

## 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. Palearctic]; 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

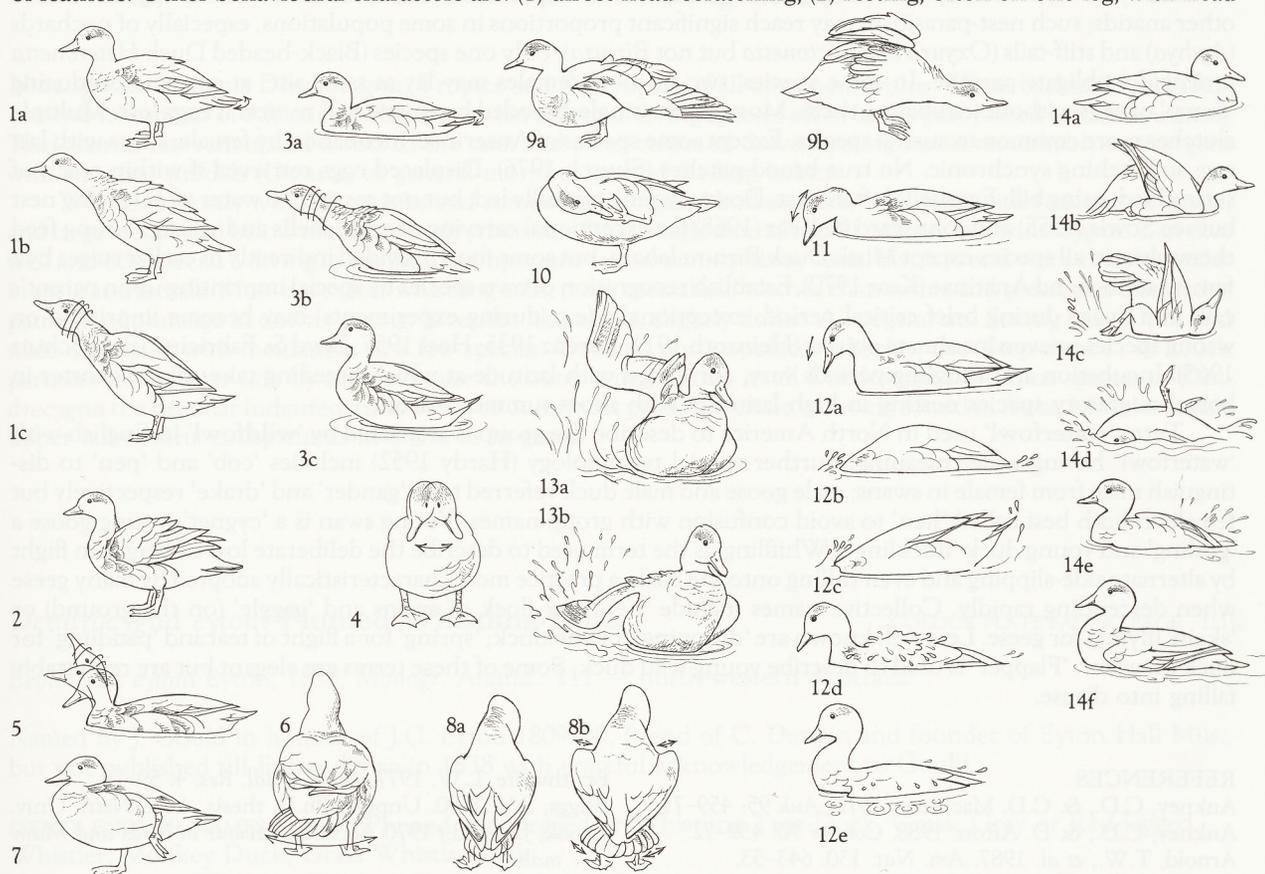
Waterbirds (some more or less terrestrial) with rather short legs and front toes connected by webs; hallux elevated and reduced. Though considerable adaptive diversity in outward appearance, size, colours of plumage, behaviour, and ecology, homogeneous in many characters, as attested by numerous, often 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*, *Plectropterus* and *Merganetta* in the Anatinae. Eleven primaries; p9 nearly always longest, p11 minute. Wide range in number of secondaries, from 12 to 24, innermost (tertiaries) often long and brightly coloured; diastataxic. 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-cranning**, **Chin-lifting**, and **Head-thrusting** movements, also lateral **Head-shaking**. Social patterns and behaviour of *Chenonetta* most like those of typical dabbling ducks. **Inciting** display of female also much as in *Anas*. In more generalized genera, however, pair-bonds weak or absent (Johnsgard 1965). Pre-copulatory behaviour varies; includes **Head-pumping** (as in *Anas*), **Head-dipping**, and **Bill-dipping**. Post-copulatory behaviour also varies, but little studied. Voice characteristics vary; sexually differentiated to greater or lesser extent. Male calls mostly whistles; female calls honking, quacking, or squeaking (characteristic **Decrescendo** calls of *Anas* lacking). Some species more or less silent. Torrent Ducks are specialized river-ducks inhabiting rapids and fast-flowing rivers of the Andes of South America; very noisy. *Salvadorina* is similarly specialized but is not necessarily closely allied to the Torrent Ducks. Little is known of its social behaviour and ecology.

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

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

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

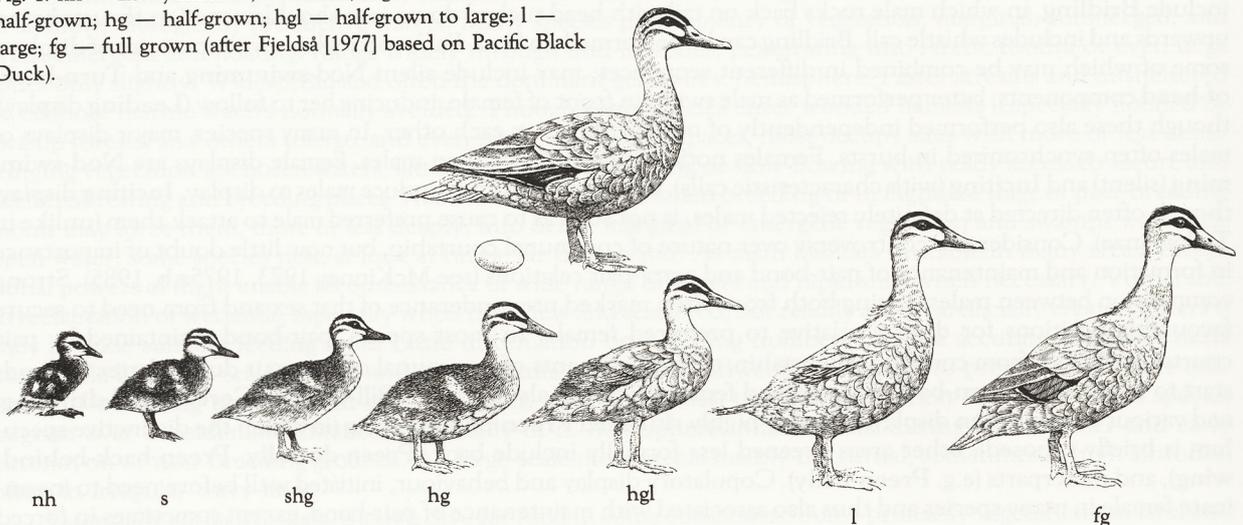
Essentially surface feeders, though dive for food in some conditions. Some primarily vegetarian, on land and

