

Order ANSERIFORMES

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

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

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

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

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

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

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Family ANATIDAE wildfowl

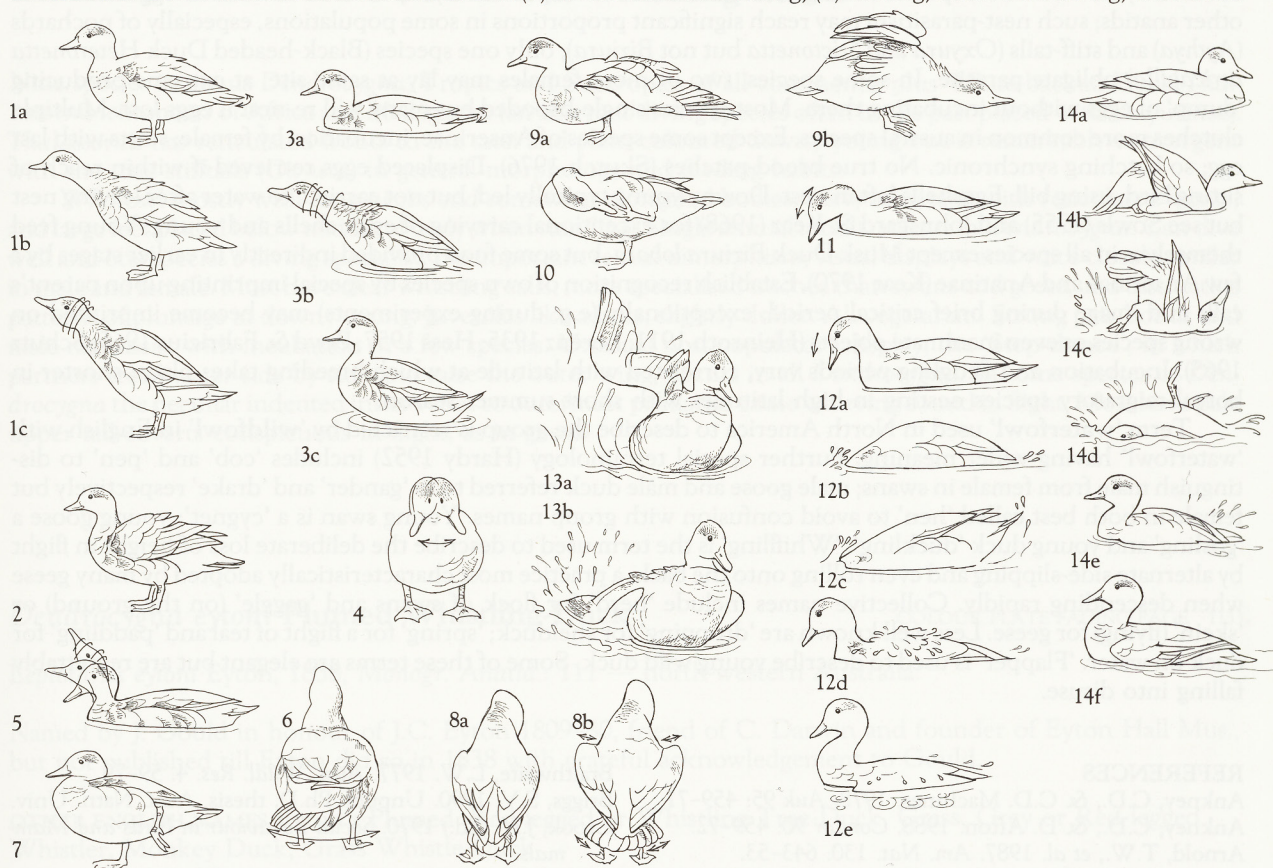
Waterbirds (some more or less terrestrial) with rather short legs and front toes connected by webs; hallux elevated and reduced. Though considerable adaptive diversity in outward appearance, size, colours of plumage, behaviour, and ecology, homogeneous in many characters, as attested by numerous, often fertile, interspecific hybrids reported, chiefly in captivity (see Gray 1958). About 160 species in six sub-families: (1) Dendrocygninae (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 (tertials) often long and brightly coloured; diastatic. Many species, particularly in Tadorninae, Anatinae and Merginae have a specialized, contrastingly coloured patch (speculum) on upper surface of inner wing, important for sexual and social signalling. Most fly fast and have large, high-keeled sternum. Tail, short and square or slightly rounded in most; long in some diving species (serving as rudder), pointed or with elongated central feathers in some others. Tail-feathers, 14–24 but varying even in single species. Bills show much adaptive variation but typically of medium length, broad, often flattened centrally and distally but high at base, and rounded at tip with horny nail at tip, producing slight terminal hook; covered with soft skin. Edges of mandibles with rows of lamellae, showing different development in various ecological types and taxonomic groups; most highly specialized in surface plankton-feeders, least so in species (such as scoters *Melanitta*) that swallow molluscs whole. Tongue, thick and fleshy; epithelium covered with papillae and horny spines. Lower part of tibia and tarsus bare; front toes connected by webs (reduced in a few species), hind toe elevated. Gait, striding or waddling. Oil gland, feathered. Aftershaft, reduced or absent. Special intromittent copulatory organ present in males; vascularized sac everted from wall of cloaca, protruded by muscular action; facilitates sexing by examination (Hochbaum 1942), even of small young. Salt-secreting nasal glands subject to adaptive variation in size, even in same species; enlarged in forms inhabiting saltwater or brackish habitats, modifying profile of head considerably. In many species, males have remarkably lengthened, bent, or locally widened trachea forming resonating tubes; also syngo-bronchial sound-boxes (bullae), either fully ossified or with membranous fenestrae. These vocal structures highly characteristic of species or larger taxonomic units (see Eyton 1838 and, especially, Johnsgard 1961, 1971). Considerable diversity in types of plumage: male and female similar, nearly similar, or show extreme sexual dimorphism. In all species, except some sheldgeese, flight-feathers moulted simultaneously, producing period of flightlessness lasting 3–4 weeks. Two body-moult per cycle. Young precocial and nidifugous, covered with thick down; pattern often cryptic and characteristic of taxonomic groups within sub-families. Able to swim soon after hatching.

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

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

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



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

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

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

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

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Sub-family ANATINAE ducks

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

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

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

Perching ducks and aberrant species

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

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

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

Cosmopolitan but most species tropical or subtropical. Most species surface-feeders, some very specialized, though others (notably *Plectropterus* and *Chenonetta*) terrestrial grazers. Often in flocks. **Pre-flight** signals diverse; include **Neck-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.

