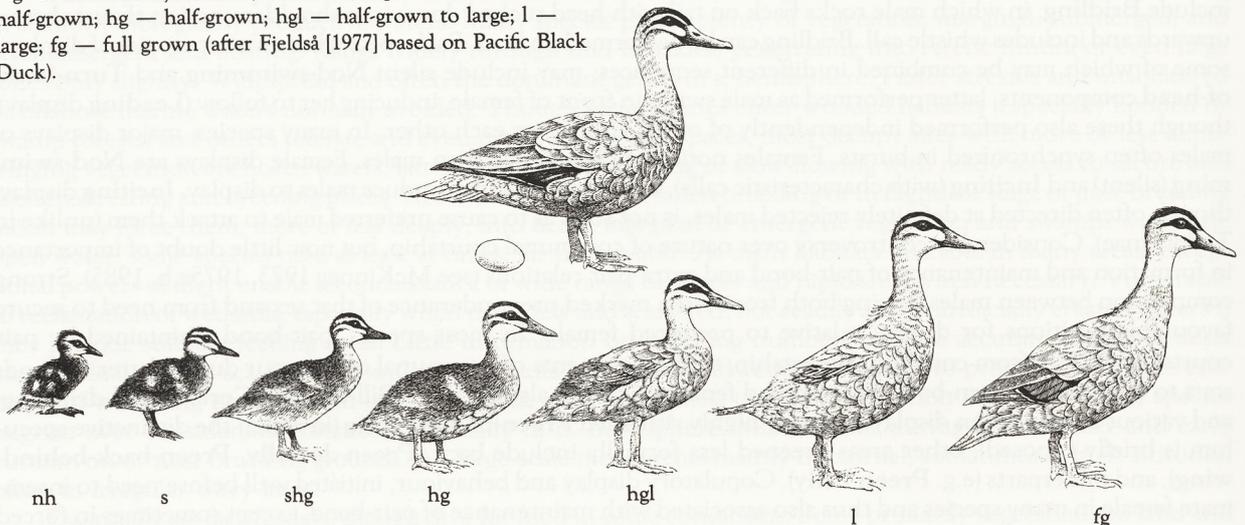
Essentially surface feeders, though dive for food in some conditions. Some primarily vegetarian, on land and

in shallow water. Many omnivorous, taking chiefly seeds and invertebrates mainly from shallow water by dabbling at surface at the same time pumping water and mud through bill, using lamellae to sieve out food (**Suzzling**). Also filter-feed by dipping head and neck below water, and up-ending; some highly specialized filter-feeders (shovelers), others also forage on land. Feed singly, but most often in pairs and flocks; otherwise usually gregarious when not nesting. Main pre-flight signals: lateral **Head-shaking** and repeated vertical **Head-thrusting**. Before and during initial stages of nesting, each pair typically occupies home-range which overlaps with those of other pairs. Within home-range, one or more small areas frequented for feeding, loafing, and preening; variously named 'core area', 'activity centre', 'waiting area' (where male stays while female at nest and where pair meet at times during laying and at times during incubation); defended as territories, to greater or lesser extent, in some species (mainly by male). Monogamous pair-bonds, long-term in monomorphic resident or nomadic, often tropical, species (see Siegfried 1974; Fullagar *et al.* 1988) but more usually of seasonal duration, especially in boreal migratory species. In latter, pair-formation typically starts in flock during autumn and winter after assumption of breeding ('nuptial') plumage, though initial pairings often temporary; final pair-bond ended at some stage during incubation when males again flock. In addition to maintaining firm bond with eventual mate, males of many species also show promiscuous tendencies, displaying to other females and also copulating with them, mainly by forced copulation. Extent of such promiscuity subject to ecological factors that affect intensity of defence of own mate and territory (McKinney *et al.* 1983; Birkhead 1988). Same factors also influence types and frequency of pursuit-flights of a female, which are of three main types: (1) courtship-flights: chase by several males originating from displaying party on water and initiated by female; (2) three-bird flights: chase of intruding pair by single male based on own activity centre; (3) forced copulation intent-flights: chase by several males often ending in attempts at forced copulation. Second and third types connected by intermediates; much controversy over details and interpretation, especially role of such pursuits in dispersing pairs. Courtship, typically on water but sometimes on land or even in flight (during pursuits), of two main types: (1) communal courtship (also termed 'social display') and (2) pair-courtship ('directed courtship' of von der Wall 1965). In communal courtship, often starting in autumn or winter, group of several males typically display to one or more females, both unpaired and (increasingly as season advances) paired birds of both sexes taking part. Courting party develops progressively in many species, as more and more males join in; in some, notably *A. superciliosa* in our region, group typically assembles before display starts. Male displays often elaborate, consisting of secondary and major forms, males tending first to assume special **Courtship-intent** posture, indicative of impending display. Marked tendency for each male to align body parallel to courted female before displaying; components of some displays also show marked directional bias towards female (McKinney 1975a,b). Secondary displays, mainly derived from comfort-behaviour and closely similar to latter in form, usually silent; often precede one or other of major displays. These are: **Upward-shake** and **Wing-flap** (both involving brief rise as bird treads water), lateral **Head-shake** (with bill inclined down), and **Head-flick** or **Head-roll** (with vertical component most marked). Major displays often more elaborate; usually with vocal components produced by contortion of tracheal tubes, which determines posture of neck. These are: **Grunt-whistle** (or **Water-flick**) and **Head-up Tail-up**; in both of which tail elevated and speculum momentarily exposed, specially in latter. **Grunt-whistle** has loud vocal component and deliberate action of spraying stream of water towards female using rapid flick of bill across the surface. **Burp** display, which is mainly a vocal signal, and **Down-up**, which also exposes speculum prominently and includes raising the tail and making contact with the water without directing it away. **Down-up** not usually addressed to female. Other displays include **Bridling**, in which male rocks back on tail with head tucked down into shoulders; action thrusts breast upwards and includes whistle call. Bridling can be performed on land. Each species has own repertoire of displays, some of which may be combined in different sequences; may include silent **Nod-swimming** and **Turn-back-of-head** components, latter performed as male swims in front of female, inducing her to follow (**Leading** display), though these also performed independently of other displays or each other. In many species, major displays of males often synchronized in bursts. Females noticeably less active than males. Female displays are **Nod-swimming** (silent) and **Inciting** (with characteristic calls), either of which may induce males to display. **Inciting** display, though often directed at definitely rejected males, is not such as to cause preferred male to attack them (unlike in Tadorninae). Considerable controversy over nature of communal courtship, but now little doubt of importance in formation and maintenance of pair-bond and extra-pair relations (see McKinney 1973, 1975a,b, 1985). Strong competition between males, arising both from often marked preponderance of that sex and from need to secure favourable positions for display relative to preferred female. In most species, pair-bond maintained by pair courtship distinct from communal courtship, though elements of communal often occur during latter as bonds start to form. Male **Turn-back-of-head** and female **Inciting**; also includes **Bill-dip**, full **Ceremonial-drinking**, and various **Mock-preen** displays, notably highly ritualized **Preen-behind-wing** (in which the distinctive speculum is briefly exposed); other areas preened less formally include back (**Preen-dorsally**, **Preen-back-behind-wing**), and underparts (e.g. **Preen-belly**). Copulatory display and behaviour, initiated well before need to inseminate female in many species and thus also associated with maintenance of pair-bond, except sometimes in forced