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

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

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

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



## Pochards

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

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

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

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

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

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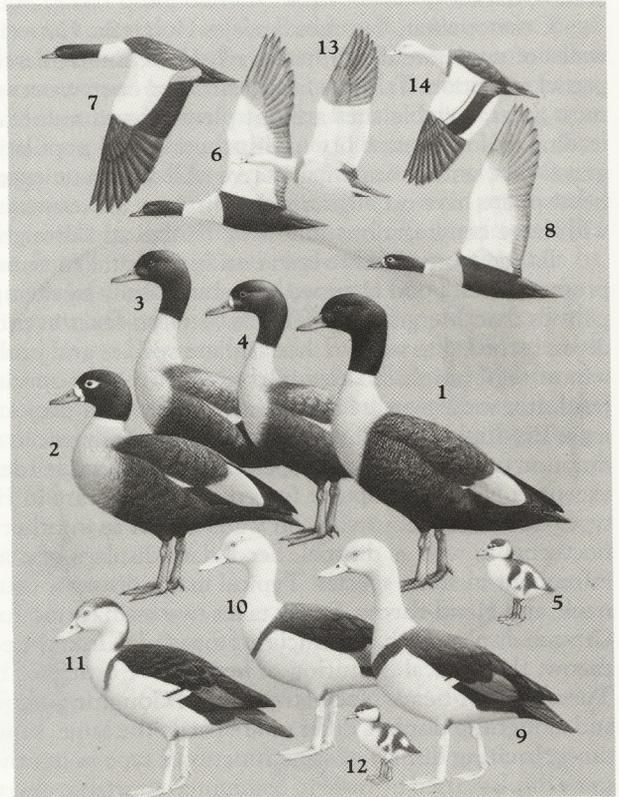


Plate 87

Australian Shelduck  
*Tadorna tadornoides*

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

Radjah Shelduck *Tadorna radjah*

9. Adult male
10. Adult female
11. Juvenile
12. Downy young
13. Adult male (flight)
14. Adult male (flight)

*Anas membranaceus* Latham, 1801, *Index Orn. Suppl.*:69 — New South Wales.

The generic name is compounded of the Greek μαλακός (soft) and ῥύγχος (beak); *membranaceus* is an adjectival form of *membrana*, Latin for 'membrane' or 'thin skin'; the bill is large and broader at tip, which is soft and membranous (Latham 1801).

OTHER ENGLISH NAMES Pink-eyed or Zebra Duck; Whistling or Zebra Teal, Pink-ear, Pinkie, Pink-eye, Whistler, Widgeon.

MONOTYPIC

**FIELD IDENTIFICATION** Length 36–45 cm; wingspan 57–71 cm; weight 270–480 g. Small duck with hunched appearance and large square-tipped bill; diagnostic striped flanks, breast and lower neck; dark eye-patch and white face. Much smaller than Australasian Shoveler *Anas rhynchos* with which it shares similar bill-shape. Sexes identical in plumage; females smaller but differences not distinguishable in field. No seasonal plumage changes. Juveniles separable.

**DESCRIPTION** **ADULT.** Forehead and crown, grey; large dark-brown eye-patches, bordered in front by white anterior lores and grey crown above, narrow above ear-coverts, continue as stripes to hindneck, joining below nape; striking narrow white eye-ring; rest of face white with fine light-brown barring except for small tuft of bright pink feathers behind eye-patch. Front of lores, chin and throat, white. Mantle, white barred dark brown, continuous with barring of upper breast; back and upperwings, uniform dark brown with fine pale vermiculations (visible only at close range); upperwing has narrow white trailing-edge; in flight, shows as uniform brown upperwing with white trailing-edge narrowing to wing-tip, which is wholly brown. Rump, white. Upper tail-coverts, dark brown; uppertail, dark brown with narrow white terminal band. Underparts, white with broad dark-brown barring from upper breast to vent, becoming bolder and broader on flanks, giving distinctive zebra-striped appearance. Under tail-coverts, chestnut. Underwing: remiges brown with narrow white trailing-edge to secondaries and inner primaries; wing-tip, brown; contrasting with white coverts. Bill, leaden-grey, spatulate square-tipped with soft membranous flaps on tip of upper mandible hanging below lower mandible. Iris, brown. Legs and feet, dark grey. **DOWNY YOUNG.** Crown and neck, dark brown; face, grey with large dark patch through and round eye. Upperparts, uniform light brown. Underparts and throat light grey or white; sides, light brown with light grey patch behind wing. Wing, light brown

above, grey below. **JUVENILE.** Similar to adult but paler and with less barring, almost absent on mantle and underparts; forehead, grey-brown (not grey) and lack pink ear-patch.

**SIMILAR SPECIES** Unmistakable; dark eye-patch, obvious white eye-ring, pink spot on ear-coverts, striped flanks and strangely large bill, diagnostic. In flight, tail pattern distinctive; only Aust. duck with dark white-tipped tail, contrasting with white rump and trailing-edges of wings. **Australasian Shoveler** similar only in large, but differently shaped, bill; bill forms a straight line with top of head (Pink-eared has obvious forehead); has much darker more uniform plumage and floats low in water (Pink-eared sits high in water). Ducklings distinctive because they hatch with spatulate bill, in contrast to Shoveler, which develops distinctive bill after hatching.

In pairs or small to very large flocks; typically associated with shallow inland wetlands; rarely at coast. Often seen hauled out on logs and low branches of trees over or in water. Feed with bill submerged to eyes and rarely, if ever, up-end. Fly with rapid wing-beats and will often circle wetlands when flushed; often fly at night (heard calling) and said to land on corrugated iron roofs, mistaken for waterbodies reflecting moonlight. Call much in large flocks and in flight; chirruping whistle.

**HABITAT** Widespread on terrestrial wetlands; stronghold in inland plains, regularly reaching coast only where mean annual rainfall <400 mm (Frith 1982). Bill specialized for filter-feeding (Crome 1985) limits foraging to water and soft mud; almost entirely aquatic, usually feeding away from shore (Frith *et al.* 1969). Prefer shallow stagnant turbid water with abundant aquatic fauna and so concentrate on large sheets of floodwater covering shrubby alluvial plains (salt-bush, bluebush, canegrass, lignum) (Hobbs 1957; Frith 1959; Fjeldså 1985). Clear fast-moving recent floodwaters not used,

but gather on warm receding waters where invertebrates concentrated (Hobbs 1957); also on sewage ponds and sewage-polluted lakes (Brown & Deerson 1982; Hewish 1988). Few occur on deep swamps, lakes and billabongs where food scarce, although concentrations may form during dry conditions inland; in deep wetlands feeding limited to shallow margins or where mats of floating rotting vegetation shelter invertebrates (Frith 1982). Also recorded from irrigated fields, fresh meadows, shallow fresh swamps, and farm dams; rare on watercourses (Frith *et al.* 1969; Corrick & Norman 1980; Gosper 1981; Jaensch & Vervest 1988a,b). Generally uncommon in saline habitats, although many recorded on some brackish or salt lakes (Warham 1958; Hewish 1988; Jaensch *et al.* 1988); rare on saltpans, saltmarsh flats and coastal lagoons (Gosper 1981; Corrick 1982; Wood 1985). May be found in unusual habitats during dispersal from inland as floodwaters dry e.g. city parks, high-mountain lakes, tropical waterlily pools, rock pools in desert ranges, mangrove swamps, estuaries (Frith 1982).

Huge breeding concentrations form inland on shallow turbid receding floodwaters over shrubby alluvial plains (Hobbs 1957); nests on any available surface over water (Frith 1982). Breeding stimulated by drying and refilling, which increases levels of organic matter, and aquatic flora and fauna (Crome 1988). May also breed on seasonal or permanent lakes