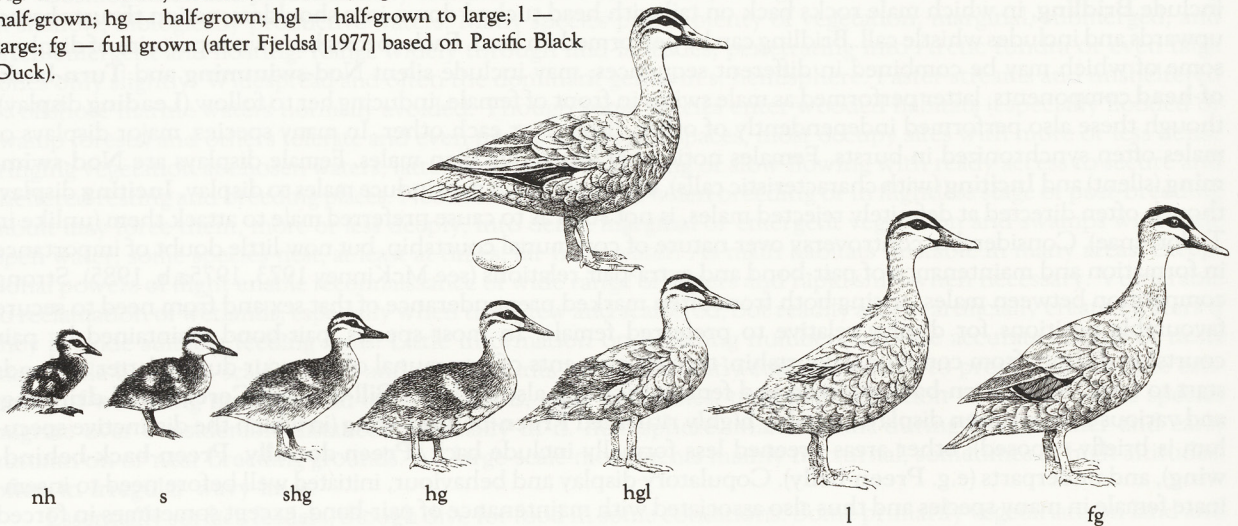
Essentially surface feeders, though dive for food in some conditions. Some primarily vegetarian, on land and

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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Mareca castanea Eyton, 1838, *Monogr. Anatid.*: 119, Pl. 19 — New South Wales.

The Latin *castanea*, chestnut-tree, is for the plumage of the male.

OTHER ENGLISH NAMES Black, Brown, Chestnut-breasted, Green-headed, Mountain or Red Teal.

MONOTYPIC

FIELD IDENTIFICATION Length: male 40–50 cm; female 35–45 cm; weight: male 700 g, female 600 g. Small compact dabbling duck with high forehead and deep rounded head; identical structure and overlapping in size with Grey Teal *Anas gracilis* with which often seen; noticeably smaller than Pacific Black Duck *Anas superciliosa*. Marked sexual differences: males have glossy bottle-green head and rich-chestnut underparts and flanks, and dark upperparts; females show pale throat streaked brown and scalloped dark-brown plumage ventrally; female very similar to Grey Teal in appearance. Eclipse plumage in male. Juvenile and eclipse male like female.

DESCRIPTION **ADULT MALE BREEDING.** Head and upper neck, iridescent bottle-green, appearing bronzed or black in some lights; lower neck, rich chestnut. Back, dark brown; feather margins, chestnut. Rump and uppertail, black. Upperwing, dark brown; speculum, dark glossy green-purple, edged with white, broadly in front (in flight, appears as small white patch). Breast and abdomen, rich chestnut, each feather with obvious dark-brown blotch. Undertail, glossy black; conspicuous white patch on vent contrasts with dark tail and upperparts. Underwing, dark brown; tips of secondaries, white (in flight, gives appearance of white wing-pit). Iris, claret. Bill, blue-grey. Legs and feet, green-grey. **ADULT MALE ECLIPSE.** Head, dull green; breast, dull chestnut; shadowy suggestion of pale vent. Has patchy appearance but can appear very similar to appearance of female, though not so dull. Bill, horn-grey. **ADULT FEMALE.** Crown, dark brown flecked buff; cheeks, chin, throat and foreneck, fawn lightly streaked with black; stripe through eye, dark brown to black; hindneck and back, dark brown with light-brown margins to feathers. Rump and tail, dark brown. Upperwing, dark brown; speculum as male. Breast and abdomen, pale brown, feathers centrally blotched dark brown. Underwing as male. Bare parts, as

male. **JUVENILE.** Like female but paler; breast and belly feathers, suffused with yellow and streaked, not blotched, black to dark brown. **DOWNY YOUNG.** Upperparts, grey-brown with white spots on wing and head. Underparts, paler with pale yellow wash; two conspicuous brown stripes on head, one through eye, one below it.

SIMILAR SPECIES Chestnut Teal male is distinctive and should not be confused with other Aust. ducks; plumage superficially similar to male **Australasian Shoveler** *A. rhynchotis*, which has blue-grey head but shows white crescent down front of face, conspicuous yellow iris and dark-brown breast and distinctive large spatulate bill; in flight, upper wing-coverts of Shoveler, blue-grey with broad white band across leading-edge of wing; **Mallard** *A. platyrhynchos* male shares dark glossy-green head with male Chestnut Teal but shows white ring round neck, pale-grey underparts and yellow bill. Greatest risk of confusion is between female, eclipse male and juvenile Chestnut Teal, and **Grey Teal**, whose ranges overlap widely in e., se. and sw. Aust.; identical in structure, no difference in shape of head as sometimes stated (P.J. Fullagar) and indistinguishable in flight unless exceptional views of head and throat-pattern obtained; underwing patterns identical; Grey does not have more white, as sometimes stated (P.J. Fullagar). In good views, Chestnut Teal in these plumages distinguishable by darker buff appearance of chin and throat (paler or even white in Grey Teal); dark colour of crown extending lower on cheek (below eye) than Grey Teal; slightly larger though size overlaps and, even in direct comparison, doubtfully distinctive. Female appears generally warmer toned and darker with more streaking across sides of face. Eclipse male usually shows some residual alternate feathering: dark crown with signs of green, occasional chestnut feathering on body and suggestion of pale thigh-patch at base of tail. Female **Garganey** *A. querquedula*

(rare visitor to our region) could also be confused with female, eclipse male and juvenile Chestnut Teal but Garganey distinguished by boldly marked face (very similar to facial-pattern of Pacific Black Duck): dark crown, buff-white supercilium, dark eye-stripe and pale stripe from base of bill below eye-stripe towards hindcrown; also white or pale abdomen; in flight, shows striking blue-grey inner forewing. Other risks of confusion: **Pacific Black Duck**, which shows distinctive boldly-striped facial-pattern and is much larger; female **Australasian Shoveler**, which has large spatulate bill and blue shoulder-patch in flight.

Seen in pairs, small groups or large flocks, often with Grey Teal, in shallow areas of permanent open freshwater wetlands, and semi-permanent or permanent saline and estuarine wetlands; on tidal mudflats and islands; also deeper water, in high altitude lakes and creeks. Often seen by day swimming or loafing on mudbanks, logs, dead trees, rocks or short grassland partially or completely surrounded by water. Roost and nest above waterline, often in places partly or entirely surrounded by water. Feed by dabbling and probing at water's edge, upending in shallows, pecking at surface matter or stripping seeds from plants. Call of male excited clear *g'dee*; female rapid penetrating chuckle of about eight syllables.