copulations. On water, pre-copulatory displays consist typically of mutual **Head-pumping**; post-copulatory displays of males vary more but include **Burp** display, **Bridling**, and **Nod-swimming**. Marked sexual differences in voice. Calls of males vary; often weak nasal, rasping, wheezing, clucking, or rattling sounds but also include penetrating whistles (sometimes followed by grunts) in many species; uttered chiefly during display, when disturbed, aggressive, or separated from mate or companions in flock. Calls of females typically louder and coarser, often quacking; most characteristic vocalizations: **Decrescendo** call (pattern of which tends to be constant individually, facilitating identification) and **Inciting** call. In some species, pair call simultaneously while posturing during and after antagonistic encounters (**Pair-palaver**); when mates separated, often call: **Decrescendo** calls from females; **Burp** calls from males. Non-vocal sound-signals produced in some species. Behaviour includes mass dashing-and-diving during bathing. Most complex repertoire of displays found in almost all teals, pintails and mallards but some of these do not have certain displays; e.g. most pintails and some teals do not have the **Down-up**; most mallards do not have the **Bridle**, except post-copulatory **bridling**. Gadwalls resemble mallards but never bridle and some also do not **Grunt-whistle**, **Head-up Tail-up**, and **Down-up**. All wigeons, the silver teals (*A. versicolor*; *A. punctata*) and the blue-winged ducks (typified by the shovelers) do not have any of these displays but all the last group have the added display of **Lateral Dabbling**, often use the **Jump-Flight** (less common in most other *Anas*); courtship pursuit-flights are particularly significant for shovelers. For details see McKinney (1978).

Breeding strictly seasonal in most species; short breeding periods in those forms nesting in Arctic, but more prolonged in others. Sites often on ground, concealed in thick cover, sometimes well away from water; less often in open but in our region commonly either above ground in cavities in trees (will use artificial nest-boxes) and old nests of other species or in vegetation, surrounded by water in most, and again often using old nest-sites of other species. Nests usually well dispersed but sometimes grouped even quite densely, at protected places. Shallow depressions with rim of vegetation, lined copiously with down plucked by female. Building by female only. Eggs oval, yellowish or pinkish-white, grey-green, buff, rarely bluish; smooth. Clutches usually 6–12, averaging smaller in forms on remote islands (see Lack 1968); multiple layings sometimes occur. Replacements laid after loss of eggs and several species normally double-brooded. Eggs laid at 24-h intervals. Incubation by female only, leaving nest two or more times per day when usually joins male (if still present). Incubation periods usually 21–28 days (Johnsgard 1968; Todd 1979). Young cared for only by female in some species in our region, and is typical pattern in boreal ducks but male parental activity common for many austral or tropical species with long-term pair-bonds; in them, male and female accompany young though only female broods them (see Kear 1970; Siegfried 1974; Fullagar *et al.* 1988). Young and parents, particularly the female, communicate and recognize each other by characteristic calls. Young aggressively defended by both sexes in species with dual parental care, but main anti-predator reaction otherwise distraction display of female in form of 'injury-feigning', parent flapping awkwardly over water or land with wings open, exposing speculum, and giving **Distraction** calls. In some species male also defensive but never as demonstrative as female. Young become independent just before or at fledging. Mature at 1 year old. Growth of ducklings can be described by reference to appearance that is usefully categorized in the sequence: newly-hatched (nh); small (s); small to half-grown (shg); half-grown (hg); half-grown to large (hgl); large (l) and full grown (fg) (Fig. 1 after Fjelds  [1977] based on Pacific Black Duck).

Fig. 1. nh — newly-hatched; s — small; shg — small to half-grown; hg — half-grown; hgl — half-grown to large; l — large; fg — full grown (after Fjelds  [1977] based on Pacific Black Duck).



Pochards

Medium-sized, mainly freshwater diving ducks. Designation 'diving duck' used not as taxonomic term but as ecological characterization for these and other ducks that plunge from the surface and swim underwater. Sixteen species in three genera: *Netta* (three species) and *Aythya* (12 species); monotypic *Rhodonessa* (Pink-headed Duck of India and Nepal) recently extinct. *Netta* intermediate in some characters between *Anas* and *Aythya*. Latter composed of three species-groups: (1) typical pochards, none in our region; (2) white-eyed pochards, including Hardhead *A. australis*; (3) scaups, including New Zealand Scaup *A. novaeseelandiae*.

In *Aythya*, body, short and heavy; head, big; wings, broader and less pointed than in typical Anatinae, necessitating faster wing-beats, often producing whistling sound; tail, short; bill, rather heavy (less so in white-eyed pochards), about as long as head, flattened and, in some, wider at tip; legs, short, with large toes and broadly lobed hind toe, and set well apart far back on body. *Netta* similar but body longer and narrower, bill narrower, legs longer and more slender. All take-off from water with some difficulty. *Aythya* clumsy on land; *Netta* much less awkward, with even more upright stance. Though *Netta* somewhat less well adapted for diving than *Aythya* (Delacour & Mayr 1945), all dive with considerable facility, typically without using wings. Sexes differ in tracheal anatomy; as well as showing 1-2 enlargements of tracheal tubes, males have large, rather angular bullae, with several fenestrae, not rounded and evenly ossified as in *Anas* males. Males, mainly patterned simply: black, brown, or chestnut and white; unstreaked females, varying shades of brown. Broad pale (often white) panel on rear half of upper wing; no metallic speculum. In most species, male eclipse. Females often nest in plumage homologous to non-breeding plumage. Bill, usually slate or bluish but red in two *Netta*; eyes, red (most pochards of both genera), white (males of white-eyed pochards), brown or yellow (females of scaup), or yellow (male scaup). Juveniles resemble females. Downy young mostly like other Anatinae but head-stripes faint or absent; young of scaups, dark.

