

## Order ANSERIFORMES

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

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

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

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

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

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

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## Family ANATIDAE wildfowl

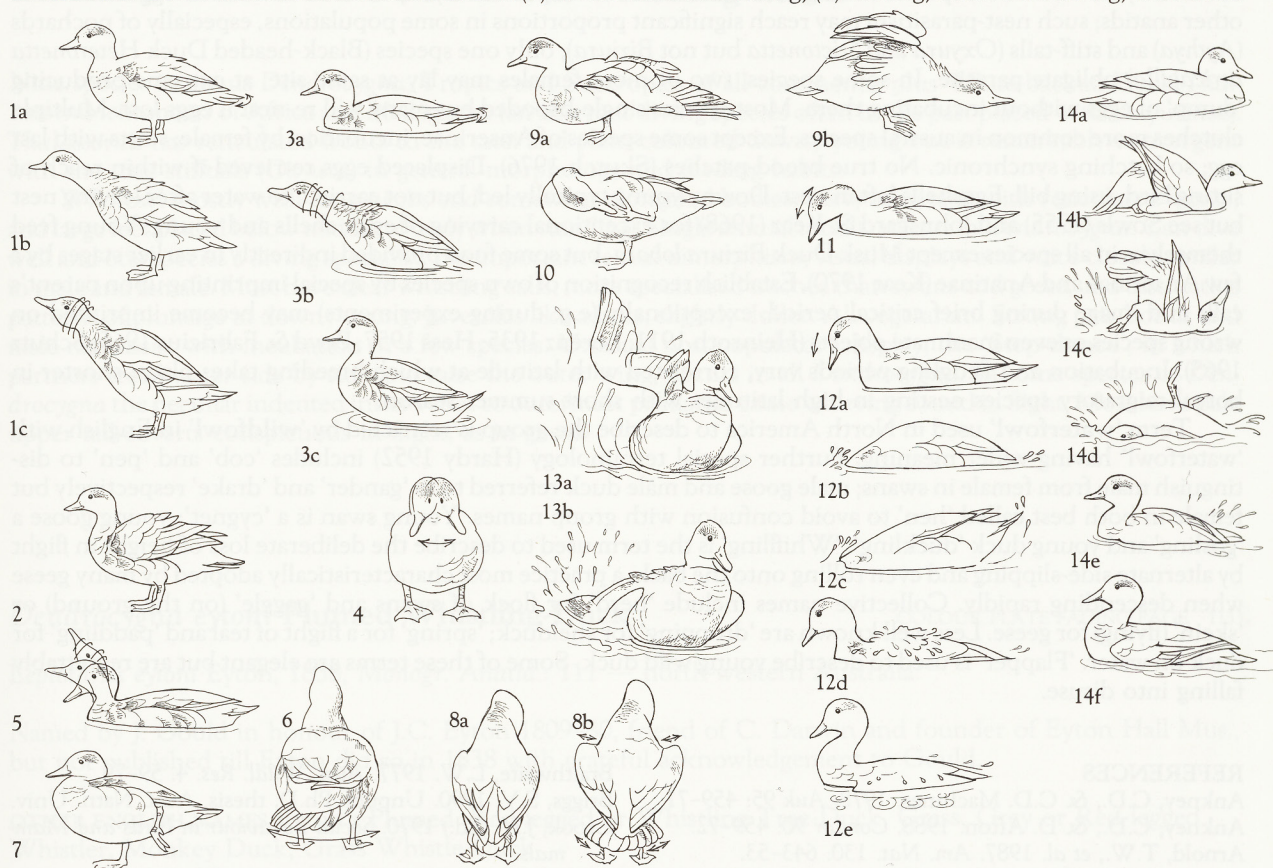
Waterbirds (some more or less terrestrial) with rather short legs and front toes connected by webs; hallux elevated and reduced. Though considerable adaptive diversity in outward appearance, size, colours of plumage, behaviour, and ecology, homogeneous in many characters, as attested by numerous, often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

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

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

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

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



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

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

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

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

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## Sub-family ANATINAE ducks