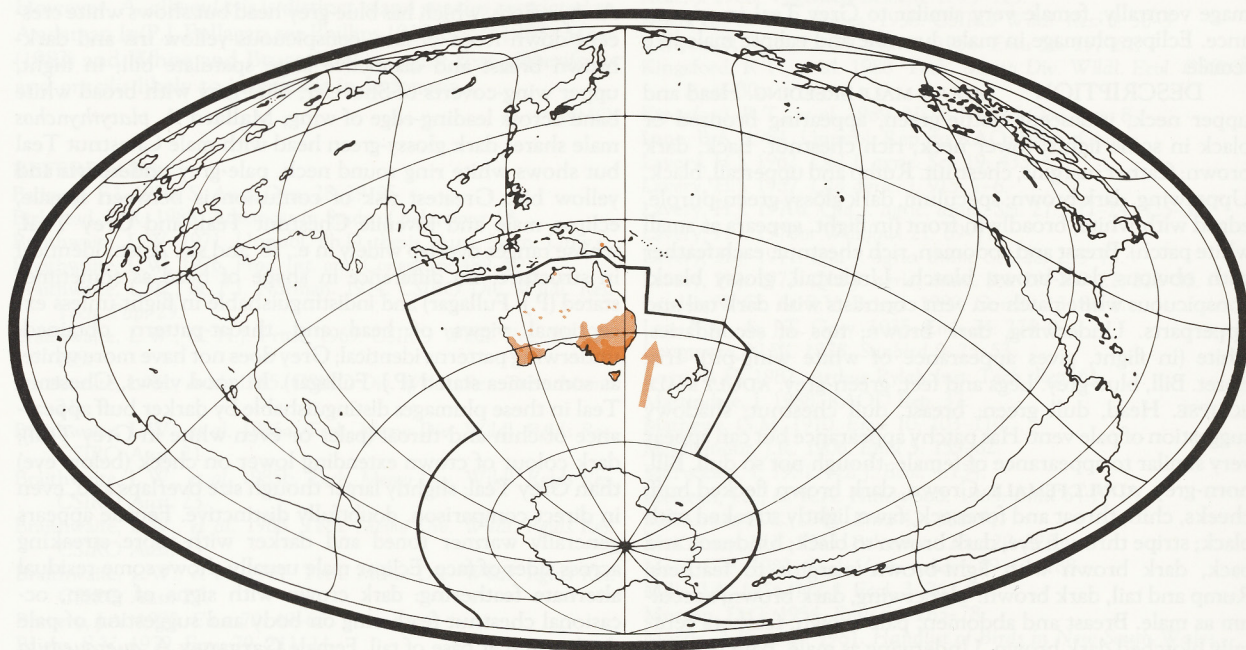
HABITAT Inhabit terrestrial wetlands and estuarine habitats, mainly in coastal regions of se. and sw. Aust. (Aust. Atlas). In breeding season, dispersed on small and large wetlands; in non-breeding period, gather on large bodies of water (Aust. Atlas). One of few species of duck that tolerates high-salinity waters (Delroy 1974; Loyn 1978; Crawford 1975), though need of freshwater for drinking has been suggested (Norman 1983). Regular on saline habitats: estuaries, inlets, mangrove swamps, saltpans, salt lakes, coastal lagoons, saltfields, saltmarsh, and lower reaches of rivers, often using large coastal wetlands as refuges in summer or during drought (Delroy 1974; Corrick & Norman 1980; Gosper 1981; Norman 1983; Hewish 1988; Jaensch & Vervest 1988a,b). Permanent open fresh-waters (lakes, reservoirs, sewage ponds) also sup-

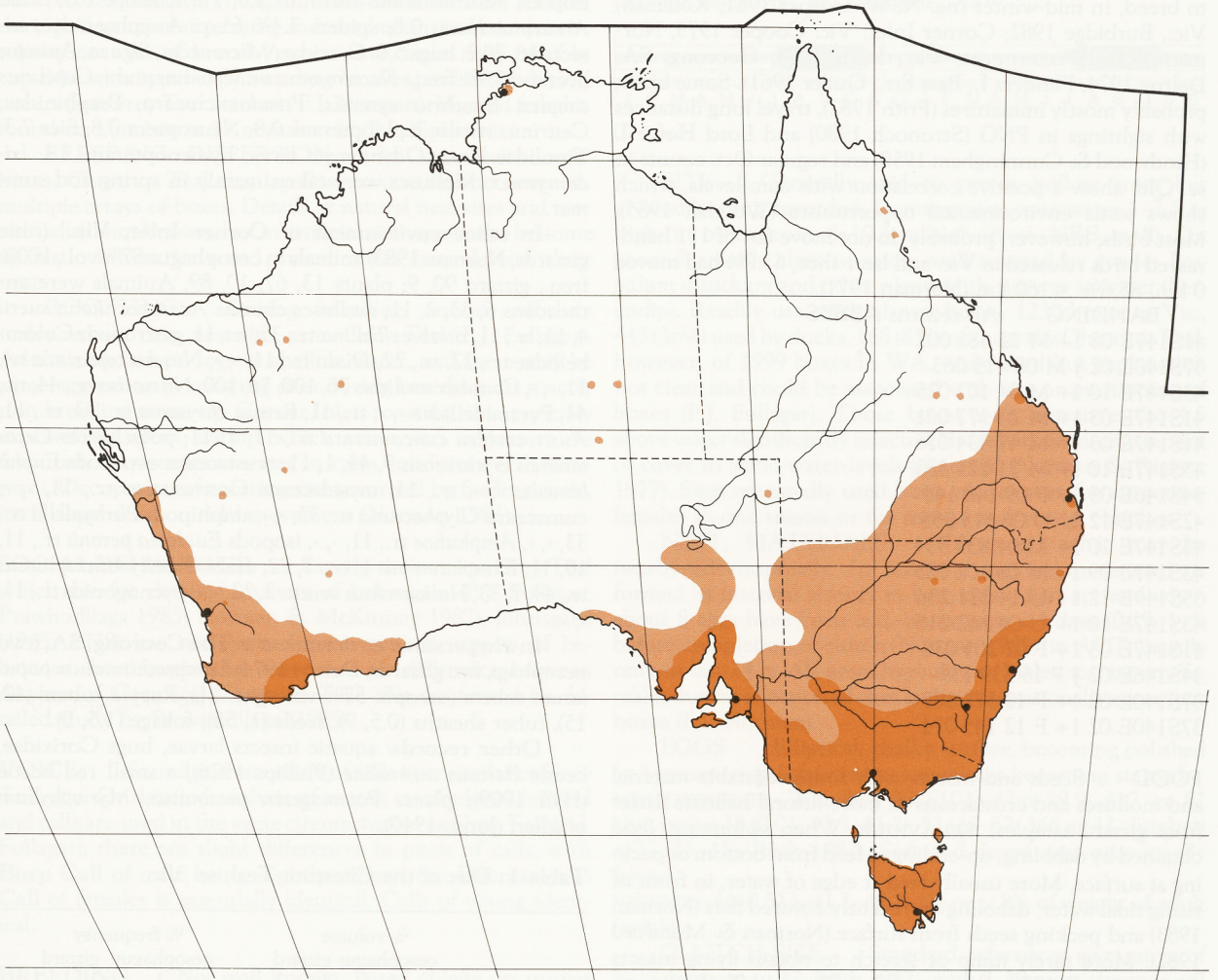
port many birds in dry season (Hewish 1988; Norman & Brown 1988). Other records in many habitats, with or without emergent vegetation: fresh meadows; shallow or deep swamps; rivers, river pools and billabongs; farm dams; and occasionally ricefields (Frith 1957; Vestjens 1977; Corrick & Norman 1980; Gosper 1981; Jaensch & Vervest 1988a,b). Aquatic; feed particularly along edges of wetlands or over sand or mudflats, in shallows with aquatic or emergent plant growth; in freshwater wetland at Serendip, Vic., among flooded grass and rush (*Cynodon*, *Eleocharis*) (Norman *et al.* 1979; Norman & Mumford 1982; Norman 1983).

Breed (mostly in tree hollows) mainly in coastal regions (Norman & Brown 1988), on islands or shores in swamps, lakes, billabongs, coastal lagoons and mangroves (Hobbs 1956; Corrick & Norman 1980; Gosper 1981; Burbidge 1982); ground nesting well established in some areas; frequently use nest-boxes in Vic. (F.I. Norman); low numbers nest in lignum swamps in inland NSW in flood years (Frith 1982).

Reach considerable heights in flight. Food taken from water surface or just below. For roosting, select isolated sites beside water; on freshwater wetland at Serendip, Vic., preference for dead trees or logs in water, and short grassland on islands and banks (Norman *et al.* 1979); at Corner Inlet, Vic., open areas facing mudflats and backed by mangroves (Norman 1983).