Cosmopolitan, but most species Holarctic. Concentrated both as breeders and in winter on standing fresh water of moderate depth, usually 1-15 m; one Holarctic species (Greater Scaup *A. marila*) marine in winter, partial exception. Tolerate fairly restricted open waters with dense marginal vegetation, even in forest setting. In most areas, suitable sites are not plentiful and vulnerable to desiccation, drainage, and other adverse factors, leading to some instability in distribution and population. Some colonize modern artefacts such as reservoirs, gravel pits, and ornamental waters. All Holarctic species migratory to greater or lesser extent. Species in s. hemisphere have no migration but in Aust. *A. australis* has irregular and sometimes long dispersal movements with large congregations following rainfall and drought.

Range from chiefly vegetarian (e.g. *Netta*) to omnivorous; in some species (e.g. *A. australis*) animal food predominates. Food obtained in water, mainly by diving from surface to bottom. Usually submerge for shorter periods than Merginae. Difference between sexes in preferred depths of diving, and hence in mean duration of dives, recorded in some n. hemisphere species and probably widespread; may be contributory factors in partial winter segregation of sexes in those areas. Most species (especially in *Netta*) also dabble on surface at times, head-dip, and up-end. Feed mainly in pairs and flocks. Largely gregarious at most times. Repeated **Bill-lifting** main **Pre-flight** signal, but **Head-flicks** also frequent in some *Aythya*. Monogamous pair-bonds of short seasonal duration typical in Holarctic species. Promiscuous tendencies of males much less marked than in other Anatinae; except in *Netta*, attempts at forced copulation rare in Holarctic species, and pursuit-flights largely of courtship type. Communal courtship on water much as in other Anatinae though most major displays different. Often nocturnal as well as diurnal. Secondary displays of males are: **Head-flick** and **Upward-shake**, though latter infrequent in some species. Typical major displays, usually accompanied by calls, are: **Sneak** display, **Kinked-neck**, and **Head-throw**. Sneak takes two main forms: full version with head along water; incomplete version (or **Crouch** display) with head inclined forward. **Kinked-neck** involves sudden horizontal distortion of neck; **Head-throw**, the vertical posturing of head above centre of back with bill pointed upwards. Other displays include **Turn-back-of-head**, **Neck-stretch**, and **Coughing**, though some confusion in literature whether **Neck-stretch** and **Coughing** displays differ or are partly the same. In some species, females perform male-like major displays at times; **Inciting** display of same functional type as in other Anatinae but differs largely in form. In most species, some displays used by male in communal courtship also used in pair-courtship; others distinct, including unique **Courtship-feeding** of *N. rufina*. Displays performed by both male and female, sometimes mutually, include **Ceremonial-drinking** and **Mock-preening**. Copulation also part of pair-courtship. Pre-copulatory displays include **Bill-dipping** and **Preen-dorsally**; in *Netta*, also *Anas*-like **Head-pumping**. Prone-posture of female differs from that of *Anas* in that neck stretched diagonally forward not flat on water. Post-copulatory displays include characteristic **Bill-down** posture by male or both sexes. Calls of males often whirring or cooing and not far-carrying, but some (notably scaups) also whistle. Used chiefly in courtship, of two main types given (1) during **Head-throw** and **Kinked-neck** displays and (2) during **Coughing** display. Females usually not highly vocal; calls mostly growling and harsh, louder than those of males, include **Inciting** calls but **Decrescendo** calls lacking in most species. Non-vocal rattling sound produced in **Preen-behind-wing** display in all or most species.

Holarctic species strictly seasonal breeders; probably similar for species in our region. Nests sited over shallow water or on ground never far from water; usually in thick cover. Well dispersed or grouped, sometimes close together. Shallow depressions with rim of available material, lined with down plucked by female. Building by female only. Eggs oval, green-grey or pale buff; smooth. Clutches usually 5-12; multiple laying common in some species. Single-brooded; replacements laid after loss of eggs. Eggs laid at 24-h intervals. Incubation by female only. Incubation period 24-28 days (Kear 1970; Todd 1979). Young cared for by female only. **Distraction** display, in form of 'injury-feigning', occurs (at least in *Aythya*) but less common than in other Anatinae. No true crèching but broods sometimes amalgamated. Young independent at or before fledging in most species. Mature in first year.

REFERENCES

- Baerends, G., et al. 1975. *Function and Evolution in Behaviour*.
- Birkhead, T.R.. 1988. *Adv. Study Behav.* 18: 35-72.
- Crook, J.H. (Ed.) 1970. *Social Behaviour in Birds and Mammals*.
- Delacour, J. 1954-64. *Waterfowl of the World*.
- Delacour, J., & E. Mayr. 1945. *Wilson Bull.* 57: 3-55.
- Farner, D.S. (Ed.) 1973. *Breeding Biology of Birds*.
- Fjeldså, J. 1977. *Guide to the Young of European Precocial Birds*.
- Fullagar, P.J., et al. 1988. *Proc. Int. Symp. Wetlands, 1986. Shortlands Centre, Newcastle*: 81-98.
- Hafez, E.S.E. (Ed.) 1975. *The Behaviour of Domestic Animals*.
- Humphrey, P.S., & G.A. Clark. 1964. Pp. 167-232. In: Vol. 4, Delacour 1954-64.
- Humphrey, P.S., & K.C. Parkes. 1959. *Auk* 76: 1-31.
- Johnsgard, P.A. 1965. *Handbook of Waterfowl Behavior*.
- Johnsgard, P.A. 1968. *Waterfowl. Their Biology and Natural History*.
- Kear, J. 1970. Pp. 357-92. In: Crook 1970.
- Lack, D. 1968. *Ecological Adaptations for Breeding in Birds*.
- McKinney, F. 1973. Pp. 6-21. In: Farner 1973.
- McKinney, F. 1975a. Pp. 490-519. In: Hafez 1975.
- McKinney, F. 1975b. Pp. 331-57. In: Baerends et al. 1975.
- McKinney, F. 1978. *Adv. Study Behav.* 8: 1-38.
- McKinney, F. 1985. *AOU orn. Monogr.* 37: 68-82.
- McKinney, F. et al. 1983. *Behaviour* 86: 250-94.
- Siegfried, W.R. 1974. *Wildfowl* 25: 33-40.
- Todd, F.S. 1979. *Waterfowl. Ducks, Geese and Swans of the World*.
- von der Wall, W. 1965. *J. Orn.* 106: 65-80.