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

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

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

### Perching ducks and aberrant species

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

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

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

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

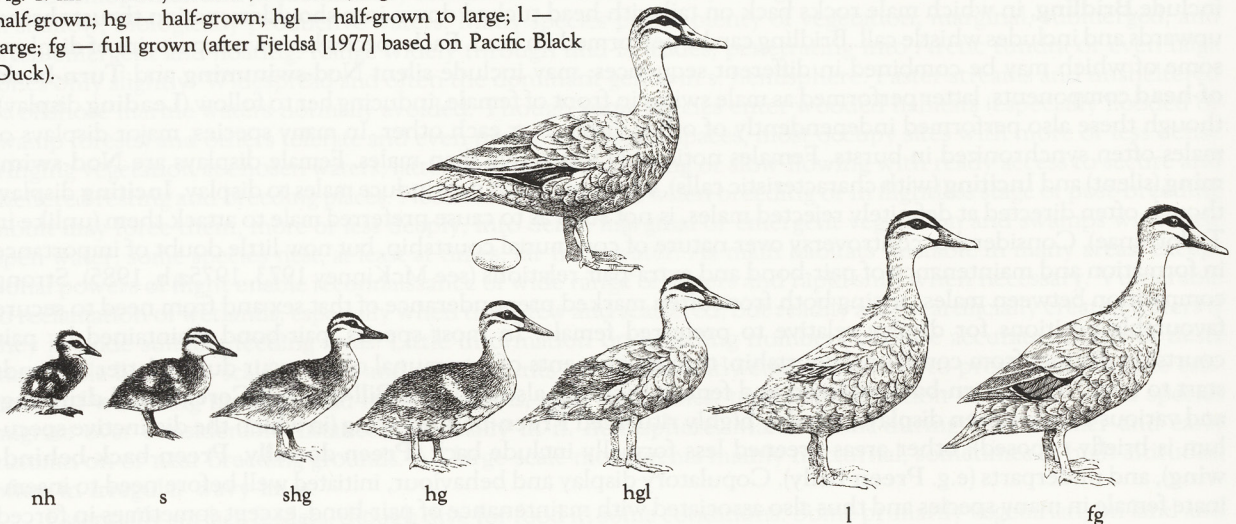


in shallow water. Many omnivorous, taking chiefly seeds and invertebrates mainly from shallow water by dabbling at surface at the same time pumping water and mud through bill, using lamellae to sieve out food (**Suzzling**). Also filter-feed by dipping head and neck below water, and up-ending; some highly 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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*Anas rhynchotis* Australasian Shoveler

COLOUR PLATE FACING PAGE 1316

*Anas rhynchotis* Latham, 1801, *Index orn. Suppl.*: 70 — New South Wales.

The specific name is made from Greek *ρύγχος* (beak) and *ὄτις* ('bustard with long ear-feathers' or simply 'ear'), referring to spatulate shape of bill.

OTHER ENGLISH NAMES Blue-winged or Southern Shovel(l)er, Spoonbill Duck, Stinker, Widgeon, Shovelbill.

Species of shovelers replace one another geographically and so **Australasian** is the best qualifier, **blue-winged** applying also to other species.

POLYTYPIC Nominate *rhynchotis* in Aust.; *variegata* (Gould, 1856) in NZ.

**FIELD IDENTIFICATION** Length 45–55 cm, of which body about two-thirds; wingspan 70–80 cm; weight c. 650 g. Distinctive slim and rather short-necked duck with dark massive spatulate bill, at least as long as head, and sloping forehead. Sits low on water with top of bill and forehead forming straight line. Flies rapidly with characteristic whirr; small pointed wings appear set far back because profile of outstretched neck and large bill exaggerated; orange legs and feet often conspicuous from below. Often seen in small numbers among larger flocks of other species of duck on secluded, heavily vegetated coastal or inland swamps, or floodwaters. Sexes differ. Seasonal differences in plumages. Juvenile as non-breeding female.