Widespread destruction and modification of wetlands by drainage, increased salinity, grazing, clearing and burning has reduced freshwater habitat (Riggert 1966; Goodrick 1970; Corrick & Norman 1980; Corrick 1981, 1982); *Melaleuca* swamps, suggested as former stronghold in s. Vic. and SA, severely affected (Frith 1982). Permanent saline waterbodies used as dry-season refuges less affected, but estuaries and inlets face increasing urban, recreational and industrial development. Readily use artificial nest boxes, selecting those in cover, >1 m above ground or water, and located in permanent wetlands (Norman & Riggert 1977). Hunted widely, but often able to take refuge as favoured coastal habitats frequently sanctuaries, or beside large bays (Norman &





Brown 1988; Loyn 1989).

DISTRIBUTION AND POPULATION Endemic to Aust., mostly SE and SW; vagrant to s. New Guinea (Stronoch 1980) and Lord Howe I.

AUST. **Qld.** Widely but not commonly spread E and S of line from Rockhampton to Barcaldine and then to Cunnamulla and Tibooburra in NSW. Widespread and locally common in **NSW, Vic., Tas.**, which are the stronghold of the species. In **SA**, widespread SE of line from L. Blanche and s. L. Eyre area to Ceduna (Fowler Bay). **WA.** Common S of line from Israelite Bay to Perth (Aust. Atlas). Generally commonest in coastal and sub-coastal areas from Brisbane to Port Lincoln; in se. Aust., 74% records within 100 km of coast and relatively more numerous on coast in Vic. and Tas. than in SA or NSW (Aust. Atlas; Norman & Brown 1988); breeding not recorded (Aust. Atlas) W of longitude 150°E and N of Murray R., except in area of Macquarie Marshes and Narrabri, NSW. Elsewhere, scattered or vagrant records near Cairns, Qld. (Aust. Atlas); w. interior WA (Serventy & Whittell 1976); Darwin and Alice Springs, NT (Aust. Atlas).

LORD HOWE I. Vagrant; several birds and attempted breeding 1943-44, two present several months 1949 (Hindwood & Cunningham 1950).

POPULATION Surveys of mainland Aust., mainly

in Jan. and Feb. 1983, counted over 21 000, mostly Vic. (16 677) though coverage between States varied; coverage in Vic. was considered to have included most larger concentrations of Teal (Norman & Brown 1988). Counts in Vic. summer surveys, 1987-89, were respectively: 19 143 on 332 wetlands; 18 331 on 472 wetlands; 31 446 on 626 wetlands; making up 6-10% of all ducks counted (Martindale 1988; Hewish 1988; Peter 1989). Counts in sw. Aust., 1986-88, were respectively: 465 on 872 wetlands; 1140 on 1201 wetlands; 1043 on 1398 wetlands (Jaensch & Vervest 1988a,b).

S. distribution exposes species to main concentration of shooters. Pre-season counts in Vic. indicate exposure to shooting high: 58-74% of total on waters open to shooting (Martindale 1988; Hewish 1988; Peter 1989) but exposure decreases between pre-season counts and opening day as birds move to marine habitats (Loyn 1989). Shot much but usually form low proportion of total harvest in se. Aust. (Norman *et al.* 1984; Briggs *et al.* 1985; Loyn 1987). Low proportion of Chestnut Teal on sample of waters in Vic. taken in 1987 open-season.

MOVEMENTS Presumably migratory between breeding areas and non-breeding refuges but no detailed studies. Flocks of $\leq 2,000$ birds gather on coastal wetlands or other large water-bodies in early summer and disperse, presumably

to breed, in mid-winter (ne. NSW, Gosper 1981; Rotamah, Vic., Burbidge 1982; Corner Inlet, Vic. Cooper 1975, Norman 1983; Westernport, Vic., Loyn 1978; Coorong, SA, Delroy 1974; Flinders I., Bass Str., Guiler 1961). Some birds, probably mostly immatures (Frith 1982), travel long distances with sightings in PNG (Stronoch 1980) and Lord Howe I. (Hindwood & Cunningham 1950) and regular Oct. counts in se. Qld. show a positive correlation with dam-levels, which shows some environmental opportunism (Woodall 1985). Most birds, however, probably do not move far: of 111 hand-reared birds released in Vic. and later shot, 63.9% had moved 0 km, 85.6% \leq 160 km (Norman 1971).

BANDING All returns ABBBS

41S147E 03 1+ M 22 381 002
 37S140E 02 J M 08 415 063
 43S147E 10 1+ M 04 102 025
 41S147E 03 1+ M 23 377 001
 41S147E 03 1+ M 47 434 016
 43S147E 10 1+ M 31 221 333
 34S146E 05 1+ F 09 148 143
 42S147E 12 U U 06 115 355
 43S147E 10 1+ M 04 839 334
 43S147E 09 1+ M 08 102 025
 35S149E 12 1+ U 14 221 236
 43S147E 10 1+ U 04 162 018
 41S147E 03 1+ F 01 205 030
 34S146E 02 J F 15 239 159
 37S140E 02 1+ F 12 572 107
 37S140E 02 1+ F 12 145 074

FOOD Seeds and insects with some vegetable material and molluscs and crustaceans in more littoral habitats (latter from gizzard samples). **BEHAVIOUR.** When swimming, food obtained by dabbling, up-ending to feed from bottom or pecking at surface. More usually feed at edge of water, in front of rising tidal water, dabbling on recently covered flats (Norman 1983) and pecking seeds from surface (Norman & Mumford 1982). More rarely jump or stretch to obtain flying insects (Norman *et al.* 1979). Suggested that Chestnut Teal relies on fresh water, even in saline habitats where feeding bouts interspersed with drinking from freshwater soaks (Norman 1983), ability to excrete excess salt said to be poorly developed (Baudinette *et al.* 1982). Most feeding about dusk or dawn and probably at night; only 18.3% of observed activities between 06:00 and 22:00 were feeding (4643 activities; Norman *et al.* 1979).

ADULT At Gippsland Ls, Vic. (124 gizzards; Norman & Mumford 1982) plants 74% vol., 99.2% freq., animals 26, 77.4.; plants incl. *Claytonia australasica* 4, 10.5, *Elatine gratioloides* 2, 9.7, *Ruppia* 5% vol., seeds 46.0% freq., tubers 8.1, *Lemna minor* 2, 18.5, Cyperaceae 22, 79.0 (*Carex* 3.2% freq., *Cladium procerum* 47.6, *Eleocharis sphacelata* 25.0, other 62.1 incl. *Bulboschoenus caldwellii*, *B. medianus*, *Isolepis fluitans*, *I. inundata*, *Schoenoplectus validus*, *Scirpus americanus*), *Chlorophyta* 2% vol., other spp 2 (incl. *Ranunculus* 4.8% freq., *Betula pendula* 1, Chenopodiaceae 10.4, *Montia fontana* 1, *Polygonum hydropiper* 9.7, *Trifolium* 1, *Vicia* 3.2, ?*Medicago*, *Myriophyllum* 13, *Hydrocotyle* 2.4, *Vallisneria spiralis* 1.6, *Triglochin procera* 0.8, *Potamogeton* 2.4, *Lepilaena bilocularis* 1, *Phragmites australis* 2.4, *Isachne globosa* 0.8, *Typha* 4.8, unidentified. 36); the animals were molluscs 9, 16.1: bivalves *Fluviolanatus amarus* 3.2% freq., gastropods *Aschoris victorae* 16.1, *Tatea rufilabris* 4.0, *Coxiella striata* 0.8; crustaceans 1, 5.6: copepods 0.8% freq., cladocerans *Daphnia* 1.6,

isopods *Austrochiltonia australis* 1.6, *Paracalliope* 0.8, crabs *Amarinus laevis* 0.8; spiders 2.4% freq.: Anyphaenidae; insects 16, 70.2: bugs 5.6: Gerridae, *Micronecta*, *Sigara*, *Anisops*; beetles 33.9% freq.: *Necterosoma undecimlineatum*, *Copelatus simplex*, *Enochrus eyrensis*, *Pseudomicrocara*, Psephenidae, *Cestrinus trivilis*; lepidopterans 0.8, Neuroptera 0.8; flies 7.3: Tipulidae larva, *Odontomyia* larva; hymenopterans 2.4: *Iridomyrmex*. Molluscs were taken mainly in spring and summer.

