

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].

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Family ANATIDAE wildfowl

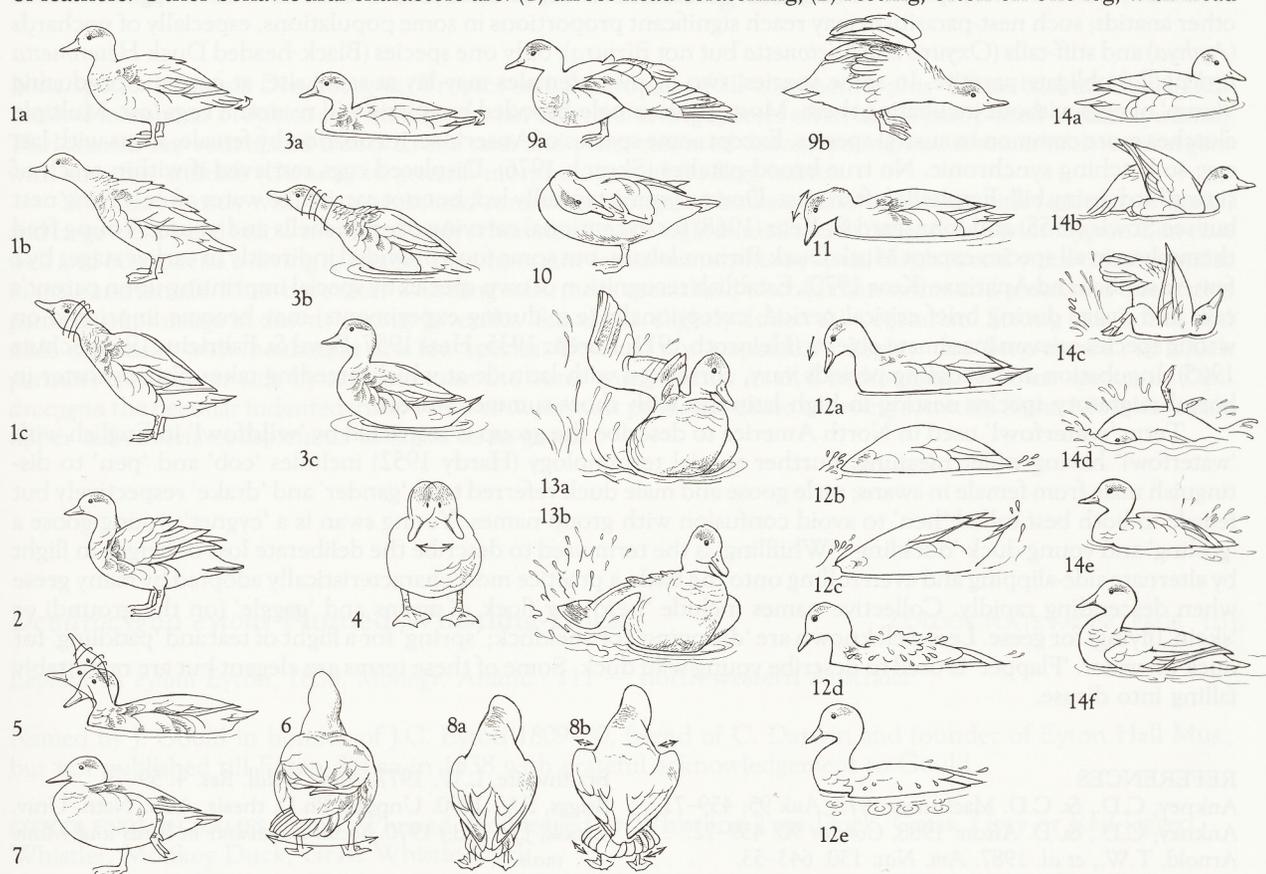
Waterbirds (some more or less terrestrial) with rather short legs and front toes connected by webs; hallux elevated and reduced. Though considerable adaptive diversity in outward appearance, size, colours of plumage, behaviour, and ecology, homogeneous in many characters, as attested by numerous, often 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.

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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.

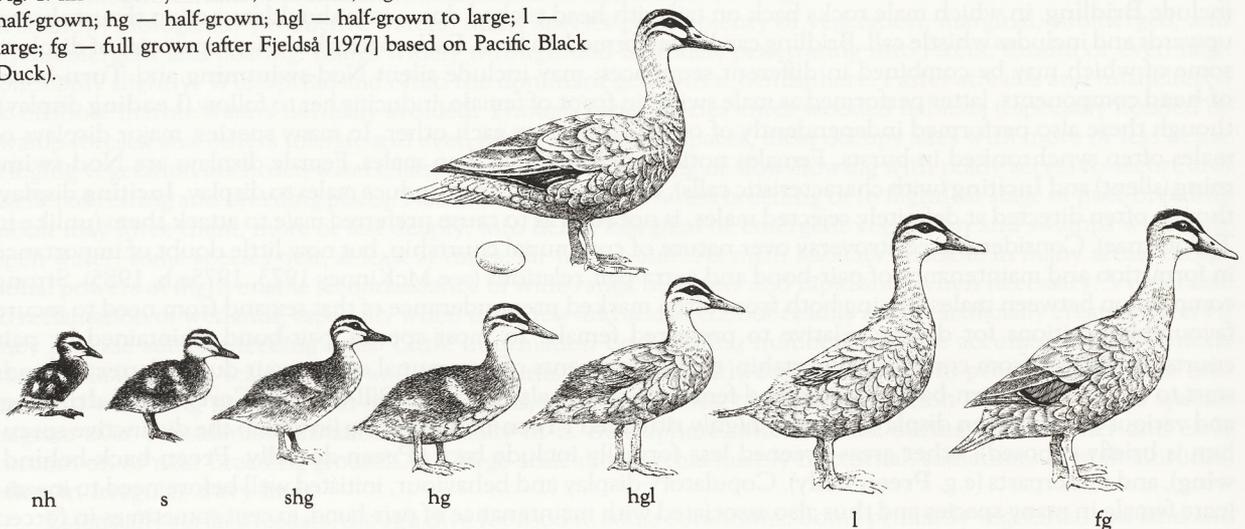
Essentially surface feeders, though dive for food in some conditions. Some primarily vegetarian, on land and

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 Fjeldså [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 Fjeldså [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.

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Chenonetta jubata **Maned Duck**

Anas jubata Latham, 1807, *Index orn. Suppl.*: 69 — New South Wales.

Chenonetta compounds the Greek words χήν (goose) and νήσσα, νήττα (duck); *jubatus*, the Latin word for *maned*.

OTHER ENGLISH NAMES Blue or Wood Duck, Maned Goose, Australian Wood Duck.