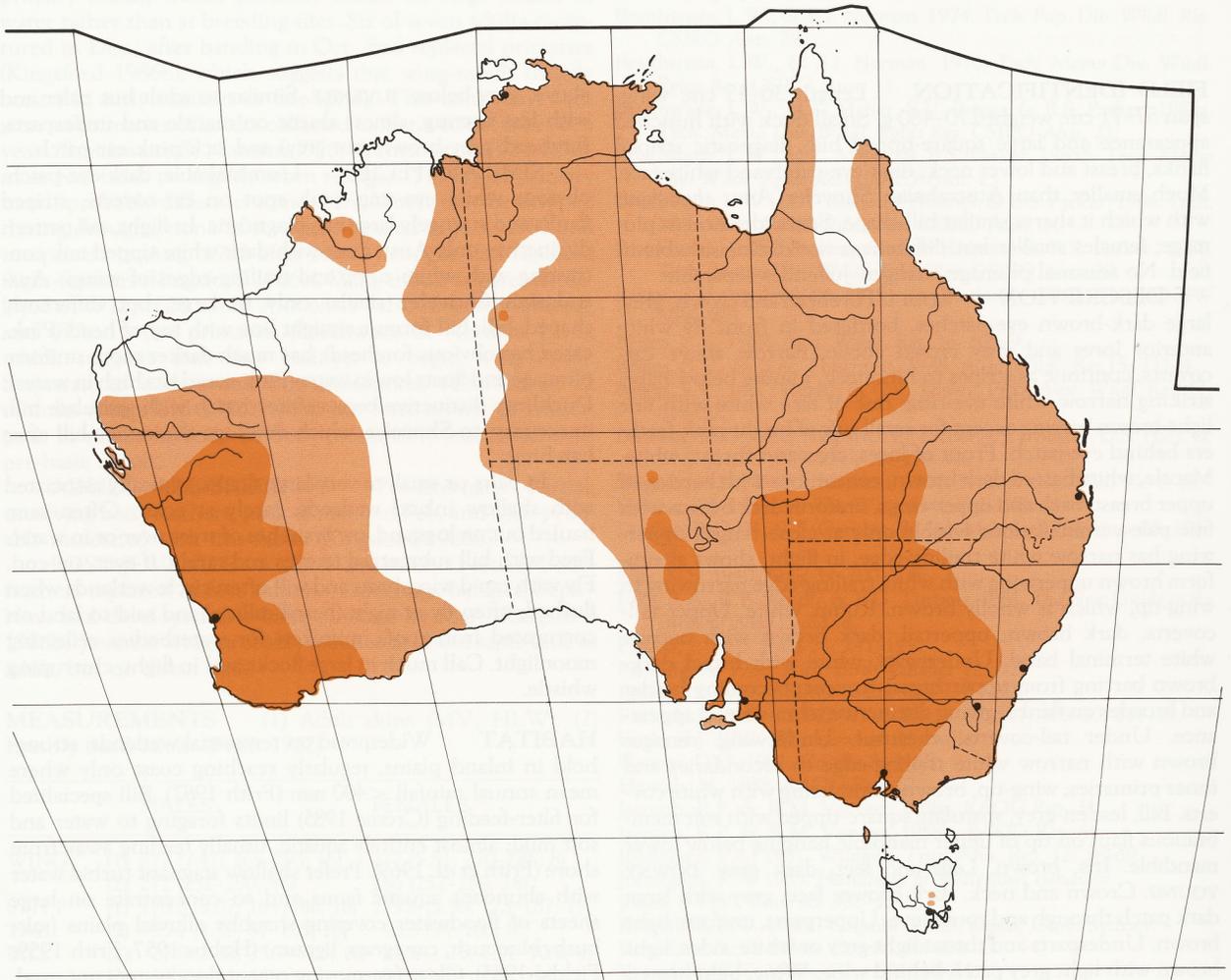
and swamps (Warham 1958; Rook 1963; Vestjens 1977); usually freshwater, but in WA use saline lakes (Warham 1958).

Fly freely; when disturbed may circle repeatedly high or low over original position. Use of underwater habitat limited to depths that can be reached by up-ending; do not dive. Roost on water's edge or low in fallen timber (Frith 1982).

Opportunistic breeding on inland floodwaters threatened by flood-mitigation works (Frith 1982). Birds make little use of artificial impoundments (Braithwaite *et al.* 1985a) except for suitable sewage ponds and lakes.

**DISTRIBUTION AND POPULATION** Endemic to Aust.

**AUST.** Widespread throughout, except in most arid areas of WA and SA, roughly between Broome and Tanami in N and Eyre and Ceduna on Great Aust. Bight, where rare or absent; scarce in coastal areas of n. Aust. from Kimberleys to Cape York Pen. N from about 15°S (Aust. Atlas); commoner in SE. **Qld.** Throughout, mostly interior regions, rare far N. (Aust. Atlas). **NSW.** Throughout, especially Murray-Darling basin (Morris *et al.* 1981). **Vic.** Widespread, mostly W. (Aust. Atlas; Vic. Atlas). **Tas.** Rare visitor, including two near Ross, 1957; one, Pearshape Lagoon, 16 Apr. 1980; four, Bells Lagoon, Tunbridge, 16 Feb. 1984; also King I. 1980; single,



shot, Flinders I., 9 Mar. 1965 (Green 1969, 1977; Tas. Bird Reps 1980, 1984). SA. Widespread, mostly E, also Kangaroo I. (Aust. Atlas; Close & Jaensch 1981; Parker *et al.* 1985). WA. Throughout, mostly interior regions, increasing SW since 1952 (Serventy & Whittell 1976). NT. Widespread, mostly S. (Parker 1969; Storr 1977; Aust. Atlas).

Breed widely in inland se. Aust. in area bounded by line from Eyre Pen. to Pedirka, SA, to Blackall and Charleville, Qld, to Walgett and Bathurst, NSW, and to Melbourne area, Vic.: also in WA, S of Murchison R. and W of line from Meekathara to Esperance (Aust. Atlas). May breed more sparingly elsewhere in range, Aust. Atlas records coming from near Derby, WA and in the Tanami but probably little breeding N of 20°S or along e. coastal areas.

**POPULATION** Annual indices of abundance from aerial surveys of wetlands in about 12% of land area of e. Aust., 1983–88, were 44 105; 121 003; 85 983; 12 071; 16 779; 13 511; concentrations occurred on floodwaters of Paroo R. and Cuttaburra Channels, nw. NSW (1988, 41–80%; 1983, 41–60%), wetlands of floodplains at the confluence of Lachlan and Murrumbidgee Rs, NSW (1987, 21–40%; 1986, 41–60%), Menindee Ls system, NSW (1985, 61–80%) and L. Galilee, Qld (1984, 41–60%) (Braithwaite *et al.* 1985a,b, 1986, 1987; Kingsford *et al.* 1988, 1989). During widespread floods in Riverina region of sw. NSW in 1956, estimate of 90 000 pairs in an area extending for about 85 km (Hobbs 1961). Counts in Vic. summer surveys, 1987–89, were: 27 769 on 332 wetlands; 45 536 on 472 wetlands; 13 016 on 626 wetlands respectively; making up 4–15% of all ducks counted (Martindale 1988; Hewish 1988; Peter 1989). Counts in sw. Aust., 1986–88, were: 2156 on 872 wetlands; 7914 on 1201 wetlands; 6131 on 1398 wetlands respectively (Jaensch & Vervest 1988a,b).

Pre-season counts in Vic. show that less exposed to shooting than other game ducks; 30–45% of total numbers counted on waters open to shooting (Martindale 1988; Hewish 1988; Peter 1989). Shot much but usually form low proportion of total bag in se. Aust., except in drought years when birds move to coast (Norman *et al.* 1984; Briggs *et al.* 1985; Loyn 1987). High proportion of Pink-eared Ducks on sample of waters in Vic. shot in 1987 open season, but in that year probably large secure population inland; appear reluctant to leave favoured wetlands and circle low and repeatedly under fire (Loyn 1987).

**MOVEMENTS** Highly dispersive from inland Aust., movements related to availability of water. Seasonality of rainfall, however, gives some regularity to variation of population though patterns of movement of individual birds unknown. Reporting rate in Vic. highest in spring and summer when varying numbers move SE from inland though at least part of population appears to be resident (Vic. Atlas). Dry weather inland often causes irruptions to coast (Serventy 1953), particularly when drought follows flooding (Frith 1982); wet weather inland followed by evacuation of coastal refuges (P. Higgins) though left L. George, se. NSW, after sustained high water-levels (Lamm 1965).

**BANDING** (All returns ABBBS).

33S144E 11 1+ M 3 274 199  
36S140E 12 1+ M 2 303 049  
36S140E 12 1+ M 6 275 354  
37S144E 11 1+ U 3 167 216

**FOOD** Mostly invertebrates, particularly chironomid larvae, though also take seeds. **BEHAVIOUR.** Most food taken

by filtering, water and food being drawn in at tip of bill and expelled between lamellae at side (Frith 1959; Crome 1985). Flaps on bill have high density of sensory corpuscles and appear to be used to increase sensory area on either side of tip of bill for detection of live particles (Kear & Burton 1971). Feeding occurs while standing in shallow water or when swimming with heads submerged up to the eyes. Sometimes submerge head in shallow water to filter near the bottom; rarely up-end. Often feed in formation, with birds at rear catching animals disturbed by those in front (Frith 1959).