In saline environment of **Corner Inlet, Vic.**, (nine gizzards; Norman 1983) animals in oesophagus 87% vol., 100% freq., gizzard 90, 9; plants 13, 67, 10, 89. Animals were arthropods 6, 33, 2, 11; molluscs chitons *Acanthochitona suerii* 4, 11, tr., 11, bivalves *Tellina* tr., 33, tr., 11, gastropods *Columbellidae* tr., 22, tr., 22, *Diala* tr., 11, -, -, *Nozeba topaziaca* tr., 11, -, -, *Conuber sordidus* 76, 100, 76, 100, *Nassarius* tr., 44, tr., 44, Pyramidellidae -, -, tr., 11, *Retusa chrysoma* tr., 33, tr., 11, *Austrocochlea concamerata* tr., 11, 1, 11; polychaetes *Ceratonereis erythreensis* 9, 44, 1, 11; crustaceans ostracods *Euphilomedes* -, -, tr., 11, mysidaceans *Gastrosaccus* tr., 11, -, -, cumaceans *Glyphocuma* tr., 33, -, -, amphipods *Parhyalella* tr., 33, -, -, *Amphithoe* tr., 11, -, -, isopods *Euidotea peronii* tr., 11, 10, 11, *Exosphaeroma* 1, tr., 1, 22, crabs *Brachynotus spinosus* tr., 44, 7, 33, *Halicarcinus ovatus* 2, 22, -, -; pycnogonids tr., 11, -, -.

In a hypersaline environment at **The Coorong, SA**, (two oesophagi, five gizzards; Delroy 1974) *Lamprothamnium papulosum* tubers (oesoph. 57% vol., gizz. 21), *Ruppia* tubers (40, 15), tuber sheaths (0.5, 9), seeds (1, 58), foliage (1.5, 0).

Other records: aquatic insects larvae, bugs *Corixidae*, beetle *Berosus australiae* (Phillips 1926), a small red beetle (Hall 1909); plants *Potamogeton pectinatus*, *Myriophyllum muelleri* (Jones 1940).

Table 1. Diet of the Chestnut Teal, se. Vic.

	% volume			% frequency		
	oesophagus	gizzard		oesophagus	gizzard	
	1	1	2	1	1	2
PLANTS	13	10	74	67	89	99
ANIMALS	87	90	26	100	9	77
Molluscs	80	77	9			16
Crustaceans	3	18	1			6
Insects			16			70
Other	6	2				

(1) Corner Inlet (Norman 1983); (2) Gippsland Ls (Norman & Mumford 1982).

SOCIAL ORGANIZATION Similar to Grey Teal (P.J. Fullagar). In pairs and in small or large flocks. In breeding areas, behaviour typical of genus observed with pairs inspecting nest-sites, pre-copulatory displays, defence of site and care of brood. Communally displaying parties of males frequent where larger numbers occur. In non-breeding habitats, pairs may persist but are aggressive and displays associated with reproduction rare (Norman 1983). In such areas, birds concentrate at roost sites where individual spacing is close (e.g. mean spacing in saline area, 0.30 body lengths [0.1; 106]) and form loose congregations while feeding (distance apart on water, 4.8 body lengths [3.8; 40]; for birds on land, 2.7 body lengths [1.9; 42]).

BONDS Monogamous (F.I. Norman); maintained

between seasons (P.J. Fullagar). Males associate with females during selection of site, laying and incubation, and take part in subsequent care of brood. At nest-sites, males may forcibly copulate with apparently breeding females, and dump-laying occurs (see Grey Teal account, F.I. Norman). Marked females found on clutches at 12 months old (F.I. Norman).

BREEDING DISPERSION In areas with nest boxes, Chestnut Teal may lay close to one another, even in multiple arrays of boxes. Details of natural nest-sites and territorialism not known, but in artificial sites appears to be some agonistic interactions and mated males may defend their nest.

ROOSTING During breeding season, off-duty males remain near nest-site, as in Grey Teal (P.J. Fullagar). Adults associate on logs in shallow water, and there may be some aggression at roosting sites during breeding. In strictly non-breeding areas, e.g. Corner Inlet, roosting sites, typically exposed flat areas, within which some sites appear to be favoured; may roost on water in calm conditions (F.I. Norman). Occupation of roosting site governed by feeding cycle, itself dependent on tidal movement (Norman 1983).

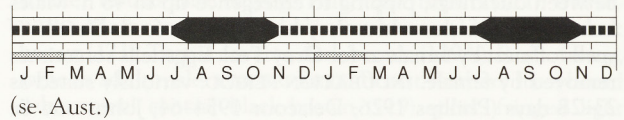
SOCIAL BEHAVIOUR Exactly the same as Grey Teal which see for detailed analysis of behaviour (P.J. Fullagar; Prawiradilaga 1985; Norman & McKinney 1987). Johnsgard (1965, 1978) has summarized some general aspects of behaviour; he thought that there was no difference between displays of Grey and Chestnut Teal; this confirmed by detailed study by Prawiradilaga (1985).

VOICE Sound and structure of calls very similar to Grey Teal (*q.v.* for detailed analysis of voice); vocabulary identical and calls are used in the same circumstances as Grey Teal (P.J. Fullagar); there are slight differences in pitch of calls, with **Burp Call** of male being slightly deeper; the **Decrescendo Call** of females is essentially identical. Calls of young identical.

BREEDING Not well known. Based chiefly on studies of captive or semi-captive birds at Serendip, Vic., by Norman and colleagues (1971, 1979, 1982) with information from Gippsland Ls (Norman & Hurley 1984), ACT (P.J. Fullagar; C.C. Davey) and Aust. NRS. Information supplied by F.I. Norman. Breed as simple pairs, often in concentrations with much dump-laying but not exactly colonial.

SEASON Extended and not easily defined. Early general statements (Aug.-Dec., North 1889; June-Dec., Campbell) too inexact to be useful, partly because this species may have been confused with Grey Teal. More recent statements have been: Tas., Sept.-Dec. (Lord & Scott 1924); King I., start in June to young in Mar. (McGarvie & Templeton 1974); NSW generally, Aug.-Apr. (Morris *et al.* 1981); ne. NSW, Sept.-Mar. (Gosper 1981); regular breeding season July-Nov. (Braithwaite 1976); L. Bathurst, NSW, laying ($n=27$) Sept.-Dec.; The Coorong, SA, laying from mid-Aug. or earlier to Dec. (Frith 1982). Claimed to breed at any time in suitable conditions (Jones 1942). From captive birds, Murton & Kear (1974) deduced that breeding centred round summer solstice. Best evidence from nest boxes at Serendip, with fluctuating and static water-levels respectively (1962-77): laying recorded in every month but least in Mar.-June, probably not affected by fluctuating water. Aust. NRS records (eggs $n=40$, young $n=35$): eggs from July (Vic.) to Mar. (NSW), mostly Aug.-Oct., generally later in NSW than in Vic.; broods Aug.-

Jan. and once Mar. at Gladstone, NSW.