Aythya novaeseelandiae New Zealand Scaup

Aythya novae Seelandiae Gmelin, 1789, *Syst. Nat.*, 1: 541; based on 'New Zealand Duck' of Latham, 1785, *Gen. Syn. Birds*, 3: 543 — New Zealand = Dusky Sound, South Island, New Zealand, *fide* G. Forster, 1777, *Voyage World*, 1:168.

OTHER ENGLISH NAME Black Teal.

MONOTYPIC

FIELD IDENTIFICATION Length 40 cm, of which body about two-thirds; wingspan: c. 60 cm; weight: male 700 g, female 600 g. Small dark diving duck with high forehead and rounded profile in water. Sexes differ. Male retains same plumage all year (F.N. Hayes), as, most likely, does female (though see Plumages). Immatures like females.

DESCRIPTION **ADULT MALE.** Head, neck and upperparts, glossy black with greenish purple iridescence strongest on head; upperwing, black with broad white band on secondaries. Breast, as upperparts; underparts similar but shading to brown-black and white-brown on belly; underwing, mottled pale brown. Iris, yellow. Bill, blue-black. Legs and feet, black. **ADULT FEMALE.** Head, dark brown; often white band of varying width at base of bill, but only c. 50% of all females in captivity display this (F.N. Hayes); neck and upperparts, dark brown; rump, black; upperwing, dark brown with broad white band on secondaries; upperbreast, dark brown; lower breast, abdomen and underwing, mottled pale brown. Iris, brown. Bill, brown-black. Legs and feet, dark brown. **JUVENILE.** Like adult female; males identifiable at six months. **DOWNY YOUNG.** Chin and sides of head, pale grey-brown. Upperparts, pale brown with four obscure cream spots: one on either side of back where folded wing sits and one either side of rump. Underparts, buffy white. Iris, brown. Bill, brown (S.J. Stokes). Legs and feet, pale brown or grey.

SIMILAR SPECIES Generally unmistakable by small size and distinctive profile. Possibly confused with **Brown Teal** *Anas chlorotis* but Teal has white eye-ring and speculum with green sheen, sits lower on water, and is longer and less dumpy. **Hardhead** *Aythya australis* (rare in NZ) has sloping forehead, brown plumage, white undertail, black bill with blue tip and white eye (male only).

Seen in flocks, small groups; occasionally lone males on shallow coastal and dune lakes, mountain, volcanic and peat-country lakes, water impoundments; also larger farm-dams. On water, skilled and frequent diver submerging to feed on lake bottom; dives usually last 15–20 s, but can stay down for well over a minute. Rarely on land. Patter along surface of water when taking wing. Fly low over water with rapid wing-beats. Call with muted quacks, male soft whistles.

HABITAT Terrestrial wetlands, and rarely sheltered estuarine habitats. Prefer large open freshwater lakes, where may be found some distance offshore over deep clear water; particularly shallow coastal and dune lakes, volcanic lakes of varying trophic status, snow-fed mountain lakes, peat-country lakes, reservoirs and impoundments for hydro-electricity; also large farm dams. Not on brackish coastal lakes and lagoons, lakes subject to extensive summer drawdown, or forested creeks. Rarely on flowing water, although large deep rivers used in the past (Buller 1888) and have been observed on slow-

flowing outlet streams of lakes (S.J. Stokes). Occasional records from small farm dams, inlets, deltas and estuaries (CSN 22; Sibson 1979; Owen & Sell 1985). In some areas, occur regularly near human settlement (Soper 1963).

Breed in dense cover near water (Axbey 1953). When flying, do not rise high; but swim and dive well, reaching depths of 2–3 m (Soper 1963; F.N. Hayes).

Since European settlement, have disappeared from lowlands of NI and SI where agricultural development widespread, but have benefited from construction of impoundments for water storage and hydro-electricity. Adapts readily to captivity and breeds well in small aviaries; captive birds adapt well to wild (F.N. Hayes).

DISTRIBUTION AND POPULATION Endemic to NZ. Scattered throughout NI and SI; numbers much decreased since European settlement, but benefiting from some habitat changes in NI; captive-reared birds released, with some success, on Matakaua I. (Bay of Plenty), at L. Mangamahoe (Taranaki), in Manawatu area and at L. Ponui in the Wairarapa (Falla *et al.* 1981; NZ Atlas; NZCL).

POPULATION Now totally protected, increasing in numbers in many areas, but still probably numbers only 5000–10,000 birds (F.N. Hayes).

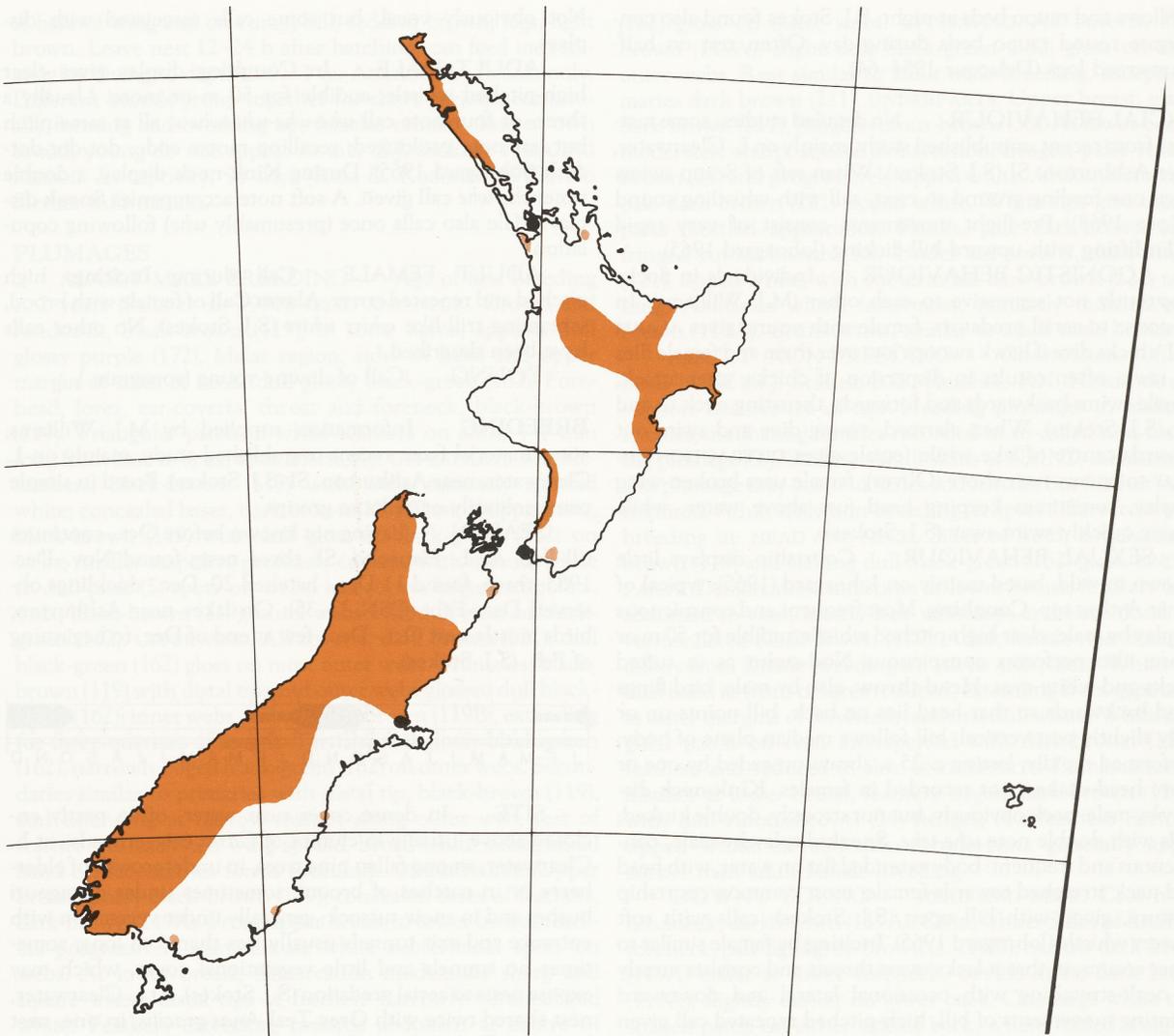
MOVEMENTS Little information but most movements appear to be local with no seasonal pattern noted. However, on lakes near Ashburton, SI, there are c. 640 birds during Jan. increasing to c. 2000 in June and dropping again in Sept. (S.J. Stokes).