Method of feeding specialized and in the past social versions have been interpreted, incorrectly, as type of display or ritualized feeding. Early accounts by Shanks (1953), Lowe & Lowe (1973), Johnsgard (1965b), and Frith (1959, 1982) give some details, not necessarily accurate; account here based on detailed observation by P.J. Fullagar and C.C. Davey in wild, specially at Lake Merrimajeele (Boooligal, NSW) in 1980 but also from captive birds.

Birds feed in one of three ways: solitarily; in parallel; or by spinning or 'vortexing' in pairs. Commonly when swimming (generally irrespective of depth of water) but also when walking on soft ooze. Four methods of filter-feeding from the surface can be recognized depending on position of head and bill. (1) Bill just at water surface; flaps dip into water but tip held just above surface. In this way birds skim food from the surface with rapid pump-action filtering method common to all ducks but specially obvious in this species (see Crome 1985 for details of bill structure and adaptations). (2) Bill plunged to level of nostrils (which are specially high on the bill); eye just above surface and bill at shallow angle in water. Again, the stream of water issuing from upper sides (gape) of bill is particularly obvious with this filtering method. (3) Head plunged completely below water and filtering continues in short bouts between withdrawals to check surroundings. (4) Up-ending when bill thrust down to limit of reach. Often used to work bottom muds. Not seen to dive.

Methods (1) and (2) can be used on the move; method (1) when walking. Commonly these filtering methods used on water with birds moving as a flotilla in parallel often for long stretches. Typically, when food abundant, group breaks up to concentrate on feeding in particular areas when range of filtering methods may be seen. No particular orientation of birds with respect to each other but often close together; 1–5 lengths apart. Common for birds to associate as pairs in these feeding flocks. Observations in captivity confirmed that these 'pairs' are not always of opposite sex but homosexual associations might not be so likely in wild if pair-bond permanent as seems probable; siblings probably stay close together until break up of the family bonds. The most elaborate form of co-operation is the spinning or circling action of birds feeding in pairs while rotating about a central point; termed 'vortexing' because function is probably to concentrate swarms of small organisms so that they can be gleaned. The action probably draws in micro-organisms and holds them in gyrating column of water caused by rotation of the two ducks; it essentially depends on two birds moving in a circle about a point in which the head of one is opposite the tail of the other. In this way the tips of the bills circumscribe a small area in the larger circle round which the two bodies rotate. Birds do not change partners and approaching individuals will be driven off vigorously. Occasionally individuals rotate but probably impossible for more than two birds to operate the method effectively; so trios or more birds rarely observed and extremely aggressive nature of species makes pairs most likely (however see

comments above about composition of pairs). Birds will use the vortexing method in a small area for many minutes; once for 2 h within a 10x3 m patch alongside a lignum *Muehlenbeckia cunninghamii* bush (P.J. Fullagar). Rotation occurs in both directions; often switching.

Methods (3) and (4) only used in stationary feeding activities without necessarily reaching the bottom in deep water.

**ADULTS** Summarized Tables 1 and 2. At **Willandra, w. NSW** (12 samples; Briggs *et al.* 1985) animals, molluscs gastropods: in oesophagus 9.5% dry wt., 33.3% freq., in gizzard -, -, crustaceans: ostracods 15.3, 78.8, 4.1, 58.3, clam shrimps 0.8, 11.1, -, -; insects: mayflies tr., 11.1, -, -, bugs Corixidae 8.4, 44.4, 1.1, 41.7, Notonectidae 1.6, 22.2, 0.4, 8.3, lacewings tr., 11.1, -, -, beetles Dytiscidae ads. tr., 22.2, 0.1, 8.3, Hydrophilidae larv. 1.6, 33.3, 23.5, 66.7, ads. -, -, tr., 8.3, unident. beetles -, -, 0.2, 8.3, flies Chironomidae larv. 48.5, 78.8, 29.1, 91.7, pupae 0.5, 22.2, 0.3, 8.3, unident. flies 11.7, 22.2, 0.3, 8.3, unident. eggs -, -, 0.6, 8.3, unident. insects 0.7, 33.3, 1.3, 16.7; unident. fish 0.9, 11.1, -, -; seeds and food of vegetable origin, Chenopodiaceae -, -, 2.5, 8.3, Portulacaceae 0.3, 10.0, 0.6, 33.3, Polygonaceae -, -, 8.1, 41.7, -, -, Fabaceae -, -, 5.7, 41.7, Malvaceae -, -, 1.4, 8.3, Boraginaceae -, -, 11.1, 58.3, Cyperaceae -, -, 6.5, 66.7, Poaceae tr., 10.0, 2.4, 8.3, vegetable fragments tr., 10.0, 0.7, 8.3.

In **nw. NSW** (5 samples; Briggs 1982) animals, crustaceans: cladocerans in oesophagus 8.9% dry wt., 80% freq., in gizzard 6.3, 60, copepods 8.1, 40, 5.3, 20, ostracods 0.3, 50, tr., 25; insects: mayfly nymphs 0.8, 20, tr., 20, bugs Corixidae ads. -, -, 4.7, 40, *Micronecta* ads. 24.9, 60, 20.4, 80, nymphs 5.5, 60, 4.2, 40, parts -, -, 5.5, 20, caddisfly larv. -, 20, 0.9, 20, flies Chironomidae ads. 10.0, 20, tr., 20, larv. 20.0, 60, 1.1, 60, Ceratopogonidae larv. 1.7, 60, 0.8, 80, unident. ad. flies -, -, 0.3, 20, unident. eggs -, -, 3.7, -, plants, *Portulaca* 9.8, 20, 9.3, 60, *Polygonum* 0.7, 40, 34.2, 100, *Trifolium* tr., 20, 0.4, 40.

In **w. NSW** (138 gizzards; Frith 1959) animals, nematodes 18.2% freq., molluscs: 7.9% vol., 6.5% freq., lamellibranchs *Alathyria*; rotifers 7.3% freq.; arachnids: 0.3, 4.4; crustaceans 100% fr.: copepods 22.1, cladocerans *Daphnia pulex* 63.4, ostracods *Cyprinotus laena* 7.2, 21.0, noto/anostracans 3.2% freq.; insects: mayflies tr., 11.1, bugs 40.8, 51.1 *Agraptocorixa euryome* 34% vol., *A. spp* 4, Notonectidae 3, beetles 27.2, 55.1, Carabidae, *Berosus* 11% vol., Aphodiinae, flies 0.8, 3.0, Culicidae 0.5% vol., Stratiomyidae larv. 0.3; plants, mostly seeds, *Chenopodium* 2.8, 3.6, 0.4, 12.3, Fabaceae 1.1, 33.9 incl. *Medicago* 0.4% vol., *Trifolium* 0.7, Poaceae 1.2, 3.8 incl. *Paspalum distichum* 0.7% vol., Marsileaceae 5.8% freq., Chlorophyta 86.0.

In another sample from **Barrenbox Swamp, w. NSW** (95 gizzards; Frith *et al.* 1969): animals, molluscs 50.0% freq. *Glyptophysa*; crustaceans, shrimps *Caridina mccullochi*, freshwater crayfish *Cherax albidus* copepods, cladocerans 51.0% freq. ostracods; arachnids 2.7% vol., 38.0% freq. *Hydracarina*; insects 13.0, 56.0: bugs 2.2% vol. *Diplonychus rusticus*, *Agraptocorixa euryome*, *Micronecta annae*, *Sigara*, *Naucoris congrex* 1.1% freq., beetles *Notomicrus*, *Berosus australiae*, *Hydrophilus latipalpus*, flies 0.8% vol., caddisfly larv. 4.8, 21.0; plants, incl. *Ceratophyllum demersum* 7.1, 21.0, *Ranunculus*, *Chenopodium* 1.0% vol., *Rumex* 1.0, *Medicago* 4.0, *Myriophyllum*, *Heliotropium*, *Potamogeton* 3.1, 9.0, *Najas marina* 3.3, 11.0, *Typha* 7.3, 40.0, *Azolla* 21.8% vol., Lemnaceae 3.6, *Juncus*, Cyperaceae 2.0 incl. *Carex*, *Scirpus*, Poaceae 2.2 incl. *Avena*, *Bromus*, *Critesion/Hordeum*, *Echinochloa*, *Paspalum*, *Oryza*, *Marsilea* 1.0, Characeae 0.3, Chlorophyta 1.8. **Other records:** n. Qld (2 gizzards; Lavery 1971) Cyperaceae seed 78%

vol. with no animal matter; sw. NSW insects (Ellis 1940).