SITE Generally said to prefer hollow trees but ground nesting recorded. In mangroves over water 1-2.5 m high; in other trees, 6-10.5 m high (Aust. NRS, $n=8$). On ground, usually close to water, well covered by grasses *Paspalum distichum* and other plants with runway to water (Serendip). Readily use artificial nest boxes: 1230 boxes in Vic., 443 (36%) used by ducks, 368 (83% of usage) by Chestnut Teal; however, of 1999 boxes in WA, none used but explanation not clear and could be associated with size or positioning of boxes (P.J. Fullagar). Those boxes with entrances 0.6-1.5 above water significantly selected; those with medium amount of cover in static water-levels preferred (Norman & Riggert 1977). Sites repeatedly used from year to year, by successive females in one season or for second and repeat clutches.

NEST, MATERIALS Nil except what may be nearby adventitiously. In boxes, a depression scraped or formed in material already in box; down first appears when about 8 eggs have been laid, on average 2.4 days (0.29; 1-5) before completion of clutch (Norman 1982); in ACT, usually only in last 24 h. All nests have down. Males accompany females during selection of sites and may occasionally enter nest boxes (F.I. Norman).

EGGS Elliptical; chalky surface, becoming polished and greasy; rich light-cream, sometimes becoming stained. **MEASUREMENTS:** Werribee 53 (0.01; 47.6-59.9; 417 ex 82 clutches) x 38 (0.01; 43.3-41.2); 52 (35-57; 366 ex 42 clutches) x 37 (35-41) (Frith 1982). Soft and dwarf eggs occasionally found.

WEIGHTS: 44 (0.513; 41.2-49.2; 18) or c. 8% of weight of adult female.

CLUTCH-SIZE Standard references give range of 5-17 (even up to 27, Frith 1982), with 7-10 most common; all best disregarded because dump-laying not taken into account. At Serendip in 1971, average of 188 clutches: 6.35 (0.38; 2-19); only 55 considered complete (incubated to hatching) averaged 10.1 (0.38; 6-19); after removal of clutches considered subject to dump-laying (>13 eggs), average 8.87 (0.31; 6-13; 39). At Werribee, 1963-74, 79% of 169 clutches were 8-13, commonest 9-10 (Norman 1982). Aust. NRS, average 9 (2.93; 3-22; 40) for maximum numbers of eggs recorded in each nest. Most critical assessment at Serendip by Norman & McKinney (1987); defined clutch-size as average maximum number of eggs in clutches that were both incubated and produced ducklings; average clutch-size 10.6 (2.94; 221) with larger mid-season clutches, 11.4 (3.36; 88) than both early clutches, 10.3 (2.67; 97) and late clutches 9.8 (2.08; 36). Possibly also varies with age and annually, though at Serendip, where most nest in artificial nest boxes, Norman & McKinney (1987) found no significant variation between seasons.

LAYING Daily, in early morning. In complete clutches 367 of 556 eggs laid at 24 h intervals; 137 at rates of 2-3/day, significantly correlated with increasing size of clutch over ten; all clutches over 14 laid at more than one a day. Replacement layings after loss of eggs or after successful fledging; may rear 2-3 broods (Frith 1982; P.J. Fullagar; C.C. Davey).

INCUBATION By female only, starting when

clutch complete. Hatching synchronized by communication between ducklings; pipping to emergence up to 48 h. Males accompany females when they leave nest to feed. Details of spells off nest by female as for Grey Teal. Eggshells sometimes removed by female. INCUBATION PERIOD: variously stated as 23–28 days (Phillips 1926; Delacour 1954–64; Johnstone & Payne 1957; Frith 1982). At Serendip, 19 eggs hatched as follows: 4x25 days, 5x26, 6x27, 2x28, 2x29 for average 26.2 (Norman 1982). Average for 11 eggs incubated artificially 26.8 days, eggs losing 10.5% of weight to within 24 h of hatching.

YOUNG Precocial, nidifugous. At hatching, downy, dark brown above (darker and less grey than Grey Teal), whitish below. *Contra* Frith (1982), who claimed that ducklings stay in nest for a day, some exoduses occur soon after hatching, female calling ducklings from nest (F.I. Norman; see also Grey Teal). Able to walk and swim as soon as leave nest, retiring with female to cover but have been seen to return to nest on first night out (Frith 1982). Some yolk reserved after hatching. In general, size of brood decreases as age of brood increases (Norman & McKinney 1987). Brood size at all ages from 33 Aust. NRS cards averaged 6.6 (3.53; 2–18). Both parents attend and defend brood; threaten other teal, drive them off with active pecking. Injury feigning, splash diving and quacking commonly used, mostly by female but occasionally by male; male will attack (P.J. Fullagar; F.I. Norman). Disturbed broods clump closely, then skeeter away in all directions, dive. For further information on parental care and broods, see Norman & McKinney (1987). FLEDGING PERIOD: hatching to first flight, from as early as 56 days, well before primaries fully grown (Frith 1982).

GROWTH At hatching: weight, 27 g (2.45; 21–34; 231) or 61.6% of fresh eggs and 4–5% of adult weight; wing length, 15.06 mm (1.12; 12–18; 231); slow to develop (F.I. Norman). In captivity, body-feathers appear at 20–29 days, primaries at 43–57 days and fully grown at 60–80 (Frith 1982). Development inhibited on saline waters (Baudinette *et al.* 1982).

SUCCESS In Vic., 78% of 169 clutches produced some ducklings; hatching rate of all eggs 65% (Frith 1982). At Serendip, from 1970 to 1977, of 221 clutches with average clutch 10.6, 8.3 ± 2.71 eggs hatched (78.3%) and 7.9 ± 2.88 ducklings left nest boxes (74.5%) though varied significantly between seasons; of 1,289 ducklings tagged in nest boxes, 3.6% later found dead in boxes and 0.47% elsewhere; of average number of ducklings that left boxes, 60% were lost by the time they attained oldest duckling stage (before becoming difficult to distinguish from female) (Norman & McKinney 1987). Fatality of 3% at exodus stage estimated by Frith (1982). In artificial incubation, during 1966–68, average 75.2% (74.7–82.4) eggs hatched; of these, 91.4% reared to release at 5–7 weeks old or total success 68.7% from laying to fledging. In 1968, 958 eggs produced 710 ducklings and 642 ducklings reared to release or total success 67% (F.I. Norman). **PREDATION.** Little Ravens *Corvus mellori* take many eggs and young. During egg-stage, nesting by Common Starlings *Sturnus vulgaris* and House Sparrows *Passer domesticus* in nest boxes an important factor in losses (F.I. Norman). Snakes may take eggs (Frith 1982) but this not confirmed with tests with Tiger Snakes *Notechis scutatus*. Blue-tongued Lizards *Tiliqua scincoides* proved to take eggs. Purple Swampheens *Porphyrio porphyrio* and Musk Ducks *Biziura lobata* take ducklings (F.I. Norman). Swamp Harriers *Circus approximans* and Peregrine Falcons *Falco peregrinus* take adults. Foxes take eggs, young

and adults (Edwards 1924).