Because the bird is neither a goose nor close to the American species of wood ducks (*Aix*) it seems best to compromise and call it **Maned Duck**.

MONOTYPIC

FIELD IDENTIFICATION Length: male 48 cm, female 47 cm; wingspan: male 80 cm, female 78 cm; weight 800 g. Medium-sized goose-like grey-and-brown duck with long legs, small head and bill and upright stance. Sexes distinct. Immatures like females but paler and more striated on breast. Eclipse plumage in males.

DESCRIPTION ADULT MALE BREEDING. Head and upper neck, brown with short black mane on back of neck; lower neck and upper back, grey spotted and washed with brown; lower back and tail, black; scapulars grey, feathers with broad black margins; upper wing-coverts, grey; speculum, bright green edged white, broadly behind; primaries, black; upper breast, grey mottled black-and-white; lower breast and flanks, grey with fine black vermiculations; abdomen and undertail, black; under wing-coverts, pale grey; trailing-edge of secondaries, white; primaries, black proximal half grey. Lighter coloured males have been recorded, with head and neck fawn not brown and abdomen grey not black. One individual reverted to normal plumage (Kingsford 1986a). **ADULT FEMALE.** Head and neck, pale brown with white line above and below eye. Mantle, grey washed with brown; back, rump and uppertail, black; upperwing like male. Lower foreneck, breast and flanks, brown, feathers crossed with white band; abdomen and undertail, white; underwing like male. **DOWNY YOUNG.** Face white with conspicuous dark line through eye and below it; upperparts, grey-brown with two white spots on back; sides of neck, underparts and trailing edge of wing, white. **IMMATURE,** resembles female but paler. Appearance of small number of finely barred flank-feathers at 3 months identifies males.

SIMILAR SPECIES Generally unmistakable by silhouette of small bill, thick neck and upright stance. Distinguishable from small-billed **pygmy-geese** *Nettasp* spp, which are much smaller with bold white patches on face and usually found on water. **Whistling-ducks** *Dendrocygna* spp have longer legs and necks, larger duck-like bills and an even more upright stance. In flight distinguished from all other ducks by white secondaries and dark wing-tips.

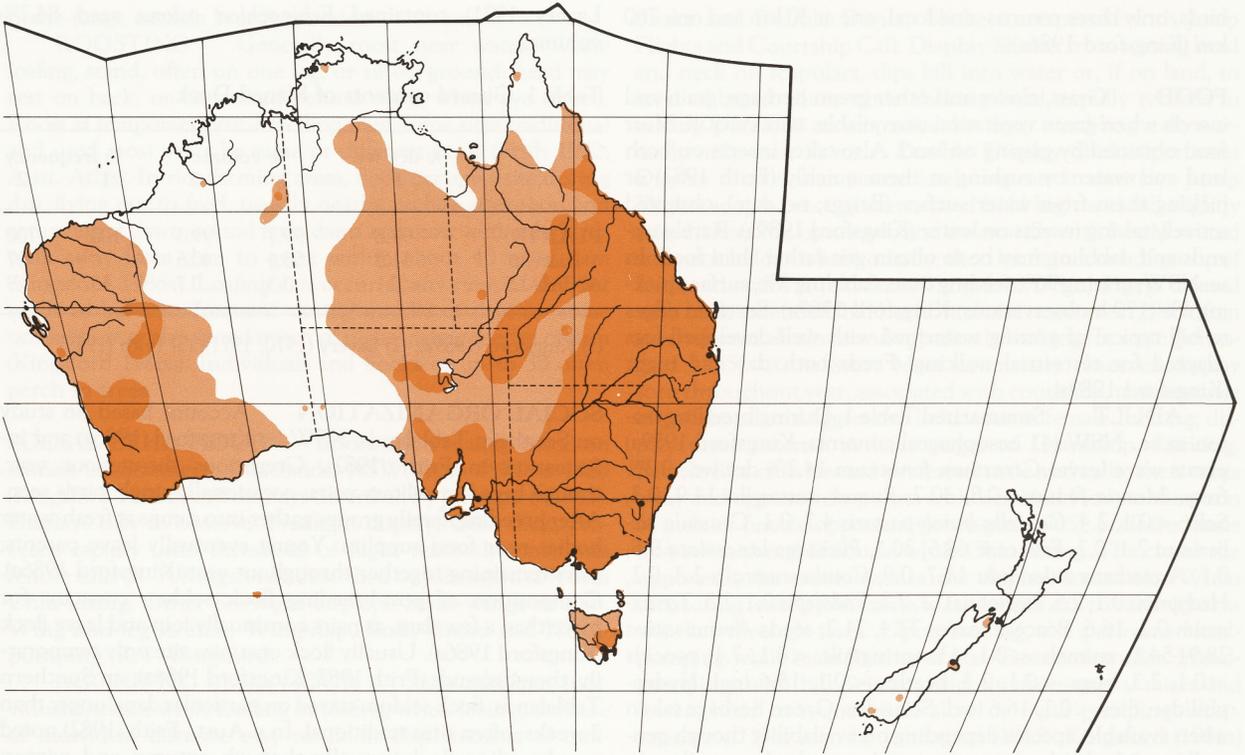
Seen in pairs or more often in flocks in lightly timbered areas near water and short pasture, on muddy banks of dams, inland tanks, swamps, lakes, reservoirs, sewage farms, occasionally at inlets and bays. Typically loaf (29% of diurnal time) and graze (33%) throughout day near water's edge; mostly loaf at night but graze on moonlit nights; also dabble at water's edge; rarely on water (<7% of diurnal time) (Kingsford 1986a), but readily fly out and settle on water when disturbed from banks. Easy, goose-like walk, nodding head but not at

every step, giving impression of limping. Swim awkwardly, seldom dive. In flight, slow wing-beat compared with other ducks, but flight fast and very manoeuvrable. Often vocal; call, distinctive *new* or *wee-ow* with rising inflection; call of male more highly pitched than that of female.