Table 1. Oesophagus contents of Pink-eared Duck.

	% dry wt.		% frequency	
	1	2	1	2
animals	99.6	88.7	100	100
crustaceans	16.1	62.9	r79	r80
insects	73.0	62.9	r79	r80
plants	0.3	10.5	22	40

(1) Briggs *et al.* (1985); (2) Briggs (1982).

Table 2. Gizzard contents of Pink-eared Duck

	% dry wt.		% volume		% frequency	
	1	2	3	4	3	4
animals	60.9	56.9	94.4	34.1	100	95
crustaceans	4.1	11.6	7.2	18.4	100	57
insects	56.9	41.6	80.0	13.0	100	56
plants	39.0	42.9	5.6	65.9	86	88

(1) Briggs *et al.* (1985); (2) Briggs (1982); (3) Frith (1959); (4) Frith *et al.* (1969).

**SOCIAL ORGANIZATION** No detailed studies. Gregarious; seen in small to large flocks; during dry periods, can form spectacular flocks of up to 10 000–20 000, frequently associated with Grey Teal (Hobbs 1957; Frith 1977). Often birds in flocks appear paired (Lowe & Lowe 1973). During breeding season, some birds seen in small groups of two or three (Warham 1958). Feed singly (Hobbs 1957), in pairs or in groups (Frith 1977). At times, groups often forage communally in arrowhead formation with rear birds taking advantage of disturbance caused by leading birds (Hobbs 1957); often flocks break up into rotating pairs for feeding (see Food); also seen feeding in scattered flocks (Lowe & Lowe 1973). Sometimes feed in mixed species flocks (Warham 1958).

**BONDS** Monogamous, probably lifelong (P.J. Fullagar). Only female incubates; both parents tend young (Hobbs 1957; Warham 1958; P.J. Fullagar). When breeding density high, broods may amalgamate in groups of up to 16 (Hobbs 1957). Display stimulated when breeding conditions become suitable (Frith 1977).

**BREEDING DISPERSION** In some drier parts of Aust., nesting density can be high after flooding, such as near Deniliquin, NSW where Hobbs (1957) states: 'every hole, whether high or low, big or small was occupied . . . One nest hole contained at least 60 eggs'. After hatching, Hobbs found one brood every 4.5–6 m along a creek and estimated that 96 000 pairs were breeding in stretch of some 90 km. **TERRITORIES.** Male defends area round female, round nest during incubation and round young (Warham 1958; P.J. Fullagar).

**ROOSTING** Roost in flocks on edge of water or on low branches above water; during breeding, male loafs or perches near nest-site. Rest on water in mixed species flocks (Scott 1958; Warham 1958; Hobbs 1959).

**SOCIAL BEHAVIOUR** No detailed studies. Based on Warham's (1958) study at Moroa, WA, Johnsgard (1965a,b),

Frith (1977) and Lowe & Lowe (1973); observations by P.J. Fullagar. Sexual differences in behaviour virtually unknown because sexes indistinguishable in field. Tamer than most Aust. ducks (Warham 1958; Frith 1977). When disturbed, flocks take flight calling noisily (Johnsgard 1965b). Perch readily; climb sloping limbs without difficulty although may have to make several attempts if slippery; gape in hot weather; when roosting, stand on one leg with head tucked into shoulders. Before taking flight birds often perform lateral head-shaking (Johnsgard 1965a,b). Bathing in flocks; often at dawn and before roosting.

**AGONISTIC BEHAVIOUR** Defend preferred roosting-site. During breeding, male of pair defends area round female and both sexes round nest and brood; also aggressive towards other species of waterfowl e.g. Eurasian Coot *Fulica atra*. Presumed female very aggressive at time of hatching (Scott 1958; Warham 1958; Johnsgard 1965a; Frith 1977). **THREAT. Bill-tilting.** Pronounced chin-lifting, with upward tilting of bill (from 46 to 60° above horizontal), accompanied by neck-stretching and whistle call; often followed by overt attack (Johnsgard 1965a, b). Sometimes performed by one or both participants of rotating feeding pair when unwanted intruders attempt to join in, though may also give lateral head-shakes or stab with bill (Johnsgard 1965b; Lowe & Lowe 1973). In another display, rush across water with neck erect and bill swinging repeatedly to 45° elevation, uttering loud trill (Frith 1977). On other occasions, swim towards intruder with head and neck outstretched flat on water, opening and closing bill; Frith (1977) reports as silent whereas Warham (1958) reports loud trilling call. Warham (1958) also noted that when call given by one of pair, other answered and stood alert. Rushing threat display, often leads to fighting. Following successful encounter, individual stretches out neck, points bill to sky and calls (Warham 1958); male raises body from water and flaps vigorously or makes shallow dives (Frith 1977); possibly tilt slightly open bill upward (Scott 1958). **ALARM.** Call given when alarmed (Warham 1958). When incubating bird alarmed, will leave nest but returns quickly. **DISTRACTION DISPLAY.** Warham (1958) noted display absent in adults, whereas Hobbs (1957) reported adults feigned injury when guarding young. Male approaches intruder noisily; female leads brood away (P.J. Fullagar). **ESCAPE.** Young dive when adults feign injury, as do adults to escape aerial predators (Hobbs 1957; Frith in Hobbs 1959). Displacement preening recorded (Warham 1958).

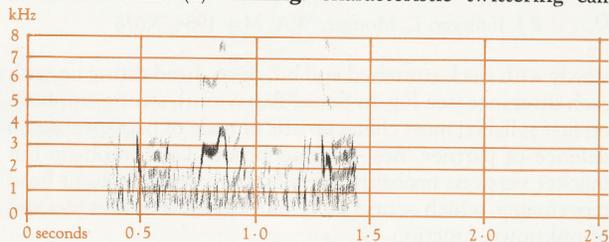
**SEXUAL BEHAVIOUR PAIR-FORMATION. Uplift Call.** Commonest pair-forming display and similar to threat display. Rapidly tosses bill upwards then lowers while holding extended neck vertical and uttering drawn-out whistle (see Voice); possible male display (Johnsgard 1965a; Frith 1977). Often repeated several times in succession and can initiate chorus within flock; both sexes stimulated to perform (Frith 1977) contrary to Johnsgard's (1965a) suggestion that it was exclusively a male display. In some instances, leads to performing bird being threatened or attacked (Johnsgard 1965b; Frith 1977). Johnsgard (1965b) observed other possible display (which he attributed to males); bird gave lateral head-shake (made conspicuous by enlarged, slightly open bill), followed by dorsal preening of scapulars. Warham (1958) noted pair perched side-by-side on log and one head-bobbing with bill held stiffly at c. 45°, but partner gave no reaction; head-bobbing also observed by Hobbs (1957); no information on function. **GREETING.** When flying in, greet each other with loud flute-like whistle (Trilling call; see Voice); no other greet-

ing ceremony (Lowe & Lowe 1973). No apparent pre-copulatory displays. Male snatches at female's nape and mounts, **COPULATING** rapidly. Post-copulatory displays consist of dabbling, head-tossing then with preening breast and wing-flapping, and finally swimming in small circles and up-ending as if feeding (Johnsgard 1965a,b; Lowe & Lowe 1973).