PLUMAGES

ADULT BREEDING MALE Alternate. Age of first breeding, 1 year (Frith 1982). **HEAD AND NECK.** Most of head and sides of neck, black-brown (119), which in some lights appears glossed dark-green (162A), sometimes bronzed or even black; gloss not prominent on throat, lores and malar area. At nape and hindneck, feathers elongate and form tuft-like crest; in some lights these feathers attain olive-green (150) gloss. Sharp demarcation at lower foreneck with underparts. **UPPERPARTS.** Feathers of upper mantle, black-brown (119), sparsely vermiculated rufous brown (340) near tips. Rest of mantle, uniformly black-brown (119), fringed rufous-brown (340); fringes become progressively broader from upper to lower margins of mantle; when worn, fringes buff (124). Back, black-brown (119); concealed bases of feathers, dark brown (119A); some central back-feathers have dark-green (162A) gloss on webs. Rump, black-brown (119); in some lights, fringes glossed dark green (162A), less so on rest of webs. Lateral rump-feathers, varyingly patterned, some entirely white, others bicolored, white and tipped black-brown (119); some, dull-white, vermiculated dark brown (119A). Together with lateral vent-feathers, forms large white patch on side of body. Upper tail-coverts, black-brown (119), glossed dark green (162A) on webs. Scapulars, rather long, rounded and dark brown (121); largest scapulars have black-brown (119) patch on outer webs; most scapulars, narrowly fringed brown (223B) or light brown (223C). In some lights, scapulars have slight olive-green (150) shade. **TAIL,** dark-brown (121); t1, edged black-brown (119) and in some lights, this edge glossed dark green (162A). **UPPERWING.** Tertials, dark brown (121) with olive-green (150) shade, edged on outer webs, light brown (223C). Second outermost tertial, black (89) shaft-streak on outer web. Primaries, dark brown (121); rachis, dark-brown (219A). S1–4, dark-brown (121); other secondaries, dark brown (121) on outer webs, narrowly tipped white on outer web. Inner web of s5, black (89) tipped white; inner web of s6, similar with patch of dark-green (162B) gloss adjacent to rachis. Outer webs of s6–8, glossed dark green (162B), bordered distally by black (89), narrowly tipped white. Feathers with black (89) outer web, or black (89) and glossed dark green (162B), form speculum; in direct light, speculum appears golden-green. Outermost greater coverts, dark brown (119A), broadly tipped white; white tips to feathers progressively diminish towards innermost greater coverts; innermost, often edged light rufous-brown (139) on outer web. Rest of coverts, including alula, dark olive-brown (129); slight olive-green (150) gloss on webs of alula and greater primary coverts. **UNDERPARTS.** Upper breast, dark rufous-brown (340), feathers fringed slightly paler, with subterminal central black-brown (119) spots on webs; spots small on upper breast but progressively larger and more exposed on outer margins adjoining mantle, and towards abdomen; on underparts spots range from 5 to 7 mm in diameter. When worn, feathers, fringed brown (121C). Feathers from breast to abdomen become paler, being brown (37), fringed light brown (39), to uniformly light brown (39). From breast to abdomen, concealed, speckled black-brown (119) shaft-streaks become progressively more prominent. Upper flank-feathers, dark rufous-brown (340) with speckled black-brown (119) shaft-streaks, merging to black-brown (119) subterminal spot; concealed bases, brown (119B). Towards lower flank-feathers, black-brown (119) spot lost and feathers rufous brown (340)

narrowly vermiculated black-brown (119), fringed dark rufous-brown (340). Thighs, light brown (39) or pale light-brown (39), vermiculated, or minutely spotted brown (119B). Vent and under tail-coverts, black-brown (119); lateral under tail-coverts become glossy dark-green (162A) in some lights; rachis of under tail-coverts white. Lateral vent-feathers, varying in pattern, some entirely white, others tipped black-brown (119) or white. Demarcation with adjoining rump-feathers moderately sharp. Axillaries long and white. UNDERWING. Greater primary-coverts, dark brown-grey (80) with dark olive-brown (129) shade. Marginal coverts, dark brown (121). Median coverts, dark brown (121), narrowly fringed white. Lesser coverts, dark brown (121) with mottled white fringing. Greater coverts, dark olive-brown (129).

ADULT NON-BREEDING MALE (ECLIPSE)

Basic. When in full eclipse plumage, general appearance similar to adult female. Differs from adult breeding male in: HEAD AND NECK. Chin and foreneck, dull white; some feathers, tipped dark brown (119A), giving spotted appearance; extent of spotting varying, some males, particularly non-breeders (see Moulting) only partially develop spotted foreneck. Some feathers on lower foreneck, may be tipped pale pink-buff (121D), similarly on forehead and malar area. Some feathers on crown, sides of head and nape glossed with dark green (162). Hindneck, dark brown (119A), feathers tipped pale pink-buff (121D); duller with light grey-brown (119D) tips on lower hindneck. UPPERPARTS. Feathers, mostly black-brown (119) with olive-green (150) shade, fringed buff (124) or light brown (223D); concealed bases, dark brown (119A). Rump, dark brown (119A), some feathers tipped black-brown (119) for half length; within black-brown (119) tip in some lights, slight dark-green (162A) gloss. Lateral rump-feathers, white, finely vermiculated dark brown (119A); white patch much less obvious to non-existent. Upper tail-coverts, black-brown (119) with dark olive-brown (129) shade, narrowly fringed light brown (223D). Scapulars, black-brown (119A) with dull gloss of olive-green (150) on webs, narrowly fringed light brown (223D). UPPERWING. Tertiaries not edged on outer web. UNDERPARTS. Upper breast to abdomen, heavily spotted. Subterminal spots on upper breast, dark olive-brown (129), fringed brown (121C); fringes from mid-breast to abdomen, light brown (123A). Spots on mid-breast average 6 mm in diameter. Lower flank-feathers, large and rounded, dark olive-brown (129), narrowly fringed light brown (223D). Thighs and vent-feathers, brown (119B), narrowly fringed buff (124). Under tail-coverts proximal to vent, dark brown (121) fringed brown (121C). Rest of under tail-coverts, black-brown (119). UNDERWING. Greater and median coverts, brown-grey (79), and differ in lacking white fringes.

ADULT FEMALE HEAD AND NECK. Head and neck has streaked appearance. Forehead, crown and nape, black-brown (119); feathers, edged pale pink-buff (121D) or buff (124), giving feathers streaked appearance. Hindneck, dull white or pale pink-buff (121D), feathers tipped dark brown (119A). Chin, dull white, feathers tipped dark brown (119A), giving appearance of minute spots. Throat, uniformly dull white. Rest of foreneck, dull white, tipped dark brown (119A). UPPERPARTS. Mantle feathers, dark brown (119A) approaching black-brown (119) towards tip, fringed light brown (223D). Back, dark brown (119A) with olive-green (150) gloss and very little to no fringing. Rump and upper tail-coverts, dark-brown (119A) fringed light brown (223D). Scapulars, dark brown (119A) with slight olive-green (150) shade, narrowly fringed buff (124). Largest tertiaries, dark brown

(119A), narrowly edged light brown (223D) on outer web; smaller tertiaries lack edging. TAIL, dark brown (121). UPPERWING. Most coverts, very dark olive-brown (129) or very dark brown (121). Tertiary coverts, dark brown (119A). Rest of wing, same as adult male. UNDERPARTS. Breast-feathers have broad subterminal central black-brown (119) spots, fringed light brown (123A) to buff (123D); in general, fringes vary from brown (223B) to light brown (223D). Vent and under tail-coverts, dark brown (119A), fringed buff (124); lateral under tail-coverts have light grey-brown (119D) bar across middle of feather. Thighs, brown (119B) with slight buff (124) fringe. Upper flank-feathers, dark brown (119A) merging to black-brown (119) towards tip, fringed buff (124). Lower flank-feathers, rounded and long, dark brown (119A) fringed light brown (223D). UNDERWING, same as adult male.

DOWNY YOUNG HEAD AND NECK.