HABITAT Widespread in grasslands, wooded lands and terrestrial wetlands; particularly better-watered parts of inland in mixed farming and grazing areas (Frith 1982). Forage in short grass or herbage, mainly on land but also in shallow water at edges of wetlands; activities centre round wetlands that provide open banks or wide beaches for loafing near feeding grounds. Prefer grassland and pasture, especially short green growth such as clover, but not long coarse growth; grain crops and stubble; and open or dense woodland but not dense forest (Frith 1982; Fjeldså 1985; Kingsford 1989a). Particularly associated with small wetland systems; farm dams, creeks, rivers and river pools, irrigation channels (Frith 1959; Fjeldså 1985; Hewish 1988); in arid zone, on rainwater pools, swamps round bores, springs (Badman 1979; Frith 1982). Often on ricefields (Frith 1957). After breeding, gather beside large open lakes, particularly reservoirs (Hewish 1988; Peter 1989); some reservoirs too deep, cold and exposed to support large numbers of other species of waterbird, but favoured by Maned Ducks, which congregate on grassy banks and seldom on water when undisturbed (Hewish 1988; Peter 1989; R.H. Loyn). Also found in freshwater meadows, shallow swamps, sewage ponds, wooded lakes, and occasionally ornamental ponds in city gardens (Serventy 1948; Vestjens 1977; Corrick & Norman 1980; Gosper 1981). In densely vegetated, deep or large swamps, restricted to edges (Frith 1982). Largely confined to fresh water, but occasional records from coastal saltmarsh and lower reaches of rivers (Gosper 1981; Jaensch & Vervest 1988a,b).

Breeding associated with freshwater wetlands, although nest may be placed some distance from water; in lightly or densely timbered areas where tree holes provide nest-sites. Agile fliers in low to medium airspace, threading through trees rather than over them; reach heights of 20–100 m (Kingsford 1986a). Feeding zone in water restricted to, or just below, surface; rarely upend (Kingsford 1989a).

Range expanded since European settlement (Aust. Atlas). Clearing and establishment of pastures and crops has provided additional feeding areas, although can breed only where some trees remain; grazing stock maintain preferred short-grassland; farm dams used for loafing, feeding and caring for young; and reservoirs support post-breeding flocks



(Frith 1982). Birds can damage crops and pastures.

DISTRIBUTION AND POPULATION Endemic to Aust. Vagrant NZ.

AUST. Widespread, perhaps as disjunct e. and w. populations; separated by arid zone from Pilbara to Kimberleys, WA, running SE to coast of Great Aust. Bight between Israelite Bay, WA, and Eyre Pen., SA, and crossing Great Sandy, Gibson and Great Victoria Deserts and much of Nullarbor Plain, where only occasionally vagrant. Also rare or vagrant in Top End, NT, and n. C. York Pen., N of c. 15°S. Breed widely SE and S of line roughly from Cairns to Winton and Thargomindah, Qld, to Innamincka and Oodnadatta and on to Port Lincoln, SA, but most commonly E of c. 145°E and S of c. 33°S; also in sw. WA, S of Gascoyne R. and inland towards L. Carnegie and S to Israelite Bay but mainly S and W of line from Geraldton to Kalgoorlie and Esperance (Aust. Atlas). Perhaps breed sparingly throughout range outside chief breeding areas, there being one Aust. Atlas breeding record S of Hall's Ck, WA. In Tas., rare visitor before 1972, when breeding first reported near Ross (Tas. Bird Rep. 1973) with subsequent increase. Vagrant in Torres Str.: one, Badu I., 1976 (Draffan *et al.* 1983). General expansion of range and increase in numbers since European settlement.

NZ Vagrant; Glendhu, Wanaka 1910, Orawia, Lindwood and Wairaki; Southland 1944; Wairu Lagoon 1979, near Blenheim, Marlborough, mid-Apr. 1980 (Falla *et al.* 1981; NZCL; CSN 28).

POPULATION Counts in Vic. in summer surveys, 1987–89, were respectively: 11 667 on 332 wetlands; 14 148 on 472 wetlands; 12 107 on 626 wetlands; making up 4–6% of all ducks counted (Martindale 1988; Hewish 1988; Peter 1989). Counts in sw. Aust., 1986–88, respectively: 2386 on 872 wetlands; 9599 on 1201 wetlands; 13911 on 1398 wetlands (Jaensch & Vervest 1988a,b). Annual indices of abundance

from aerial surveys of wetlands in about 12% of land area of e. Aust. 1983–88 were 52 295; 109 553; 25 139; 6700; 12 050; 13 390 (Braithwaite *et al.* 1985a,b, 1986, 1987; Kingsford *et al.* 1988, 1989).

Pre-season counts in Vic. indicate that exposure to hunting high; 63–82% of total on waters open to hunting (Martindale 1988; Hewish 1988; Peter 1989). Hunted widely and sometimes form high proportion of total harvest in se. Aust. Harvest possibly under-estimated as favoured small wetlands under-sampled in bag-counts (Norman *et al.* 1984; Briggs *et al.* 1985; Loyn 1987).

MOVEMENTS Highly dispersive in ephemeral habitat, movements localized in better-watered areas. Post-breeding pairs with young concentrate at flocking sites by May, as early as Feb. in dry years; usually disperse to breed July–Aug., sometimes as late as Oct. (Frith 1982), first birds returning to breeding sites early Sept., last birds leaving late Jan. (Lamm 1965). Same individuals may return to same flocking sites repeatedly (Frith 1982). Population in Vic. concentrated on a few wetlands in late summer and autumn and reporting rates lower (Vic. Atlas) but no regular long-distance movement suggested. In se. Qld numbers counted each Oct. inversely correlated with local winter-rainfall, which suggests that heavy rain can act as proximate stimulus for dispersal inland (Woodall 1985). May follow storm-fronts across dry areas (Brooker *et al.* 1979) and has crossed Tasman Sea to NZ (Oliver).

BANDING Of 1533 banded 1951–67 in Vic., 58.6% of 295 recoveries were <200 km from banding site, most dispersing N from a coastal banding site (Norman 1971); in NSW, 75% of 141 recoveries were within 80 km of banding site (Frith 1959) but banding returns from distances of >3000 km confirm that long-distance flights do occur, probably in response to local deterioration of habitat (Frith 1982; Norman 1971). In one study on Southern Tablelands, NSW, of 873 banded

birds, only three returns: one local, one at 30 km and one 760 km (Kingsford 1986a).

FOOD Grass, clover and other green herbage; grain and insects when green vegetation unavailable. **BEHAVIOUR.** Most food obtained by grazing on land. Also takes insects on both land and water by rushing at them quickly (Frith 1982) or picking them from water surface (Briggs, no date); observed actively taking insects on water (Kingsford 1989a). Rarely upends and dabbling may be to obtain grit rather than food. In se. NSW, grazing 96% feeding time, dabbling 3%, surface picking 1% (170 h observations; Kingsford 1989a). Serrated edges to bill typical of grazing waterfowl with well-developed legs adapted for terrestrial walking. Feeds both day and night (Kingsford 1989a).