**DESCRIPTION** **ADULT MALE BREEDING.** Crown, chin and throat black-brown; white vertical crescentic line in front of eye; rest of head and neck, blue-grey with turquoise gloss when fresh; back, black-brown, feathers edged buff-white or pale brown; rump and tail-coverts, black, glossed green; longest scapulars, pale blue with white streak. Upperwing primaries, dark brown; most coverts, pale powder-blue, forming patch separated from glossy green speculum by obvious broad white band. Upper breast, mottled black-brown and buff; lower breast, belly and flanks, bright chestnut to dark reddish-brown spotted with black; prominent white patch on posterior flanks. White under wing-coverts contrast with dark grey-brown remiges. Iris, bright yellow. Bill, grey-black. Legs and feet, orange. **ADULT MALE ECLIPSE.** Similar to adult female (below), but with muted white facial crescent and flank-spot; no eye-stripe; lower breast, belly and flanks, dull red-brown spotted black. Iris, yellow. **ADULT FEMALE.** Crown and nape, dark brown; face, chin and neck, streaked buff and dark brown, with indistinct dark-brown eye-stripe. Upperparts, dark brown with fine buff scallops, broader in non-breeding; underparts, off-white to pale brown with dark-brown mottling. Speculum, dark brown with greenish gloss; upper wing-coverts, greyer than male. Iris, dark brown. Bill, dark grey tinged olive, sometimes with small dull yellow-orange patch at base of tomia. Legs and feet, brownish orange. **DOWNY YOUNG.** Crown, hindneck and upperparts, dark brown with cream spots at base of tail and wing-pad; trailing-edge of wing-pad, buff. Face, buff-yellow or paler, with dark-brown eye-stripe and large dark-brown rectangular patch in lower ear-coverts, often meeting nape. Underparts, cream to off-white. Iris, dark brown. Bill, dark grey; rather short at hatching, but spoon-shaped and longer than head at two weeks old. Legs and feet, dark brown. **JUVENILE.** Similar to adult female, but underparts slightly paler, with

finer dark markings. Forewing patch of juvenile male like adult female; that of juvenile female, dark brown with narrow grey-blue scalloping.

**SIMILAR SPECIES** Unlikely to be confused with any other ducks of our region. Main identification difficulty, vagrant **Northern Shoveler** *A. clypeata*, very similar in size, structure and posture. Male breeding plumage of Northern Shoveler, dark green head contrasting with pure white fore-neck and upper breast, unmistakable. Supplemental plumage similar to pale-breasted breeding male Australasian Shoveler; Australasian has more white on breast and usually brownish feathering mixed on flanks and under tail-coverts. In flight, Northern shows broad white fringes to tail; at close range, dark glossy green head (blue-grey in Australasian) and different pattern on longest scapulars, reliable identification guides. Adult male non-breeding Northern differs from eclipse Australasian: usually has eye-stripe, black crescent-shape on flanks, broad white fringes to tail and varying extent of orange on sides of bill. Juvenile and adult female Northern have broad orange edges to upper mandible (Australasian have dark bills, occasionally with small yellow-orange patch at junction of mandibles). Adult female Northern Shoveler generally paler on the head and body, but varying, not diagnostic, though sometimes useful in attracting attention to possible Northern Shovelers; also has rather broad white edges to tail visible at close range when swimming or flying. Took call of male Northern Shoveler distinctive and diagnostic (P.J. Fullagar). Few other species present difficulties. **Pink-eared Duck** *Malacorhynchos membranaceus* has bill proportionately as long, but with triangular leathery flap at tip making tip of bill look deeper than base; also has distinctive more steeply sloping forehead, bold eye-patch and black-and-white barred sides visible in most conditions. Only Pink-eared Duck has similar shape in flight but holds head high, neck not fully extended, wings broader and wing-beat rather short and slow; on upper-side, has distinctive white upper-tail coverts and white trailing-edge to wing. Shoveler swim lower in water than all local ducks except perhaps **Hardhead** *Aythya australis*, **Blue-billed Duck** *Oxyura australis* and **Musk Duck** *Biziura lobata*; differs from these in distinctive front-heavy posture; head often held back over mantle, with bill pointing forward and resting on or near foreneck and upper breast. In this posture, when size of bill may be less easy to judge, male can be separated from male **Chestnut Teal** *A. castanea*, which has chestnut upper breast, no white facial crescent and no elongate scapulars. Indistinct dark eye-stripe of female and juvenile differs from bold facial pattern of larger **Pacific Black**

**Duck** *A. superciliosa* and smaller **Garganey** *A. querquedula*. At distance, rather plain upperwing and head pattern of female can cause confusion with **Freckled Duck** *Stictonetta naevosa*, but head of Freckled Duck peaked at rear and bill markedly scooped out. **DUCKLING**. At 2 weeks, ducklings have developed unmistakable spoon-shaped bill, at least as long as head (Frith 1982). Before this, confusion possible with downy young Pacific Black Duck and Mallard *A. platyrhynchos*; these differ from Shoveler in having more sharply defined eyestripe, small circular spot on lower ear-coverts (rather than large and rectangular), and white trailing-edge to wing.