Crown, hindneck and eye-stripe, dark brown (119A). Malar stripe, wide extending to ear-coverts. Rest of sides of head, including supercilium, light rufous-brown (139). Foreneck, dull white. UPPERPARTS, dark brown (119A); down on back, hair-like. Small single oval-shaped dull-white patch on either side of rump. Similar patch on either side of middle of back, where wings folded. TAIL. Down hair-like and dark brown (119A). UPPERWING, dark brown (119A); trailing-edge on radius-ulna, dull white; dull-white down merges with dull-white down on middle of back when wings folded. UNDERPARTS, dull white. Under tail-coverts and vent, dark brown (119A). UNDERWING, dull white. Full details of plumage development (in captive birds) to juvenile, in Frith (1982).

JUVENILE HEAD AND NECK.

Crown, black-brown (119) narrowly edged light grey-brown (119D); forehead, edged dull white. Patch of feathers on chin, dark brown (121). Foreneck and sides of head, dull white, tipped dark brown (121). Lores and malar area, dull white with black-brown (119) shaft-streaks. UPPERPARTS. Mantle, black-brown (119), broadly fringed light grey-brown (119D). Back, black-brown (119) with narrow dark-brown (119A) fringes. Rump and upper tail-coverts, dark brown (119A); fringes vary from brown (119B) to light grey-brown (119D). Scapulars, dark brown (119A) with olive-green (48) shade on webs. Largest scapulars lack fringes; smallest scapulars, fringed light brown (223D); when worn, fringes, light grey-brown (119D). TAIL, dark brown (121), narrowly fringed light grey-brown (119D); rectrices notched. UPPERWING. All coverts, dark brown (119A) with slight olive-green (48) shade on webs. Marginal coverts, narrowly fringed brown (119B). Most of rest, similar to adult breeding male but paler. All white areas, washed light brown (223D). Tertiaries, dark olive-brown (129), narrowly edged light grey-brown (119D) on outer web. UNDERPARTS. Breast-feathers have black-brown (119) central subterminal spots, fringed warm light-brown (223C) to buff (124). Generally males tend to show warm light-brown (223C) fringes, but any sexual difference requires further study. Spots become less obvious towards abdomen. Upper flank-feathers, black-brown (119); lower flanks, dark brown (119A), broadly fringed buff (124). Abdomen and vent-feathers, uniform dark brown (119A) to brown (119B). Under tail-coverts, dark brown (119A) to black-brown (119) with narrow buff (124) to light grey-brown (119D) fringes. Axillaries, white. UNDERWING. Marginal lesser and median coverts, dark brown (119A). Rest, similar to adult male but paler.

SUBSEQUENT PLUMAGES During pre-breeding moult, some adult males appear largely free of 'spots' on underparts, and generally appear brighter. Differ from adult

breeding male in: UNDERPARTS. Small but few spots on abdomen and midbreast, slightly larger but vermiculated patches on upper flanks, still larger and vermiculated on lower flanks. Upper breast, dark rufous-brown (340) becoming paler, through brown (223B) to light brown (223C) towards vent; concealed bases of feathers, pink-buff (121D); spots on feathers, dark brown (121). Upper flanks, finely vermiculated. Lower flanks, almost entirely vermiculated and fringed brown (121B). Thighs, pink-buff (121D); concealed bases of feathers, light grey-brown (119C).

BARE PARTS Based on photos in Pringle (1985).

ADULT BREEDING MALE Iris, red-brown (132B). Upper mandible, light blue-grey (88). No data on lower mandible. Tomia, nail and surrounds of nostril, grey-black (82). Legs and feet, grey.

ADULT NON-BREEDING MALE Similar to adult female.

ADULT FEMALE Iris, rufous brown (240). Bill, legs and feet, as in male.

DOWNY YOUNG No data.

JUVENILE Similar to adult female but duller.

MOULTS Data based on Frith (1982) and skins (MV). Few data.

ADULT POST-BREEDING Complete; remiges simultaneous; body partial. In se. Aust., occurs Jan.-Feb. Body-moult shows no association with condition of gonads (Norman 1984). Males that have bred successfully usually attain full eclipse plumage; unpaired birds may undergo body-moult without eclipse plumage (P.J. Fullagar).

ADULT PRE-BREEDING Partial; in adult males, almost uniform underparts conspicuous; involves body-moult in Apr.-May.

POST-JUVENILE Partial; occurs at 4 months of age (Frith 1957); Blaauw (1894) states that males moult at 5-6 months.

MEASUREMENTS SE Aust.; adult skins (MV).

	MALES	FEMALES
WING	217.6 (4.44; 211-227; 9)	203.2 (6.01; 195-212; 4) *
8TH P	136.3 (4.37; 130-142; 9)	129.6 (0.94; 129-131; 3) *
TAIL	91.3 (3.03; 88-97; 6)	
BILL	40.8 (1.98; 36.9-43.4; 9)	38.3 (1.08; 36.9-39.6; 4) *
TARSUS	38.1 (1.26; 36.2-39.7; 9)	36.1 (0.77; 35.6-37.5; 4) *
TOE	51.7 (1.73; 48.8-54.4; 9)	48.6 (1.06; 47.1-50.1; 4) *

Further measurements in Frith (1982).

WEIGHTS At Gippsland Ls, Vic., Norman (1984) gives weights of spermatogenically active and inactive males respectively as 660 (62.4; 562-755; 24) and 697 (62.8; 569-816; 39); general weights of males as 683 (63.2; 562-816; 67) and notes no significant seasonal changes; for females, 593.0 (146; 505-766; 50).

STRUCTURE Wing, short and broad. Eleven primaries: p9 usually longest, p10 2-5 mm shorter, p8 2-5, p7 10-14, p6 18-33, p5 28-45, p4 39-57, p3 51-70, p2 62-82, p1 72-93, p11 minute. P10 emarginated on inner web; p9 on outer and inner; p8 slight on outer and inner. Seventeen secondaries including five of tertial form. Fourteen to 18 rec-

trices, t1 longest, t7 26-42 mm shorter than t1; t8 30-32 mm shorter than t1. Under tail-coverts end 12 mm short of tail tip. Tail, pointed. Bill, slender, concave, with slender nail. Legs, slender, with tarsus rounded. Feet, webbed. Outer toe c. 93% of middle, inner c. 75%, hind c. 23%.

GEOGRAPHICAL VARIATION No variation; considered monotypic (Peters). Considered conspecific with Grey Teal by Ripley (1942); see Geographical Variation for Grey Teal.

RMO

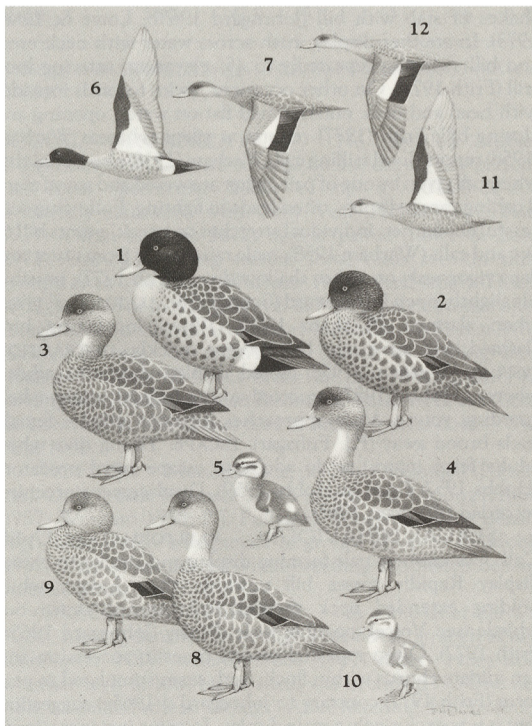
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Chestnut Teal *Anas castanea*

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

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