ADULT Summarized Table 1. During breeding season in se. NSW (41 oesophageal contents; Kingsford 1989a) plants were leaves *Cerastium fontanum* 14.2% dry wt., 0.3% freq., *Montia fontana* 0.8, 30.7, *Rumex acetosella* 14.9, 0.3, *Salix* <0.1, 2.4, *Capsella bursa-pastoris* 4.7, 0.1, *Crassula sieberiana* 7.1, 0.2, Fabaceae 68.5, 20.1, *Plantago lanceolata* 9.5, 0.1, *Arctotheca calendula* 11.7, 0.9, *Cotula australis* 2.3, 0.2, *Hedypnois* 0.1, 7.5, *Isoetopsis* 0.2, 7.2, *Podolepis* 0.1, 2.3, *Taraxacum* 0.2, 16.6, Poaceae leaves 22.4, 71.2; seeds *Avena sativa* 28.9, 54.1; animals <0.1, 43: springtails <0.1, 7.1, psocids <0.1, 2.3, bugs <0.1, 2.3, beetles <0.1, 15.6 incl. Hydrophilidae, flies <0.1, 16.6 incl. Sciaridae. Green herbage taken when available, species depending on availability though generally avoids thistles; more insects, brown herbage and grain eaten during drought. In sw. NSW (552 gizzards, all year; Frith 1959) plants incl. Polygonaceae 12.5% vol. (*Polygonum aviculare* 5.1, *P. hydro Piper* 2.0, *P. prostratum* 5.3), Chenopodiaceae 0.7, Fabaceae 6.1 (*Medicago minima* 0.5, *M. spp* 4.1, *Trifolium tomentosum* 0.9, *T. spp* 0.6), *Cucumis myriocarpus* 2.4, *Myriophyllum* 0.2, Asteraceae 11.7 (*Carthamus lanatus* 1.0, *Sonchus oleraceus* 9.6), *Juncus* 0.4, Cyperaceae 17.1 (*Carex* 5.1, *Cyperus difformis* 1.5, *Eleocharis plana* 8.1), Poaceae mostly grass blades: *Danthonia caespitosa* 5.1, *Echinochloa crus-galli* 4.4, *Lolium perenne* 2.9, *Oryza sativa* 3.7, *Paspalum jubiflorum* 1.0, *Phalaris paradoxa* 4.5, *Schismus barbatus* 1.1, *Typha angustifolia* 2.0, *Marsilea drummondii* 0.9, Chlorophyta 0.4; animals were 1 mussel *Corbiculina australis*, a few bugs *Agraptocorixa euryome*. Grasses and legumes taken principally in summer and autumn with herbs predominating winter and spring.

In n. Qld (46 gizzards; Lavery 1970, 1971) plants were Fabaceae 0.3% vol., 8.7% freq. incl. *Stylosanthes humilis*, *Brachiaria mutica* 18.8% vol., *Digitaria ciliaris*, *Echinochloa colona* seeds 20.6, leaves & stems 15.6, *Paspalum orbiculare*, *Pseudoraphis spinescens*, Pontederiaceae 0.3, 8.7, Marsileaceae 0.8, 4.3, unidentified. 44.9, 52.2; animals were terrestrial bugs, beetles.

Other records: *Medicago* seeds (McKeown 1934), sprouting peas (McKeown 1923), *Solanum aviculare* fruit (Fleming 1988), *Hypochoeris* (Rose 1973), *Triglochin procera* (Jones 1940), *Echinochloa*, *Oryza* (Ellis 1940); insects mayflies (Kingsford 1989a), orthopterans *Gastrimargus musicus* (Rose 1973), hymenopterans (Kingsford 1989a).

DUCKLING Almost entirely insects, often as they are disturbed by tending parent. However, on Southern Tablelands, NSW, ducklings started grazing from 2-3 days old, only occasionally taking insects (Kingsford 1989a). Reported to take flies, midges, beetles (Frith 1982). By 6 weeks, diet resembles that of adult. In n. Qld, downy flappers (5;

Lavery 1971) contained *Echinochloa colona* seed 84.2% volume.

Table 1. Gizzard contents of Maned Duck.

	% dry wt.		% volume		% frequency	
	1	2	3	1	2	
PLANTS	99.8	99.7	99.3	100	100	
<i>Poaceae</i>	51.3	53.4	40.5		87	
ANIMALS	<0.1	0.3	0.7	43	9	

(1) Kingsford (1989a); (2) Lavery (1970, 1971); (3) Frith (1959).

SOCIAL ORGANIZATION Account based on study on Southern Tablelands, NSW by Kingsford (1986a) and information in Frith (1982). Gregarious throughout year, though breed in solitary pairs; occasionally single birds seen. After breeding, family groups gather into camps at fresh-water bodies near food supplies. Young eventually leave parents, pairs remaining together throughout year (Kingsford 1986a). Composition of post-breeding flock seldom constant for more than a few days, as pairs continually join and leave flock (Kingsford 1986a). Usually flock occupies site only temporarily, then disbands (Frith 1982; Kingsford 1986a); on Southern Tablelands, flock seldom stayed on particular dam longer than 2 weeks; often sites traditional. In s. Aust., Frith (1982) noted post-breeding flocks usually through autumn and winter; Kingsford (1986a) noted pairs from autumn to spring and flocking in summer; difference probably attributable to different breeding conditions. Post-breeding flocks can number up to 2000 but usually less than 100 (Frith 1982); average size at Goulburn, NSW, 10-30 with range of 1-153 (R. Kingsford). Some birds remain in smaller flocks during breeding season; age and breeding status of these birds unknown. During breeding, feed in pairs; male, when female incubating, remains on nearby dam and feeds alone. Flocks feed as cohesive unit away from water. In rice-growing areas, Frith (1982) found large flocks usually went to and from feeding areas as small groups following one another; flocks from different localities mingled at shared feeding areas.

BONDS Monogamous; sustained, possibly life-long; on Southern Tablelands, during 3 years, minimum duration of bond 16 months for two pairs, six pairs had pair-bonds that lasted more than 1 year (Kingsford 1986a). Sex-ratio appears to be 1:1 (from information on trapped birds and surveys except during breeding when female on nest) (Kingsford 1986a). Can form pairs and breed in first year (S.V. Briggs). Remain paired throughout year. Only female incubates and broods; both parents tend young until sometime after fledging. Little known of juveniles, except that they congregate in family groups towards end of year; when family group breaks up, unknown.

BREEDING DISPERSION Solitary pairs nesting in holes in trees (Frith 1982; Kingsford 1986a); site may be used from year to year (Kingsford 1989b; S. Marchant). Frith (1982) stated that, when female incubating, male occupies and defends nearby dam from other males; Kingsford (1986a) found no evidence of breeding territories and noted that male, when female incubating, tolerated and even grazed with conspecifics. Pairs maintain and defend 'moving territories' while feeding or loafing. When movements restricted by mobility of young, occupy definite home-range; possibly also occupy

home-range outside breeding season.