BANDING 40S175E 11 J F 18 194 338 NZNBS.

FOOD Little information but apparently mixture of aquatic invertebrates and plants. **BEHAVIOUR.** Food obtained by diving or chasing surface insects (Reid & Roderick 1973). Dive to at least 2–3 m (F.N. Hayes), kicking as they submerge then paddling with their feet to bottom, where they probe substrate or graze vegetation. Keep themselves on bottom by slow paddling with splayed feet, which are twisted till almost over bird's back (Oliver). Wings not used at all. After feeding, cease paddling and glide to surface at c. 45°. Dives usually last 15–20 s, but up to a minute.

ADULT Almost no information. Seen taking chironomid larvae in captivity, gastropods, littoral vegetation, and tips of submerged macrophytes in wild (M.J. Williams).

SOCIAL ORGANIZATION Very little known; some material from recent unpublished study, mainly on L. Clearwater, near Ashburton, SI (S.J. Stokes). Very gregarious. Highly social with flocks seen autumn or winter (Guthrie-Smith 1910; Delacour 1954–64; Soper 1963; Turbott 1967), or



throughout year (Soper 1963). In pairs or small parties at other times (Delacour 1954–64). Flocks of non-breeders persist during breeding season (Falla *et al.* 1981). At L. Clearwater during breeding season, pairs appear to remain separate from large groups; groups of 10–16 seen, often one female accompanied by 9–15 males; large groups of >80 males seen near breeding sites (S.J. Stokes). Sizes of flocks often small, generally less than 50; throughout year, ten or more birds (Soper 1963); during post-breeding and moulting stage, rafts of up to 50 form (S.J. Stokes); during winter large flocks of up to 150 or of several hundred recorded (Turbott 1967; Soper 1963; CSN 19); after winter, in pairs or small parties (Delacour 1954–64) of four or five (Turbott 1967). Flocks spend day in deep water far from shore and move to shallows in evening (Guthrie-Smith 1910). Flocks mingle freely with Pacific Black Duck *Anas superciliosa* and other species of waterbird (Turbott 1967; S.J. Stokes). Latham (1986) observed, in July, two dense feeding groups each c. 15 m in diameter with c. 100 ducks; c. 35% Scaup and c. 65% Australasian Shoveler *Anas rhynchos*; both sexes represented; Scaup formed perimeter of group while Shovelers formed centre.

BONDS Monogamous; unknown whether persists

from season to season (M.J. Williams) although claimed that pairs formed for only one season. Captive Scaup breed in first year (F.N. Hayes); age of first breeding not known with certainty from wild; probably some breed at end of first year, but most two years (M.J. Williams). Yearlings wait to Dec. to breed (Oliver). Only female incubates (M.J. Williams; S.J. Stokes). Soper (1963) found solitary male stayed close to incubating mate, but S.J. Stokes found no evidence for this though large all-male groups (of unknown breeding status) present c. 100 m from site. Only female tends brood through to fledging.

BREEDING DISPERSION Nest in simple pairs, solitary or in loose groups, close to water on edge of lakes; tendency for many pairs to establish nests close together giving impression of loose colony (Falla *et al.* 1981). Little recorded on actual density; four nests in area 20x20 m and three in area 10x10 m (Axbey 1953); a couple of metres between nests (Guthrie-Smith 1910); closer nests at least 0.5–1.0 m apart (S.J. Stokes). No apparent aggression between individuals when in flocks (M.J. Williams).

ROOSTING Flocks rest on water at some distance offshore or closer near reed swamps (Oliver); according to Guthrie-Smith (1910) offshore during day and venture to

shallows and raupo beds at night; S.J. Stokes found also congregate round raupo beds during day. Often rest on half-submerged logs (Delacour 1954-64).

SOCIAL BEHAVIOUR No detailed studies; some material from recent unpublished study, mainly on L. Clearwater, near Ashburton, SI (S.J. Stokes). When raft of Scaup swims from one feeding ground to next, call with whistling sound (Soper 1963). Pre-flight movements consist of very rapid **Chin-lifting** with upward bill-flicking (Johnsgard 1965).

AGONISTIC BEHAVIOUR Individuals in flocks apparently not aggressive to each other (M.J. Williams). In response to aerial predators, female with young gives **ALARM** call; chicks dive if hawk swoops low over them and female flies at hawk; often results in dispersion of chicks; after attack, female swims backwards and forwards, thrusting neck to and fro (S.J. Stokes). When alarmed, young dive and swim out towards centre of lake while female gives **DISTRACTION DISPLAY** to enemy near shore (Oliver); female uses broken-wing display, sometimes keeping head just above water, while young quickly swim away (S.J. Stokes).