**RELATIONS WITHIN FAMILY GROUP** Following based on observations by Warham (1958). When returning to nest during incubation period, pair, giving greeting call (purring), approach nest in tree-hollow together; one bird flies up to nest, calling (usual flight call), and sometimes has to make several attempts before obtaining foothold; other usually swims immediately to favoured perch nearby. At start of incubation shift, female shuffles into position with series of sideways quiverings of its body then sits quietly with bill tucked into scapulars; changes position at half-hour intervals and frequently turns eggs with its bill. After hatching, sitting bird often calls with soft purr. Warham (1958) witnessed departure of young from nest hollow: female, calling with loud flutter *tew-ee* and male, giving soft purring, swam away from hollow then circled back towards tree; chicks then jumped out of hollow into water, family group formed and all began to move; one member of pair swam back to nesting tree where remained for a few minutes, lifting its bill upwards and whistling; then flew back to brood. Family group feeds together. Soft calling probably serves to integrate chicks on the water.

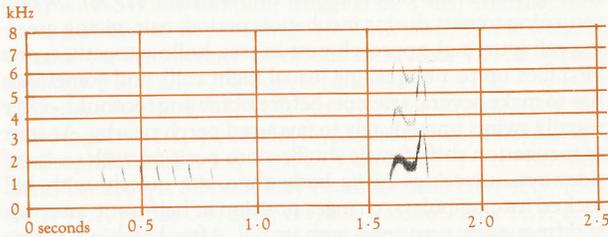
**VOICE** No detailed study; Lowe & Lowe (1973) tried to categorize calls and reconcile descriptions of other authors; incidental observations by Warham (1958), Johnsgard (1965a,b) and Frith (1982). Repertoire and variation in types of calls not known with certainty because descriptions by authors vary and there has been no detailed study. Flocks very noisy in flight and on water, continuously uttering characteristic chirruping or twittering whistles. Lowe & Lowe (1973) considered calls probably vary more than is known. All authors unable to distinguish sex by calls except Frith (1982) who considered calls of females differed in pitch, but evidence lacking and not confirmed (P.J. Fullagar). Based on information supplied by Frith, Johnsgard (1965) reports that the tracheal structure of the male is very similar to that of Grey Teal implying the presence of a large bulla. This is later contradicted by Frith (1982). The trachea of the male has no bulla (G.F. van Tets; P.J. Fullagar). Observations on captive birds suggest that no differentiation in the character of the calls occurs in this species; both sexes capable of the full repertoire but certain calls more typical of male and seem less often given by female (P.J. Fullagar).

**ADULT** Observations by P.J. Fullagar and C.C. Davey on birds in field and in captivity suggest at least four distinctive calls. (1) **Trilling:** characteristic twittering call



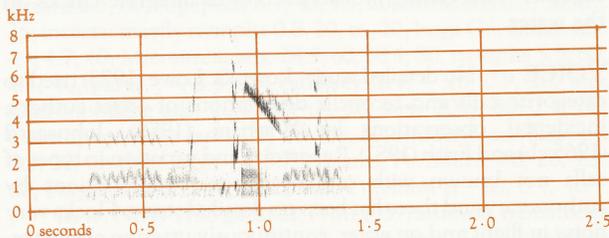
A P.J. Fullagar; Booligal, NSW, Oct. 1979; X076

given at varying intensities, some almost frenzied; probably a contact call and typically the dominant call of birds in flocks, specially in flight; rendered as *we-we-we-we-ooo* (sonagram A); often rise and fall in pitch. A soft purring call may be a subdued version of this vocalization used in short distance contact (see Social Behaviour). (2) Sharp ticking *tu-ick*, *puik* or *twick* call when heard at a distance but close up sounds more like *tick-uk* (sonagram B, with preceding twitter); often re-



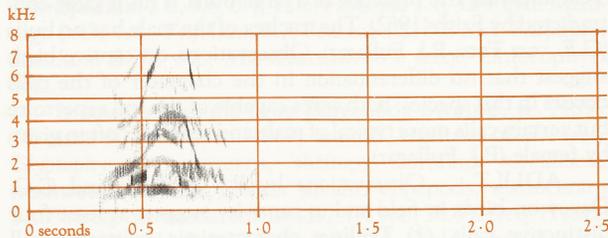
B P.J. Fullagar; Booligal, NSW, Oct. 1979; X076

peated several times in close succession; other versions seem to be *tew-ee* (Warham 1958) and sharp *k-teeoo* or *k-tuu* and *tea-you-da*; all given in circumstances that suggest they function as loud alarm or contact calls. Probable all given by both sexes. (3) Deep *gronk* or nasal *grunk* call given with head raised a little and bill open and dipped slightly (sonagram C); in fact



C P.J. Fullagar; L. Mouger, WA, May 1984; X076

call starts with a high-pitched syllable falling suddenly to guttural note. (4) **Uplift Call** (Bill-tossing Call of Johnsgard 1965a). Loud advertising call in the form of a drawn out trumpeting whistle *whee-ooo* and *weeee-you* or *who-ee-oo* (Johnsgard 1965a,b) with rising and falling inflexion (sonagram D); given

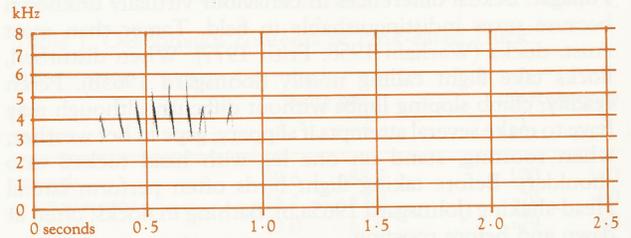


D P.J. Fullagar; L. Mouger, WA, May 1984; X076

slowly with neck stretched and bill open, head tilting up with each utterance (see Fig. in Social Behaviour); strong emphasis on first syllable; most characteristic of male of pair specially in defence of partner, nest-site and brood. Less emphatic but quicker versions probably given by both sexes without head movements, which sound more like *knee-you* or *kree-you* and of unknown function.

**YOUNG** Two calls: piping *shripp shripp*; apparently distress call; and softer, twittering *tititi*; apparently content-

ment note (sonagram E) (Warham 1958).



E P.J. Fullagar; Canberra, ACT, Nov. 1983; X119

**BREEDING** No major studies. Information compiled by J. Starks.

**SEASON** No precise breeding season. May breed at any time of year when conditions suitable. In se. Aust. usually breed Aug. to Feb., following winter rains (Crome 1986). In n. Aust. usually breed Mar. to May following summer rains. Eggs said to be laid when water receding, synchronizing hatching of young with increase in concentration of food in drying water bodies (Frith 1982; Jaensch *et al.* 1988; Aust. NRS), but more

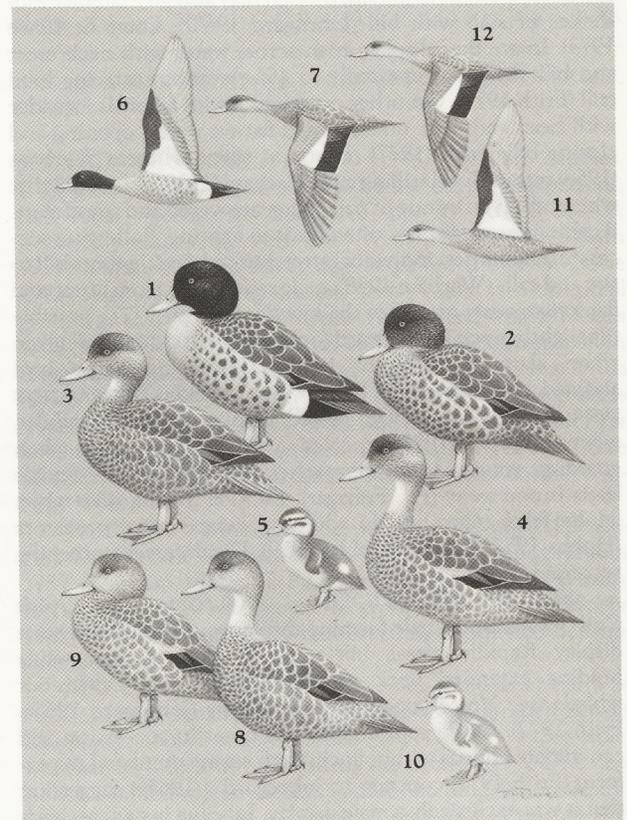


Plate 91

Chestnut Teal *Anas castanea*

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

Grey Teal *Anas gracilis*

8. Adult
9. Juvenile
10. Downy young
11. Adult
12. Adult

likely to be consequence of simple enrichment of food supply after flooding (Crome 1986); may also be taking advantage of nest-sites used by species that breed earlier (P.J. Fullagar).