ROOSTING Generally roost near water. While loafing, stand, often on one leg, or sit on ground; head may rest on back, or be tucked behind wing, when eye closed. Roost at temporary post-breeding sites; some sites traditional and used most years by same or different birds (Frith 1982; Aust. Atlas). In rice-farming areas, flock occupies site during day, flying out to feed, usually nearby, in late afternoon and returning at dawn; round farm dams and most wetlands, birds walk away from dam to graze within about 40 m of dam (Kingsford 1986a). Loafing can occur at any time of day but tends to be most frequent during middle of day; on some occasions may also spend much of night loafing at edge of dam (Kingsford 1986a). Individuals and flocks of up to 30 often perch in trees.

SOCIAL BEHAVIOUR Information mainly based on studies on Southern Tablelands, NSW, from 1981 to 1983 (Kingsford 1986a), and displays described by Johnsgard (1965). Displays easy to observe. Pre-flight display, **Chin-flick**, proceeds rapidly until threshold of flight reached; sometimes female calls (R.T. Kingsford); described by Johnsgard (1965) as **Chin-lifting**. Other pre-flight displays: **Both-wings-stretch**, **Wing-and-leg-stretch**, **Wing-flap**, **Body-shake** and **Head-pumping** (R.T. Kingsford).

AGONISTIC BEHAVIOUR Pairs maintain individual distance while feeding or loafing; when loafing, defence of individual distance may result in displacement of individual. **THREAT**. Female Inciting display (see below), commonly observed in aggressive interactions but mainly relates to sexual behaviour. Male may perform movements of neck similar to female Inciting when protecting young in presence of conspecifics. **Rush** similar to that of geese. With outstretched neck parallel to ground and bill usually gaping, bird moves quickly towards opponent; performed on land or water and most common when birds have young. Sometimes both birds of a pair will launch all-out attack on another individual. When with young, attack other species that approach too closely such as Galahs *Cacatua roseicapilla*, Australian Magpies *Gymnorhina tibicen*, Australian Ravens *Corvus coronoides*, White-faced Herons *Ardea novaehollandiae*, Laughing Kookaburras *Dacelo novaeguineae* and Sulphur-crested Cockatoos *Cacatua galerita*. May avoid Pacific Black Ducks *Anas superciliosa* if threatened. **FIGHTING**. Birds often peck each other if they approach closely enough but fighting rarely occurs. If it does, birds stand opposite each other and spar with bills until one gives way. **ESCAPE**. Usually run away but, if attack intense, may fly. **ALARM**. Birds freeze with head and neck extended vertically and watch silently (Frith 1982). **ANTI-PREDATOR BEHAVIOUR**. Without young: if predator approaches during day, may move a few metres; if approached too closely, move to safety of water; when alarm call of other birds given, run or fly towards water (Kingsford 1986a), as when Brown Goshawk *Accipiter fasciatus* attacks; wounded birds or birds escaping aerial predators, dive; when female incubating, male adopts prone posture to avoid detection, folding legs underneath body and laying neck flat along ground (Kingsford 1986a). When with young: if predator seen from distance, often 100–200 m away, both parents lead young to cover; alternatively, lead young into middle of water, collect them into huddle and adopt prone posture; or adult feigns injury while young scatter.

SEXUAL BEHAVIOUR **ADVERTISING**. Several males will advertise round female by performing Display

Shake and Double Display Shake interspersed with Jump Flights and Courtship Call. **Display Shake**: from resting head and neck on scapulars, dips bill into water or, if on land, to level of breast then, while shaking head, rapidly returns to resting position; accompanied by deep rumbling call; normally only seen in male. **Double Display Shake**: performs Display Shake then immediately repeats it entirely. **Jump Flight**: adopts erect posture, head held high and bill slightly raised, then flies up steeply and awkwardly with head lowered and neck held out horizontally; then lands in front of group of birds and swims to join them (Kingsford 1986a). **Burp**: uttered with neck extended, bill horizontal and mane erect; also often used when male alone and apparently looking for mate (Johnsgard 1965). **COURTSHIP**. Most commonly observed display seen throughout year, associated with courtship, maintenance of pair-bond and aggressive behaviour is female Inciting; display more intense in later stages of Courtship. **Inciting**. Female lifts chin toward preferred male and calls; then turns away and aggressively points with head held low in direction of male or female opponent (Johnsgard 1965); preferred male may swim ahead of female while Chin-lifting. The closer the opponent, the more intense the display. **GREETING**. When incubating female joins male to feed, both call to each other as she flies through trees. Upon landing, she performs Head-pumping while male Rushes at non-existent intruder. **Head-pumping**: with bill pointing slightly downwards, raises and lowers head in sequence of slow or rapid pumping. **ALLO-PREENING**. Not seen by Johnsgard (1965). Kingsford (1986a) noted it rarely; seen once between adult male and female, several times between ducklings and parents, and also between ducklings usually just before fledging; impression of mutual preening may be given when in fact one bird is pecking another. **COPULATION**. If feeding in flock, pair leaves and walks quickly to nearby water with either sex leading. In water, male swims in front of female, while **Turning-back-of-head**. Sometimes both perform a drink display but bill does not actually touch water. Male eventually assumes erect posture characteristic of copulatory sequence; poses alongside and parallel to female, performs Head-pumping followed by **Head-dipping** (brief dipping of head underwater) and sometimes **Head-and-neck-dip** (whole neck and head immersed). Female occasionally performs latter two displays. Just before mounting, male increases frequency of Head-pumping before facing female whose neck is stretched forwards along water. Male mounts and grasps back of female's head. Contact during copulation, brief. Female calls just after copulation and may Head-dip; male turns-back-of-head; both birds perform drink display where bill does not actually touch water and sometimes dive (Johnsgard 1965; Kingsford 1986a). Forced copulation observed once, where male chased and copulated with apparently unwilling female (R.T. Kingsford).

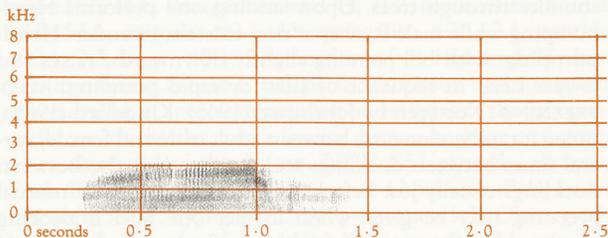
RELATIONS WITHIN FAMILY GROUP Pair remains together throughout year; both select nest-site, a period in which female calls continuously. While female incubates, male stations himself on nearby water and will accompany her for feeding bouts. Young led by both parents to water. Initially male spends most of time guarding while female and young feed; male usually found on higher ground and farther away from brood than female (Kingsford 1990). When older, ducklings unobtrusive and hard to flush. Family does not necessarily stay at same site until young fledged; Kingsford (1986a) found six broods with marked parents moved average of 0.93 km and, in 1983, 36% remained at their dam. Young accompanied by parents until at least 2 weeks after fledging

though actual time when family group breaks up unknown.