SEXUAL BEHAVIOUR Courtship displays little known in wild; based mainly on Johnsgard (1965); typical of other *Aythya* spp. **Coughing**. Most frequent and conspicuous display by male; clear high-pitched whistle audible for 50 m or more; also performs conspicuous **Nod-swim** as in tufted ducks and white-eyes. **Head-throw**, also by male; bird flings head backwards so that head lies on back, bill points up or only slightly past vertical; bill follows median plane of body; performed rapidly, lasting c. 25 s; always preceded by one or more head-shakes; not recorded in females. **Kink-neck** display by male: neck obviously, but not strongly, double kinked; calls with double note *whe-whe*. **Sneak** display by male, conspicuous and frequent: body extended flat on water, with head and neck stretched towards female; most common courtship posture, given with bill open (S.J. Stokes); calls with soft wheezy whistle (Johnsgard 1965). **Inciting** by female similar to other scaups, in that it lacks overt threats and consists mostly of neck-stretching with occasional lateral and downward pointing movements of bill, high-pitched repeated call given (Johnsgard 1965). Male performs **Turn-back-of-head** to Inciting female while swimming rapidly in front of her; feathers of head strongly depressed. **Preening-behind-wing** often performed by female; not observed in male. Precopulatory behaviour consists of male **Bill-dipping** and **Preening-dorsally**, to which female may or may not respond in same fashion. After treading, male calls once, then swims away in **Bill-down** position. **COPULATION** observed once, finished with complete immersion of female by male, with male holding onto female's neck (CSN 33).

RELATIONS WITHIN FAMILY GROUP Only female incubates; reactions of females when approached vary: some flush when 2-3 m away or on being touched; others do not flush and may sit quietly or become aggressive and stab viciously on being touched; aggressive response appears to be more pronounced closer to hatching (S.J. Stokes). Solitary male floating quietly near shoreline in summer often indicates presence of incubating mate (Soper 1963), but attendance by male not recorded by S.J. Stokes. Ducklings leave nest 12-24 h after hatching, usually closer to 24 h (S.J. Stokes). Only female tends brood, defending them from aerial predators (S.J. Stokes). Cared for until fledged at 10 weeks (F.N. Hayes).

VOICE No detailed studies; based on Johnsgard (1965).

Not obviously vocal, but some calls associated with displays.

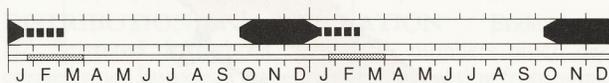
ADULT MALE In **Coughing** display gives clear high-pitched whistle, audible for 50 m or more. Usually a three- or four-note call *whe-whe-whe-whe*, all at same pitch but last note prolonged; recalling morse code: dot-dot-dot-dash (Johnsgard 1965). During **Kink-neck** display, a double note *whe-whe* call given. A soft note accompanies **Sneak** display. Male also calls once (presumably *whe*) following copulation.

ADULT FEMALE Call during **Inciting**, high pitched and repeated *errrrr*. **Alarm Call** of female with brood, screaming trill-like *whirr whirr* (S.J. Stokes). No other calls have been described.

YOUNG Call of downy young (sonagram).

BREEDING Information supplied by M.J. Williams; some material from recent unpublished study, mainly on L. Clearwater, near Ashburton, SI (S.J. Stokes). Breed in simple pairs, solitarily or in loose groups.

SEASON Laying not known before Oct., continues till Feb. At L. Hauroko, SI: three nests found Nov.-Dec. 1983; three, found 11 Dec., hatched 20. Dec.; ducklings observed Dec.-Feb. (CSN 32-35). On lakes near Ashburton, birds mostly nest Oct.-Dec., few at end of Dec. to beginning of Feb. (S.J. Stokes).



SITE In dense cover near water, often partly enclosed above; usually in clumps of *Carex* (niggerheads); at L. Clearwater, among fallen pine trees, in undergrowth of elderberry or in patches of broom; sometimes under matagouri bushes and in snow tussock; generally under vegetation with entrance and exit tunnels usually less than 1 m long; sometimes no tunnels and little vegetational cover, which may expose nests to aerial predation (S.J. Stokes). At L. Clearwater, nest shared twice with Grey Teal *Anas gracilis*; in one, nest had nine Teal and one Scaup egg; female Scaup seen incubating once and Teal otherwise; eventually nest abandoned (S.J. Stokes)

NEST, MATERIALS Bowl of broken reeds, grass or nearby vegetable debris; with down; at L. Clearwater, also pine needles (S.J. Stokes).

EGGS Elliptical; not glossy but smooth texture; creamy white to mocha-brown.

MEASUREMENTS: av 66 x 45.

WEIGHTS: fresh, c. 75 or c. 12% of female weight.

CLUTCH-SIZE No critically assessed data; av. 6.5 of 22 nests (4-8 eggs) (M.J. Williams); av 7.8 (2.7; 2-15; 48) (S.J. Stokes).

LAYING In captivity, varies; typically 6-egg clutch laid in 9-10 days (M.J. Williams); average interval between eggs c. 1.4 days (Reid & Roderick 1973); probably one egg laid every 1.5 days (S.J. Stokes).

INCUBATION By female only. **INCUBATION PERIOD.** In captivity, 28-30 days (M.J. Williams); after 29-31 days (Reid & Roderick 1973). At L. Clearwater, one nest hatched 28 days after last egg laid (S.J. Stokes). No further information.

DUCKLINGS Precocial, nidifugous. At hatching, downy, pale brown above, white below with whitish patches

at base of wing and on rump; bill, reddish brown; legs, light brown. Leave nest 12–24 h after hatching, can feed immediately by diving to depths of c. 1 m. Attended by female only. Different broods group together for short periods, continually forming and breaking up; females remain close to own brood; young do not appear to mix (S.J. Stokes). FLEDGING PERIOD. In captivity, 75 days (Reid & Roderick 1973). No further information.