Prefer large permanent wetlands with fringe of vegetation and areas of open water, but seen on most types of wetlands, and may be found on floodwaters. Usually occurs in association with other ducks, often in groups including Pink-eared Ducks. Swim low on water. When taking flight, take off vertically. Flight, swift and direct, with wings set well back, often making loud whistling or whirring. May turn suddenly. Usually feed in pairs or small groups, but during droughts may form larger flocks. Often congregate in association with other species. Generally silent, except for soft calls during display.

**HABITAT** Aquatic; mainly on Temperate Zone terrestrial wetlands and occasionally sheltered estuarine and inshore waters. Bill specialized for filter-feeding, limits foraging to aquatic habitats on open water or soft mud in fertile wetlands with abundant prey.

In Aust., prefer large deep permanent lakes and swamps where conditions stable and aquatic flora abundant (Frith *et al.* 1969; Fjeldså 1985); in inland NSW, numerous on swamps where small seasonal fluctuations in water-level promote development of rich littoral flora and fauna (Frith *et al.* 1969). Some favoured swamps support dense growth of plants (e.g. *Typha*, *Melaleuca*) (Frith 1982); but presence or nature of emergent or fringing vegetation may not be important (Fjeldså 1985), and birds often feed away from cover in deep or shallow open water (Frith *et al.* 1969; Corrick & Norman 1980; Aust. Atlas). Also occur on billabongs, watercourses and floodwaters on alluvial plains, freshwater meadows, shallow swamps, reed swamps (*Phragmites*, *Scirpus*), wooded lakes, irrigated fields, sewage ponds and farm dams (Frith 1959; Frith *et al.* 1969; Vestjens 1977; Gosper 1981; Corrick 1982; Jaensch & Vervest 1988a,b). Prefer fresh water, but may occur in high numbers on brackish or saline lakes, saltpans, meadows, coastal lagoons, estuaries and sheltered inshore waters (Goodrick 1970; Corrick & Norman 1980; Corrick 1982; Jaensch & Vervest 1988a,b), especially when salinity reduced by freshwater run-off (Jaensch 1983).

Similar habitats used in NZ, with preference for large, highly fertile, lowland wetlands, particularly those fringed with rush (*Typha*) (Caithness 1975). Also on flooded pastures, sewage ponds, and lowland freshwater lakes, reservoirs and pools (Sibson 1967; Williams 1981); uncommon on flowing water, on deep inland lakes and on oligotrophic highland lakes, where food not abundant. As in Aust., seldom on saline waters, although occasionally recorded from estuaries, and move onto open sea in hunting season.

Breed in grassy sites near freshwater wetlands, both temporary and permanent. At Booligal, NSW, breed more widely in swamps with high levels of organic matter, complex flora and diverse invertebrate population, in early stages of succession after drying and refilling (Crome 1988). Fly readily, often high. Rest in day on mudbanks, in dense cover or float-

ing on deep water. Foraging usually restricted to depth that can be reached by upending (c. 0.3 m) (Frith *et al.* 1969), but recorded diving in greater depths (Black 1959).

Have probably declined in e. Aust. since European settlement (Aust. Atlas). Freshwater wetlands much reduced by drainage (Riggert 1966; Goodrick 1970; Corrick & Norman 1980; Corrick 1981, 1982), and vegetation in inland breeding swamps grazed and trampled by stock so that little nesting cover remains (Frith 1982). Make little use of artificial impoundments (Braithwaite *et al.* 1985a), although may breed at farm dams and sewage ponds (Sibson 1967; Corrick 1981). Drainage of freshwater swamps has also reduced habitat in NZ, but construction of reservoirs and sewage ponds has allowed expansion into regions where formerly rare (Sibson 1967).