VOICE No detailed studies and poorly known. Account based on Frith (1982), Johnsgard (1965) and information supplied by R.T. Kingsford. Range of loud to soft nasal calls given in variety of circumstances; most commonly heard call, loud nasal braying *new* of female. Parental calls restricted to breeding season. Apparent sexual differences in vocabulary but little information. Male has rather large tracheal bulla (Johnsgard 1961). No information on individual differences or geographical variation.

ADULT MALE Male makes deep rumbling sound during Display Shake or Double Display Shake; suggested non-vocal sound (R.T. Kingsford). **Identity Call:** highly distinctive, soft wheezy and rather nasal *wee-ow*; much shorter (c. 0.5–1.0 s duration) than Identity Call of female. Uttered during Burp display (Johnsgard 1965). **Parental Call** of male softer, lower-toned version of Identity Call.

ADULT FEMALE **Identity Call.** Long, drawn-out mournful *new* or *now*; Johnsgard's (1965) *whroo* seems less appropriate; duration c. 1 s, sometimes to 2 s; frequency range between 300 and 2000 Hz (sonagram A); a short *new* given



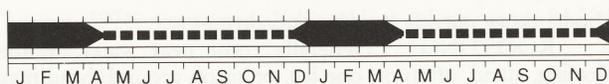
A J. Hutchinson; Manjimup, WA, May 1976; P11

after copulation. **Inciting Call** described as repeated nasal *wonk* (Johnsgard 1965). **Cluck.** Utter continuously repeated brief (<0.1 s duration) low-pitched *clucks* or *tooks* in variety of circumstances: when feeding; as Pre-flight Call during pre-flight Chin-lifting; and when searching for nest-sites (good indication that birds searching). Pre-flight Call louder and repeated more often than when feeding but not always used. Intensity of calling increases till flight and, when searching for nests, intensity increases when female moves to another tree. **Parental Call** of female undescribed.

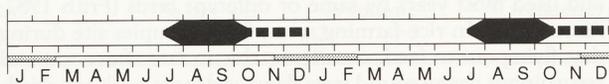
YOUNG Said to be normal duckling *peep*. Juvenile calls (undescribed) retained till moult into adult plumage when adult calls develop (R.T. Kingsford).

BREEDING Based on studies on Southern Tablelands, NSW (Kingsford 1986a) with information from Frith (1982). Information supplied by R.T. Kingsford. Breed in simple pairs, solitarily.

SEASON Vic., se. NSW, regularly July–Dec. in areas of fairly regular rainfall (e.g. at Goulburn, NSW), laying from July, young from Sept.; in ne. NSW, can nest all year, mostly Jan.–Mar.; erratic breeding inland, perhaps most in Aug.–Sept. (Frith 1982; Kingsford 1986a). On Southern Tablelands, hatching 1981–83, 21 Sept.–18 Nov., depending on climatic conditions; two broods were observed in autumn (Kingsford 1989b). Probably everywhere much controlled by rainfall and growth of green grass; on Southern Tablelands, most broods hatch during period of spring growth of pasture (Kingsford 1989b).



a) ne. N.S.W.



b) se. Aust.

SITE Always in holes in trees, usually live (Frith 1982; Kingsford 1986a), in or near water or up to 1500 m distant. Same holes may be used from year to year, not necessarily by same birds (S. Marchant). Birds usually search for nest-holes in morning, moving from tree to tree inspecting holes; both birds crane necks and look inside. Female calls much (*contra* Frith 1982), uttering rapid *took* calls (usually becoming more intense as she moves to another tree), a good indication that birds are searching for nests (R.T. Kingsford).

NEST, MATERIAL Nil but down added from end of laying; down, light grey, whitening in centre and at tip.

EGGS Oval or elliptical; close-grained, smooth, glossy; cream to creamy white.

MEASUREMENTS: 57 (53–62; 88) x 42 (40–45) (Frith 1982); 51 x 35 (Delacour 1954–64); 58.8 x 41.3 (n=37; S.V. Briggs).

CLUTCH-SIZE During two seasons, 35 nests held on average 10.5 eggs but large broods (17, 18) suggest probability of dump-laying, which confirmed by other evidence (Kingsford 1986a; S.V. Briggs; R.T. Kingsford). Range of eggs in nests given as 9–11 (North) and 8–10 (Delacour 1954–64). Lay replacement clutches if first destroyed (S.V. Briggs). No information on broods per season but late broods (av. 4.1) smaller than earlier (7.2) (Kingsford 1989b) but clutch-size did not vary seasonally in another study (S.V. Briggs).

LAYING No information.

INCUBATION By female only. Timing and length of absences for feeding not known but often returns to nest 08:00–10:00 and 17:00. When doing so, accompanied by male and pair may circle site several times before female dives straight into hole and male departs alone (S. Marchant). Male then stations himself on nearby or nearest water and waits. **INCUBATION PERIOD.** Said to be 28 days but no detailed evidence (Frith 1982); 34 days (S.V. Briggs).

DUCKLINGS Precocial, nidifugous. At hatching, downy, greyish brown above, buffy white below, with large white spots on sides of rump, on wing; two parallel dark lines on face; bill and legs, grey. Jump from nest and float to ground, while female flies to and from ground and tree, calling (Kingsford 1986a). Led by both adults, not necessarily to nearest water and even through 1 km of thick woodland with undergrowth to dam in cleared paddock. If disturbed *en route*, huddle in cover until breaking away in tight knot or scattering; adults may injury-feign nearby or fly right away. When older, ducklings skulk unobtrusively in thick vegetation round water's edge or nearby, where hard to flush (S. Marchant). Attended and guarded by both parents during fledging period. **FLEDGING PERIOD:** 57 days from hatching to first flight (Kingsford 1986a). Young remain with parents for at least 2 weeks after achieving flight.

GROWTH No information.