**SITE** Usually over water in hollow or crotch of trees, top of posts, logs or stumps, nestboxes, cane grass *Glyceria ramigera* and bluebush swamps, or often disused nests of waterbirds. Sometimes build over eggs of other birds. At height of breeding, nests may be built on top of each other (Aust. NRS; Frith 1982; Hobbs 1956, 1975). Height of nests above water: 1.04 (0.98; 0-5; 49); depth of water: 0.84 (0.39; 0.20-1.62; 43) (Aust. NRS). Density of nests along creek in s. NSW, one nest per 14-18 m (Hobbs 1957).

**NEST, MATERIALS** Round or elliptical mound of down added to nest-site. In cane grass, saucer-shaped platform often used; of grass stems up to 30 cm long, bent to form circular nest. Stems also manipulated into position by bill. Nests almost always built by other birds; e.g. specially Eurasian Coot *Fulica atra* and Black-tailed Native-hen *Gallinula ventralis*. Down oily or sticky; medium grey-brown with light grey centres; adheres readily to any rough surface; has an unusually 'tacky' feel. Wisps of down often adhering to bark round holes, but at open sites down clings so well to itself that it

forms springy blanket completely enclosing eggs and even in strong winds shows no tendency to blow away (Warham 1958). In captivity birds have been seen with down remaining stuck to upper portion of bill and flaunted as if intentionally but purpose, if any, unknown (P.J. Fullagar). Warham (1958) weighed the down from two nests (17.9; 17.5 g). Nests may have dome over platform. Tree hollows sometimes lined with adventitious grass stems, leaves and down. Some nest-sites reused in successive years, not known if by same pair (Frith 1982; Hobbs 1975).

**MEASUREMENTS:** platform 220 mm wide x 15 thick (n=1) (Hobbs 1975). Down-nest 305 x 127 (Campbell), c. 250 mm (Frith 1982).

**EGGS** Oval, pointed; smooth, greasy; white to creamy white.

**MEASUREMENTS:** 49 (45-53; 144) x 36 (34-38) (Frith 1982); 47.7 (1.35; 46.2-48.8; 5) x 34.5 (0.86; 33.0-35.6) (Campbell); 49.8 (0.69; 51.3-49.0; 13) x 35.9 (1.06; 34.3-37.3) (North).

**CLUTCH-SIZE** 7.0 (1.59; 3-10; 30) (Aust. NRS); 7.3 (3-11; 120) (Frith 1982); not critically assessed for possible dump-laying.

**LAYING** Highly synchronized on separate wetlands; sometimes begins 8-26 days after peak flood. Dump-laying not recorded but several nests may be built on one site; 60 eggs recorded in hollow on one occasion (Frith 1959, 1982).

**INCUBATION** Only female incubates. Warham (1958) found sitting bird changed position at about half-hourly intervals and often stood up and turned eggs with bill. **INCUBATION PERIOD:** said to be 26 days (Frith 1982). Warham (1958) made following notes on hatching. Length of hatching observed for one clutch of six eggs. First egg chipping at 13:00 on 25 Nov. By 07:00 on 26 Nov., all eggs chipped, young heard tapping inside eggs. In morning of 27 Nov., four young newly hatched, two eggs chipping. One young leapt from nest into water when disturbed by observer. Chick replaced at 12:15. At 13:15, sitting bird left nest, dropped into water and was joined by mate. Both swam round nest, calling. Four chicks left nest and began feeding. Other two chicks dead in eggs. Adults do not eat yolk from eggshells after chicks hatch (Warham 1958). Eggshells left in nest after hatching (Aust. NRS).

**YOUNG** Precocial, nidifugous; downy. Upperparts, light brown, unmarked. Merges into grey on sides of throat. Throat and underparts, light grey to white, mottled light brown on flanks, darker towards breast. Sides of body, light brown; small light-grey patch to rear of leg and grey patch hidden by wing. Wing, light brown; tip and trailing-edge along ulna, grey. Underwing, pale grey with brown band down centre. Sides and top of head, brown, darker than body. Light grey supercilium, extending round sides of head and joining across hindneck. Small crescent-shaped white patch below eye. Feet and bill, dark leaden-grey, bill distinctly spatulate (Frith 1955, 1982). **Parental care:** eggs completely enveloped in down (Campbell). Both sexes care for young. Counts of broods suggest that interchange of young exists when nesting density high (Hobbs 1957; Warham 1958). **Anti-predator reactions:** incubating birds drop into water and indulge in injury-feigning display (Hobbs 1957; also see Social Behaviour).

**GROWTH** No data. **FLEDGING PERIOD** not determined.

**SUCCESS** From 122 nests, average 6.4 ducklings hatched, 4.7 survived to flying age (Frith 1982). From 87 eggs

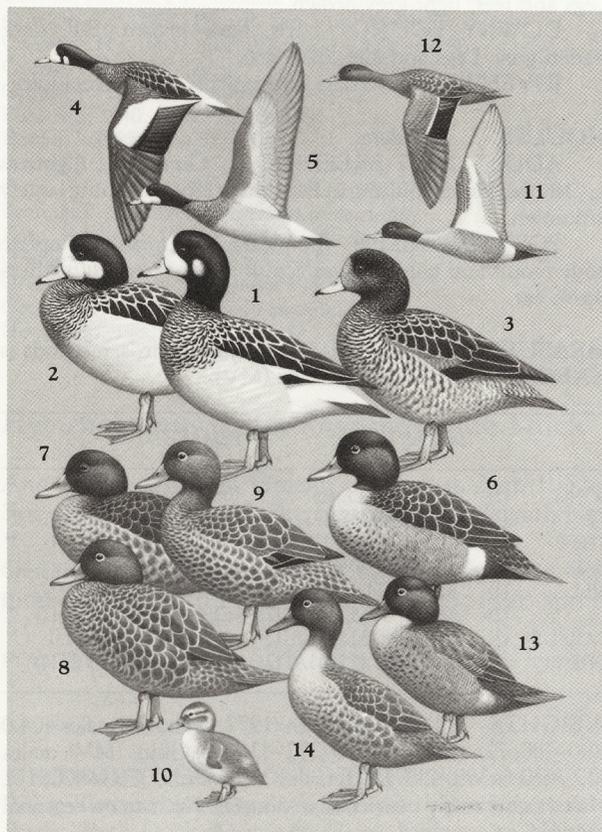


Plate 92

- Chiloie Wigeon *Anas sibilatrix*
- 1. Adult male
- 2. Adult female
- 3. Juvenile
- 4. Adult male, ventral
- 5. Adult female, dorsal
- Brown Teal *Anas chlorotis*
- 6. Adult male breeding
- 7. Adult male non-breeding

- 8. Adult female
- 9. Juvenile
- 10. Downy young
- 11. Adult male, ventral
- 12. Adult female, dorsal
- Auckland Teal *Anas aucklandica*
- 13. Adult male breeding
- 14. Adult female

laid and where outcome of nest confirmed, i.e. chicks seen out of nest or failure recorded, 46% or 40 chicks fledged (Aust. NRS). Stickiness of down suggested as deterrent against 'crows' (Campbell), but probably to prevent down blowing away (see above).