PLUMAGES

ADULT MALE BREEDING Age of first breeding c. 2 years (Falla *et al.* 1981). **HEAD AND NECK.** Crown and hindneck, black-brown (119); in some lights, appears dull glossy purple (172). Malar region, sides of head and upper margin of sides of neck, dull glossy black-green (162). Forehead, lores, ear-coverts, throat and foreneck, black-brown (119). Triangular patch of white feathers on chin, 4–7 mm long from base to apex; apex anteriorly. **UPPERPARTS.** Mantle-feathers, black-brown (119) with webs minutely spotted white; concealed bases, dark brown (121). Rest of upperparts, black-brown (119) with dull gloss of black-green (162) on webs; smaller scapulars profusely covered with minute white to dull-pink (5) spots on webs; less so, on largest scapulars. **TAIL,** black-brown (119); outer webs with dull gloss of black-green (162). **UPPERWING.** All coverts, dark brown (221); dull black-green (162) gloss on most outer webs. Primaries, black-brown (119) with distal tips and outer webs glossed dull black-green (162); inner webs dull white to brown (119B), extending for three-quarters of length. Tertiaries, dull glossy black-green (162), narrowly edged black-green (162) on outer webs. Secondaries similar to primaries with distal tip, black-brown (119), and extending as narrow margin along outer web; rest of feather white. When wing spread, broad white subterminal band on secondaries forms speculum. **UNDERPARTS.** Upper breast, glossy black-brown (119); concealed bases of feathers, dark brown (119A). From upper breast to lower breast, feathers progressively gain minute white subterminal spots on webs. At lower breast, demarcation moderately sharp and square where distal tips of feathers narrowly vermiculated white. Feathers extending towards abdomen at centre of body, often narrowly vermiculated black-brown (119); extent of this varies between individuals, possibly related to season or age. Most birds have scattered black-brown (119) vermiculations on lower abdomen and vent. Rest of feathers of abdomen to vent, brown (119B) broadly tipped white; feathers on outer margins of abdomen lack white tips. Upper flanks, black-brown (119) merging to brown (223A) at lower margins. Thighs, dark brown (119A). Under tail-coverts, black-brown (119) with dull gloss of black-green (162) on webs. Axillaries, white. **UNDERWING.** Marginal coverts, dark brown (119A). Lesser coverts, dark brown (119A) narrowly fringed white. Median coverts, basally dark brown (119A), merging to white, with mottled white subterminal webs, broadly tipped white. Greater primary coverts and greater coverts, white; basal webs, brown-grey (79).

ADULT FEMALE BREEDING **HEAD AND NECK,** mostly dark brown (221). Front of lores, white extending from base of lower mandible to forehead; narrow margin of forehead also white, or just outer margins. Throat to base of foreneck, dark brown (119A). Small triangular patch of white feathers on chin, c. 4 mm from base to apex; apex anteriorly. **UPPERPARTS.** Feathers, black-brown (119), fringed brown (219B); all webs on upperparts have slight dull black-green (162) gloss. **TAIL,** dark brown (221) with slight dull black-green

(162) gloss on outer webs. **UPPERWING.** All coverts, dark brown (119A); slight dull black-green (162) gloss on most outer webs. Rest similar to adult male breeding, except primaries dark brown (221). **UNDERPARTS.** Upper breast, glossy dark brown (221), fringed rufous-brown (36). At lower breast, moderately sharp, square demarcation; fringes, paler rufous-brown (36) and progressively tipped white. Abdomen to vent, pale dark-brown (221) tipped white. White tips give underparts mottled appearance. Flanks, pale dark-brown (221) fringed rufous-brown (36). Under tail-coverts, dark brown (221), tipped white, with subterminal dark-brown (221) mottling. Axillaries white; innermost, minutely mottled dark brown (119A). **UNDERWING,** similar to adult male breeding.

ADULT NON-BREEDING Observations of live birds in NZ (S.J. Stokes; B.D. Heather; F.N. Hayes) do not support occurrence of non-breeding plumages in males or females; incubating females recorded in so-called non-breeding plumage (S.J. Stokes). Adult skins at NMNZ, indicate that this plumage may occur in males and females but further study required. Adult male non-breeding (eclipse) differs from male breeding in: **HEAD AND NECK.** Sides of head, largely black-brown (119) and lacking dull black-green (162) gloss. **UNDERPARTS.** Demarcation indistinct at lower breast; feathers from abdomen to vent, mostly lack white tips and have distal tips vermiculated black-brown (119). Adult female non-breeding differs from female breeding in: **HEAD AND NECK.** White vertical band at front of lores reduced, extending from gape as far as outer margins of forehead; feathers, dull white. White triangular patch on chin interspersed with dark-brown (119A) feathers and reduced in size. **UNDERPARTS.** Demarcation indistinct at lower breast; feathers largely dark brown (119A), with dull rufous-brown (36) fringes; few feathers narrowly tipped white on abdomen. Underparts generally appear darker than adult female breeding.

DOWNY YOUNG **HEAD AND NECK.** Crown and hindneck, dark brown (119A). Chin, white. Sides of head and foreneck, pale light grey-brown (c. 119D); narrow dark-brown (119A) collar at lower foreneck. **UPPERPARTS,** dark brown (119A); slightly darker on lower back. One large white oval-shaped patch on either side of back, where folded wing sits. One small white oval-shaped patch on either side of outer rump. **UPPERWING,** dark brown (119A). **UNDERPARTS,** mostly white; thighs, dark brown (119A). **UNDERWING,** white.

JUVENILE Males attain green plumage coloration at c. 6 months after fledging. **HEAD AND NECK.** Crown, black-brown (c.119). Sides of head and hindneck, dark brown (119A). Lores, light grey-brown (119C) tipped dark brown (119A) giving slight mottled appearance. Throat and foreneck, light grey-brown (119C) tipped dark brown (119A). Small triangular patch of dull-white feathers on chin, c. 10 mm from base to apex; apex anteriorly. **UPPERPARTS.** Mantle, dark brown (121), narrowly fringed dark brown (121A); when worn, fringes, dark brown (119A). Scapulars similar to adult female. No minute white spots on feathers of upperparts. **UPPERWING,** similar to adult female breeding. **UNDERPARTS.** Upper breast, dark brown (119A) with narrow subterminal brown (223B) tips, tipped white; concealed bases of feathers, light grey-brown (c. 119C). White tips become broader from breast towards under tail-coverts. Abdomen, brown (119B) tipped white. Thighs, dark brown (119A). Upper flanks, dark brown (119A) with subterminal brown (223B) tips, narrowly tipped white; lowest longer flank-feathers, dark brown (119A) with brown (223B) shade. Under tail-coverts, dark brown (119A) with narrow subterminal rufous-brown (36) band, tip-

ped white. Axillaries, white except for tip and base of innermost, which finely mottled dark brown (119A). UNDERWING, similar to adult female breeding.

BARE PARTS Based on photos in NZRD and DOC library, except where stated.

ADULT MALE Iris, orange-buff (118). Upper mandible, violet (170B) tipped grey-black (82); narrow light-grey (85) rim behind nail. No data for lower mandible. Legs and feet, dark greyish-brown with light areas on inner sides of toes (label data from skins at NMNZ).

ADULT FEMALE (Label data from skins at NMNZ). Iris, dark brown. Bill, brownish black. Legs and feet, dark olive-black.

DOWNY YOUNG Iris, brown (Delacour 1954-64). Upper mandible, reddish brown; lower mandible, yellow tipped brown (Delacour 1954-64). Dried skin at NMNZ indicates lower mandible cream-yellow tipped black. Legs, brown (Delacour 1954-64).