SUCCESS Little quantitative data. Brood size at hatching on Southern Tablelands varied significantly in three

seasons: 5.4, 6.0, 7.2. Probability of duckling survival to fledging was 88% (n=33), 20% (n=6), 82% (n=30) respectively (Kingsford 1989b). PREDATORS. Australian Ravens *Corvus coronoides*, White-faced Herons *Ardea novaehollandiae*, Laughing Kookaburras *Dacelo novaeguineae* seen to take ducklings. Peregrine Falcons *Falco peregrinus*, Brown Falcons *F. berigora*, Brown Goshawk *Accipiter fasciatus*, Wedge-tailed Eagles *Aquila audax*, Foxes and feral cats take adults.

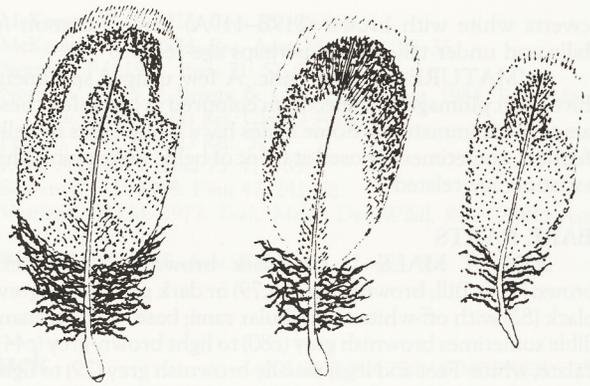
PLUMAGES

ADULT MALE BREEDING Definitive; alternate.

HEAD AND NECK. Mostly dark brown (121a). Row of elongate black (89) feathers with narrow dark-brown (121A) tips runs down neck, forming small mane. Lower throat and foreneck as breast; lower hindneck as mantle. **UPPERPARTS.** Mantle and upper back, brownish grey; feathers brown-grey (brownish 80) with broad brown (c28) subterminal bands and brownish grey (80) tips. Central back similar, but subterminal bands are dark brown (c121) on inner webs. Scapulars, brown-grey (brownish 80); most of outer web, except area near shaft, black (89); this forms sharply defined, black scapular stripe. Lower back, rump and upper tail-coverts, black (89); obscured by tertials and scapulars when wings folded. **TAIL,** black (89). **UPPERWING.** Primaries, primary coverts and alula, dark brown (c219). Marginal, lesser and median coverts, and tertials, grey (84); inner three tertials with black (89) outer webs continuous with scapular stripe. Secondary coverts and most secondaries (s1-s9) white with dark glossy basal third; concealed bases to inner webs, dark brown (119A). Inner webs, and inner quarter of outer webs of inner secondaries (s10-s11), grey (84); rest of outer webs dark and glossy. Dark glossy areas of secondaries form small dark-green (162A) speculum, most strongly iridescent near body; in dull light, speculum looks grey-black (82); in some direct lights, blue-purple. **UNDERPARTS.** Breast, grey-white with regular black spots connected by narrower dark bars; black markings boldest in centre of breast. Feathers barred greyish brown (119A-119B) and white, with cream (92) to white terminal spot bordered dark brown (119A, 119B) to black (89). Belly, feathering of tibia, vent and under tail-coverts, black (89), with concealed grey bases. Anterior flank-feathers elongate, with fine alternating black (89) and white vermiculations, from distance looking light grey (c85) or pale grey (86) (Fig. 1). Posterior flank-feathers, black (89), concealed by elongate anterior flank-feathers. **UNDERWING.** Remiges brown-grey (79); primaries have darker (91) tegmen. Proximal half of inner edge, and concealed base of inner web, white. Marginal coverts, greyish (c79) with varying white tips; other under wing-coverts, white.

ADULT MALE ECLIPSE Definitive basic. Some have identical body plumage to adult female; others similar to male with varying number of female-like feathers in head, flanks and belly (Kingsford 1986a). Unknown if all males develop complete eclipse plumage.

ADULT FEMALE Basic and perhaps alternate. **HEAD AND NECK.** Crown and face, brown (223B); hindneck, brown (121B). Supercilium and stripe below eye from bill to ear-coverts, white flecked brown; feathers white with dark-brown (221) tips or with brown (221) subterminal bands and grey-brown (239) tips. Chin and throat, brown flecked white; feathers white with broad brown (119B) tips, bases and shafts. **UPPERPARTS.** Similar to male but upper tail-coverts greyish (79). Lateral rump-feathers, brown-grey (80) with two white bars, and broad tips with fine alternating black-and-white vermiculations. **TAIL,** black (89). Wing similar to male but with



1a Adult male

1b Adult female

1c Juvenile

Fig. 1 Feathers from side of breast

slightly smaller speculum, dark green (260) in most lights, less iridescent than male. **UNDERPARTS.** Breast and flanks, brown spotted white. Flank-feathers, brown (119B) grading to light brown (119C) at base, with large white terminal spot, and narrow white bands (Fig. 1). Breast-feathers barred brown (119B) to pale brown (119D) and white; large terminal white spot bordered dark brown (221). Towards tail, less brown marking on feathers; belly, vent and under tail-coverts, white. High-feathers, barred light greyish brown (c119C) and white.

DOWNY YOUNG **HEAD AND NECK.** Forehead and crown, dark brown (119A), grading to brown (27) on hindneck. Narrow dark-brown (119A) eye-stripe from upper mandible to nape, surrounding narrow white supercilium about as wide as eye or less. Dark-brown (119A) moustachial stripe from gape to ear-coverts; often broken below eye. **UPPERPARTS,** brown (27), with pair of large white spots at sides of rump. **UNDERPARTS,** off-white, with light-brown (119C) flanks. Older chicks fade somewhat, appearing paler because down tips become light brown (39). Wing-pads, brown (27) with broad white trailing-edge inside carpal joint.

JUVENILE Differences from adult female: **HEAD AND NECK,** slightly paler in general than females; most feathers, olive-brown (29) with yellowish-brown (26) tinge at tip. White flecking of chin and throat slightly more extensive, encroaching onto sides of neck; much variation. Lower throat and foreneck as breast; lower hindneck as mantle. **UPPERPARTS.** Feathers about half length and width of adults. Mantle and upper back, dark brown (119A); feathers have small light brown (119C) tips, rapidly lost with wear. Edges of scapulars said to be white (Kingsford 1986b); no white edges in skins examined. Upper tail-coverts light brown-grey (44) with thick grey-black (82) fringes. **TAIL AND UPPERWING** similar to adult, but speculum dark brown (c121); some birds have iridescent green tinge to base of outer edges of secondaries. **UNDERPARTS.** Feathers about half length and width of adults. Breast and flanks look streaked brown, contrasting with spotted appearance of adult females; markings finer than in females (Fig. 1). Distal third of breast-feathers and anterior flank-feathers white, with irregular dark-brown (119A) spot on edges; rest of feather, light brown (119C-119D) with white bar; brown (119B) shaft-streak extends almost to tip. Posterior flank-feathers similar to adult female. In some, belly finely spotted brown; feathers white with light greyish brown (119C) bars, often broken at shaft. In such birds, under tail-

coverts white with brown (119B-119A) bars. Variation in belly and under tail-coverts perhaps age-related.