## PLUMAGES

**ADULT HEAD AND NECK.** Forehead and crown, olive-brown (29), feathers tipped dull white. Surrounding each eye, large black-brown (119) patch, joining at hindcrown and extending to hindneck. Within patch, very obvious, narrow circle of dull-white feathers round eye. Loes, chin and throat, white. Interramal space, bare. Small tuft of rose (9) feathers above ear. Rest of feathers on head, dull white vertically barred light grey-brown (119C); barring becomes progressively horizontal from lower throat towards base of neck; width of bars increases and correspondingly bars darken to dark brown (119A or 121). **UPPERPARTS.** Upper mantle-feathers, white, broadly barred dark brown (121), basally dark brown (119A); barring bold and continuous with outer breast-feathers. Barring towards lower mantle, progressively finer, faint, irregular, and eventually reduced to fine spotting at tips. Irregular bars on mantle pale pink-buff (121D), dull white, or buff (123D), alternating with narrow dark-brown (121) bars. Back, faintly barred and, together with scapulars, faintly vermiculated pink-buff (121D). Lower back, black-brown (119). Rump feathers, vary, may be blotched: basally brown (119B) or light grey-brown (119C) and broadly tipped white. Rump appears as broad white band c. 15 mm wide. Central upper tail-coverts, dark brown (119A) or black-brown (119); outermost, bi-coloured, basally white. **TAIL,** dark brown (121), innermost rectrices narrowly fringed white; fringe broadening to t6. **UPPERWING.** Tertiaries, dark brown (121) with slight sub-terminal vermiculation of pale pink-buff (121D) on outer web; rachis, brown (223A). Secondaries, dark brown (121) with white tips on outer webs; tips increasing in width towards s1. Primaries, dark brown (121); rachis, brown (223A) and cream (92) near tip. P1-p4 broadly tipped white, narrower on p4. Greater primary coverts and alula, dark brown (121). Greater, median and lesser coverts, dark brown (119A) and finely vermiculated pale pink-buff (121D). Marginal coverts similar, no vermiculation and fringed light grey-brown (119D). **UNDERPARTS.** Each feather on upper breast, alternately barred white and dark brown (121); basally white. From lower breast to vent, width of bars decreases; bars, often discontinuous with adjoining feathers giving mottled appearance. Width of bars increases down flanks; last bar, white and tip prone to wear. Thighs, narrowly barred dark brown (119A). Under tail-coverts, pale pink-buff (121D), buff (123D) to extreme, light brown (223D). Generally, females tend to have whiter underparts, from upper breast to abdomen and more irregular barring; in males (skins at MV), barring tends to be well aligned; difference may vary, requires further study. Axillaries, white. **UNDERWING.** Greater primary coverts, brown-grey (79), narrowly tipped white; two outermost with white subterminal bar; rachis, white at base, grey-brown towards tip. Greater coverts, alternately barred, dark brown (121) and white. Lesser, median and marginal coverts, dark brown (121) with white tips. Narrow glossy tegmen on inner webs of primaries.

**DOWNY YOUNG HEAD AND NECK.** Crown to base of hindneck, dark brown (119A). Rest of sides of head mostly white, with patch of dark brown (119A) down, extending from loes, through eye, to ear-coverts; patch varies

and extends slightly on to malar area, below eye. Within patch, beneath eye, small semi-circular patch of white down. Throat to base of foreneck, white to pale brown-grey (80). Down short on head and neck, longer and hair-like on upperparts. **UPPERPARTS,** brown (119B) with pale brown-grey (80) tips. Small oval-shaped pale grey (86) to pale brown-grey (80) patch on either side of rump and similarly larger patch at either side of back, where wing rests. **TAIL,** long, hair-like, dark brown (119A). **UPPERWING,** brown (119B) with broad pale grey (86) posterior margin. **UNDERPARTS,** white; upper breast duller and greyish. **UNDERWING,** pale grey (86). For more details see Frith (1955).

**Juvenile.** Differs from adult in: forehead, grey-brown; lacks rose (9) feathers above ear; alternating white and dark-brown (119A) barring narrower in all areas, noticeably on mantle, where bold bars absent; whiter underparts, with square-cut appearance, from upper breast to vent, including thighs; rectrices notched at tip.

**BARE PARTS** Based on Frith (1955) and photos in Pringle (1985).

**ADULT** Iris, dark brown (121). Bill, pale grey (87). Legs and feet, light grey-brown.

**DOWNY YOUNG** Iris, dark brown. Bill, dark leaden-grey. Legs and feet, dark grey.

**JUVENILE** No data, presumably similar to adult.

**MOULTS** Few data.

**ADULT POST-BREEDING** Complete; flightless in Oct., rectrices moulting in Feb.; duration and timing largely unknown.

**POST-JUVENILE** Few data, presumably complete body-moult and tail; involves acquisition of rose (9) feathers above ear.

**MEASUREMENTS** (1) Recently dead birds; methods as HANZAB (Frith 1977). (2) Skins (MV).

		MALES	FEMALES
WING	(1)	197.0 (172-213; 46)	188.0 (152-200; 67)
	(2)	190.0 (2.19; 187-193; 10)	181.6 (5.40; 174-191; 14)
8TH P	(1)	120.7 (3.82; 115-127; 10)	116.0 (7.22; 101-127; 14)
	(2)	60.8 (0.83; 60-62; 7)	61.4 (2.57; 57-64; 5)
TAIL	(1)	67.0 (44-74; 82)	61.0 (53-67; 83)
	(2)	68.2 (1.97; 65.3-70.9; 12)	63.4 (1.72; 60.1-66.3; 12)
BILL	(1)	34.4 (1.12; 32.9-37.1; 12)	33.0 (1.02; 31.6-35; 14)
	(2)	49.2 (1.69; 47.2-53.9; 12)	45.3 (1.73; 42.4-49.2; 14)
TARSUS	(2)		
TOE	(2)		

**WEIGHTS** Data from Frith (1977; as above): males 404.0 (290-480; 77); females 344.0 (272-423; 81). Skins (MV): males 429.7 (30.6; 385-480; 11); females 359.6 (26.1; 328.9-402; 12). Males significantly heavier than females. No data on seasonal changes.

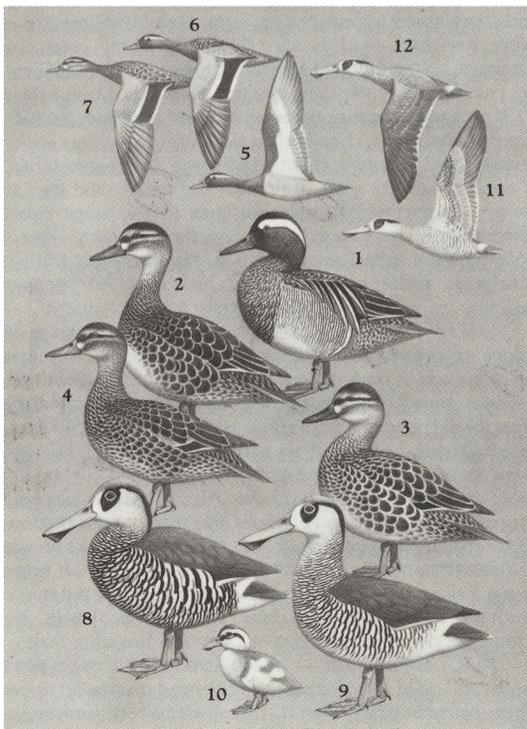
**STRUCTURE** Wing, short and broad. Eleven primaries: p9 usually longest, p10 0-2mm shorter, p8 2-6, p7 9-16, p6 19-27, p5 31-38, p4 45-49, p3 56-60, p2 65-70, p1 72-79, p11 minute. Inner web of p10 and outer web of p9, strongly emarginated; inner web of p9 and outer and inner webs of p8 slight. Tail, short, square, webs rounded; 12 rectrices, t1 longest, t6 7-10 mm shorter. Bill, long, high and narrow at base, widening towards tip and somewhat spatulate. Membranous skin extends along length and droops over edge

of upper mandible; longest near tip, moderately long near base; protects long stiff lamellae along length of outer edge of upper mandible. Nostrils, near base of bill, ovoid. In juvenile, prominent ridge on mid-line of upper mandible; little concavity as in profile of adult bill. Legs, short and feet webbed. Outer toe, c. 99% of middle, inner c. 74%, hind c. 26%.

**SEXING** Adults sexed on cloaca (see Hochbaum 1942), with difficulty (P.J. Fullagar). RMO

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**Volume 1 (Part B), Plate 90**

Garganey *Anas querquedula*

1. Adult male breeding
2. Adult male non-breeding
3. Adult female
4. Juvenile
5. Adult male breeding
6. Adult male breeding
7. Adult female

Pink-eared Duck *Malacorhynchus membranaceus*

8. Adult
9. Juvenile
10. Downy young
11. Adult
12. Adult

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