JUVENILE No data; presumably similar to adult female.

MOULTS Few data.

ADULT POST-BREEDING Complete; remiges simultaneous; duration and full details of timing unknown. Some may lay in captivity in late Sept. but most later in year, and usually complete breeding by end of Jan. (Reid & Roderick 1973); moult likely to occur Feb. onwards in captivity. In wild, breeding Oct.-Mar. (Weller 1980). On lakes near Ashburton, start moult end of Jan. though not apparent at this time in females still with young (S.J. Stokes).

ADULT PRE-BREEDING Presumably partial, involving head and body feathers; white lores in female brighter. Acquired Apr. or May-Dec. (Oliver).

POST-JUVENILE Undescribed. By analogy with other *Aythya*, probably partial (BWP).

MEASUREMENTS NI and SI, NZ; adults, skins (NMNZ).

	MALES	FEMALES
WING	187.7 (4.94; 179-196; 23)	185.2 (4.54; 178-179; 4)
8TH P	107.4 (3.03; 102-114; 19)	
BILL	38.7 (1.77; 35.6-42.1; 23)	37.9 (1.72; 35.2-39.9; 4)
TARSUS	35.4 (1.78; 31.9-39.8; 23)	34.4 (0.92; 33.2-35.8; 4)
TAIL	56.2 (2.74; 51-62; 20)	57.2 (3.34; 52-61; 4)
TOE	61.4 (2.49; 54.7-64.5; 22)	60.2 (0.67; 59.3-61.2; 4)

NI birds have been described as separate subspecies *maui* and said to have wing 186-190 mm with SI birds with wing c.

180 mm (Mathews 1937). Above sample (from NMNZ), contained only two adult males from SI. These measurements: wing 193.5 (1.50; 192, 195); bill 39.5 (0.15; 38.9, 39.2); tarsus 37.3 (0.90; 36.4, 38.2); tail 60.5 (1.50; 59, 62) and toe 61.6 (2.55; 59.1, 64.2). Additional measurements of females needed.

WEIGHT Few data. Label data from skins, NI and SI (NMNZ); varied from fat to very fat: male 677.0 (55.63; 550-746; 13); female 687.3 (62.40; 600-742; 3). Captive birds, NZ (Reid & Roderick 1973): male 695 (630-760; 11); female 610 (545-690; 15). Two females on nest (S.J. Stokes): 600, 615. No data on seasonal changes.

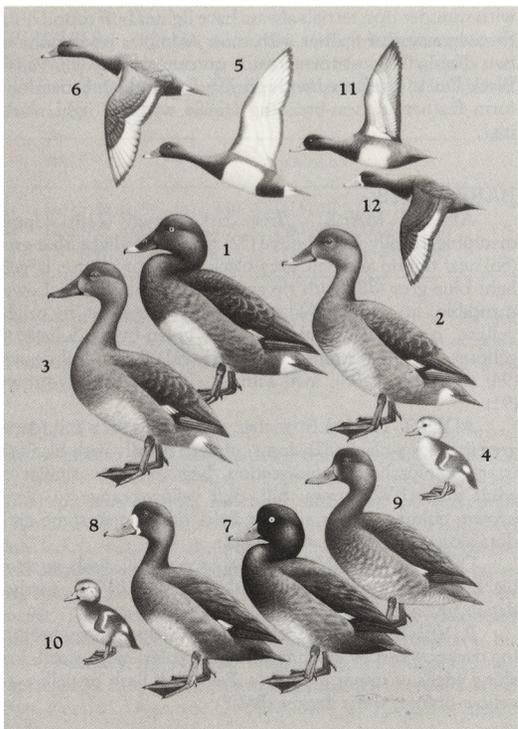
STRUCTURE Wing, short and broad. Eleven primaries: p9 usually longest, p10 0-3 mm shorter, p8 4-9, p7 14-21, p6 24-33, p5 35-45, p4 47-54, p3 56-66, p2 66-76, p1 76-85, p11 minute. P10 emarginated on inner web; p9 slight on outer web. Primaries, narrow and pointed. Seventeen secondaries including three tertials. Tail, short and pointed. 12-14 rectrices, t1 longest, t7 14-18 mm shorter. Lamellae of bill extends from gape to nail, on lower and upper mandibles. Interramal area, bare. Bill, slender; culmen, concave. Nostril, oval. Legs, short and tarsus rounded in cross-section. Feet, webbed. Outer toe, almost equal in length to middle toe, inner c. 77% of middle, hind c. 30%.

GEOGRAPHICAL VARIATION Treated as monotypic (NZCL; Peters). Mathews (1937) recognized two subspecies, *novaeseelandiae* and *maui* on SI and NI respectively claiming that *maui* differed from *novaeseelandiae* in having longer wing and being darker on both upperparts and underparts, without grey specklings on scapulars. Based on small sample (see Measurements), measurements of SI and NI birds overlap. Plumage characters can not be assessed until better sample available and plumage changes thoroughly studied; validity of *maui* requires further study.

RMO

REFERENCES

- Axbey, H.W. 1953. *Notornis* 5: 105.
 Buller, W.L. 1888. *A History of the Birds of New Zealand*.
 Delacour, J. 1954-64. *Waterfowl of World*.
 Falla, R.A., et al. 1981. *The New Guide to the Birds of New Zealand*.
 Guthrie-Smith, H. 1910. *Birds of the Water, Wood and Waste*.
 Johnsgard, P.A. 1965. *Handbook of Waterfowl Behaviour*.
 Latham, P.C.M. 1986. *Notornis* 33: 208.
 Mathews, G.M. 1937. *Emu* 37: 31-2.
 Owen, K.L., & M.G. Sell. 1985. *Notornis* 32: 271-309.
 Reid, B., & C. Roderick. 1973. *Int. Zoo. Ybk* 13: 12-15.
 Sibson, R.B. 1979. *Notornis* 26: 396-422.
 Soper, M.F. 1963. *New Zealand Bird Portraits*.
 Turbott, E.G. 1967. *Buller's Birds of New Zealand*.
 Weller, M.W. 1980. *The Island Waterfowl*.



Volume 1 (Part B), Plate 96

Hardhead *Aythya australis*

1. Adult male
2. Adult female
3. Juvenile male
4. Downy young
5. Adult male
6. Adult female

New Zealand Scaup *Aythya novaeseelandiae*

7. Adult male
8. Adult female
9. Juvenile
10. Downy young
11. Adult male
12. Adult female

© [Jeff Davies](#)