IMMATURE First basic. A few unaged specimens have adult plumage, but speculum coloured as juveniles; these are perhaps immatures. Some males have white bases to belly feathers, sometimes exposed at front of belly; unknown if this variation age-related.

BARE PARTS

ADULT MALE Iris, dark brown (22) to black-brown (119). Bill, brownish grey (c79) or dark grey (83) to grey-black (82) with off-white mandibular rami; base of upper mandible sometimes brownish grey (c80) to light brown-grey (c44). Palate, white. Feet and legs, usually brownish grey (79) to light brownish-grey (80), often with lime-green (59) hind edge to tarsus and tibia. In some, feet and legs grey-black (82) grading to grey (84) on hind edge of tarsus.

ADULT FEMALE, DOWNY YOUNG, JUVENILE Iris, feet and legs, as male. Base of bill, usually paler than in males; in many, bill mostly light pink-brown (c223D) to dirty pink (c3), but nails and underside of bill, as male.

MOULTS

ADULT POST-BREEDING Pre-basic. Complete; primaries simultaneous (ABBBS, MV skins). Elusive during primary moult, which probably occurs on large bodies of water rather than at breeding sites. Six of seven adults recaptured in Dec., after banding in Oct., had replaced primaries (Kingsford 1986b), which suggests that wing-moult usually occurs in early summer or late spring. This consistent with wear of primaries of adults collected in first week of Mar. in 6 years (Braithwaite & Norman 1976; Norman *et al.* 1984; MV); most had fresh or slightly worn remiges. Timing of primary moult probably differs in some years. Moult may be skipped during drought; none of six ducks banded in June 1982 and recaptured in Aug. 1983 after severe drought had replaced flight-feathers (Kingsford 1986b). Wing-moult apparently delayed in 1972; of 79 adults shot on 19 Feb., 10 were moulting, and 43 had worn primaries (Braithwaite & Norman 1974), which suggests that they had yet to begin wing-moult. Sequence of body-moult not understood; recorded in all months (Kingsford 1986b; MV) but least severe in winter; peak in moult of body in Dec., presumably associated with pre-basic moult.

ADULT PRE-BREEDING Pre-alternate. Partial, involving body feathers; peak of moult in Feb. and Mar. probably associated with this moult (Kingsford 1986b).

POST-JUVENILE (First pre-basic). Partial; body-feathers replaced in first summer. Ducklings hatched Sept.-Nov. had developed first basic plumage by Mar. (Kingsford 1986b). Juvenile wing probably moulted at about same time as adult, but no direct data.

MEASUREMENTS (1) Adult skins (MV, HLW). (2) Freshly dead adults (Frith 1982).

	MALES	FEMALES
WING	(1) 277 (7.47; 265-293; 16) (2) 272 (252-290; 46)	277 (5.81; 270-286; 8) 266 (252-284; 28)
8TH P	(1) 178.8 (5.07; 164-186; 16)	179.6 (5.50; 173-187; 7)
TAIL	(1) 95.7 (4.50; 87-105; 16)	98.3 (94-106; 8)
BILL	(1) 27.9 (1.80; 25.3-31.3; 16) (2) 28 (24-31; 46)	27.6 (1.25; 25.7-30.2; 8) 27 (22-31; 29)

TARSUS	(1) 51.2 (1.80; 46.9-54.3; 16)	50.4 (1.99; 47.9-54.3; 8)
TOE	(1) 53.9 (2.05; 51.4-57.1; 4)	51.2 (1.63; 50.1-54.0; 4)

WEIGHTS Adult males 815 (700-955; 45); adult females 800 (662-984; 26; Frith 1982). Body-weight and condition varies with breeding status and environmental conditions (S.V. Briggs). See Briggs & Thornton (1988) and Briggs (1989) for information on estimation of body condition.

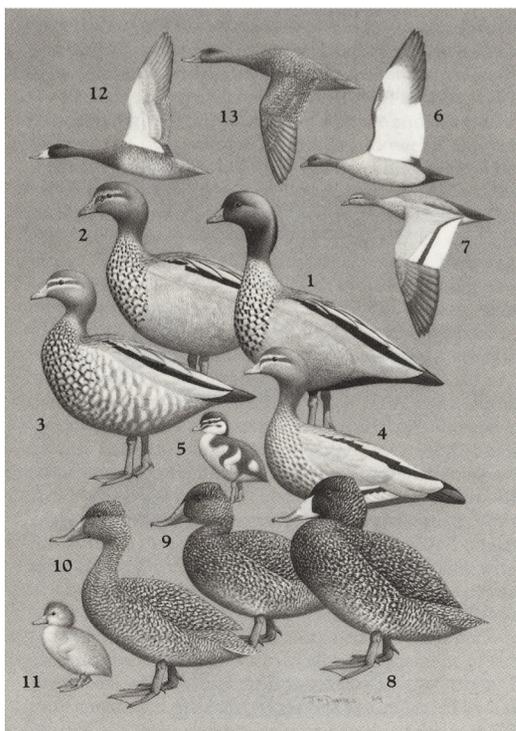
STRUCTURE Eleven primaries; p9 usually longest, p10 0-7, p9 0-2, p8 5-9, p7 16-20, p6 32-37, p5 47-55, p4 63-73, p3 78-90, p2 92-105, p1 102-116; p11 minute. Slight emarginations on outer web of p9, on inner web of p10 and sometimes p9. Seventeen secondaries, including five tertials. Tail rounded, 14 feathers; t1-t7 15-26. Bill short, with broad nail about two-thirds width of bill; wider than deep at base. Sides of bill converge slightly; culmen and tomia straight; lamellae small; can only be seen from underside of bill. Legs, rather long; tarsus slightly laterally compressed; scutellate at front. Middle toe longest, outer c. 90%, inner c. 75%, hind c. 30%.

DIR

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Volume 1 (Part B), Plate 84

Maned Duck *Chenonetta jubata*

1. Adult male breeding
2. Adult male non-breeding
3. Adult female
4. Juvenile
5. Downy young
6. Adult male (flight), ventral
7. Adult female (flight), dorsal

Freckled Duck *Stictonetta naevosa*

8. Adult male breeding
9. Adult female
10. Juvenile
11. Downy young
12. Adult male breeding, ventral
13. Adult female, dorsal

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