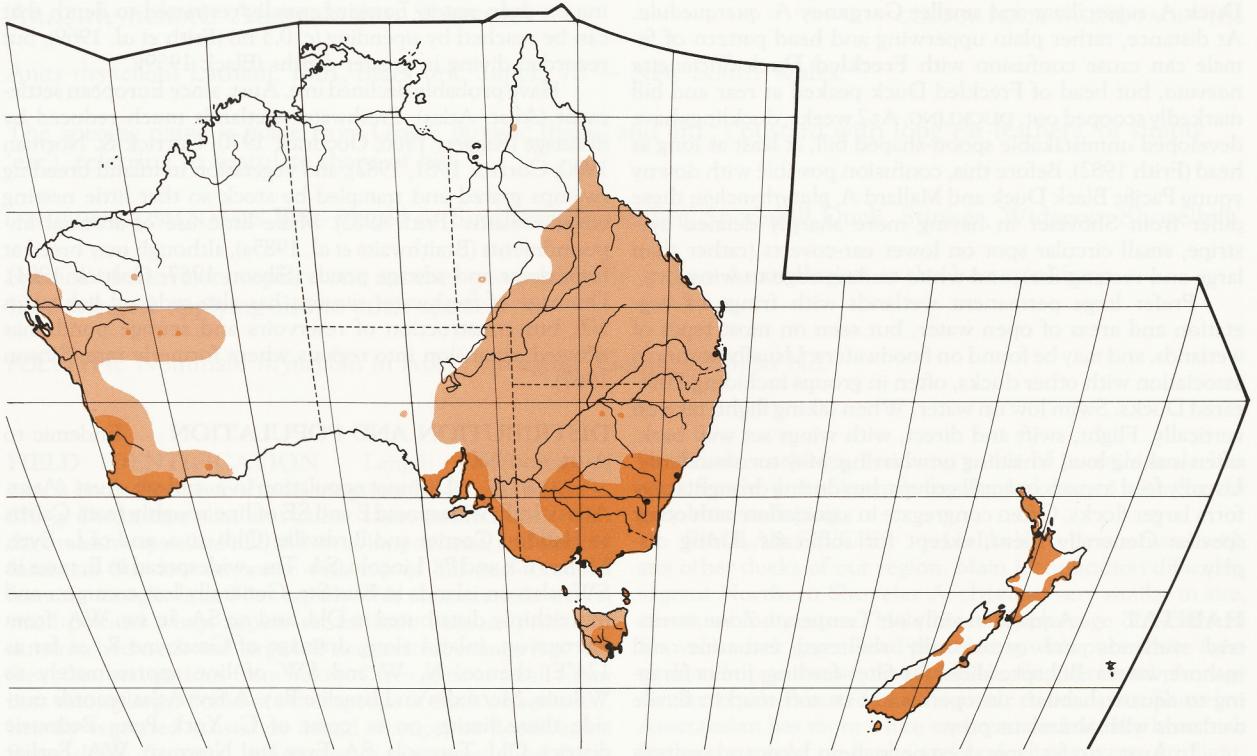
**DISTRIBUTION AND POPULATION** Endemic to Aust. and NZ.

**AUST.** Disjunct population in e. and sw. Aust. (Aust. Atlas). In E, widespread E and SE of line roughly from Cairns to Haddon Corner and Birdsville (Qld), to s. end of L. Eyre, Millers Ck and Pt. Lincoln, SA. Tas., widespread in E, rarer in SW; also on islands in Bass Str. Generally less common and more thinly distributed in Qld. and ne SA. In sw. WA: from Carnarvon, inland along drainage of Gascoyne R. as far as 124°E; thence, N, W and SW of line approximately to Wiluna, Merredin and Israelite Bay. A few Atlas records outside these limits: on w. coast of C. York Pen.; Bedourie district, Qld; Tarcoola, SA; Eyre and Newman, WA. Earlier records of vagrant occurrences in n. WA and NT not supported with details and now untraceable (Serventy & Whittell 1976; Storr 1977). Commonest apparently in Murray-Darling districts, NSW-Vic. (Morris *et al.* 1981; Aust. Atlas; Vic. Atlas).

**BREEDING** Stronghold probably in sw. NSW, Vic. and se. SA; n. limits: in nw. (Paroo Rs) NSW, in area of Macquarie Marshes, down Lachlan-Murray Rs to Fleurieu Pen., SA. In WA, coastally from Esperance to Perth. Perhaps breed more widely in suitably wet years (Aust. Atlas).

**NZ** Widespread NI and SI, but numbers vary locally and absent from many areas, particularly in n. and w. parts of SI; vagrant to Stewart and Auckland Is, formerly Chatham Is where last recorded 1925 (Fleming 1939; Pierce 1980; Falla *et al.* 1981; Owen & Sell 1985; NZCL; NZ Atlas).

**POPULATION** Considered to have declined in e. Aust. this century and no breeding reported N of 30°S since 1920; range and numbers may have expanded in WA since 1950 (Aust. Atlas). Indices of abundance from annual aerial surveys (transect counts) of e. Aust. wetlands, 1983-88 were 11 905; 22 391; 10 659; 2329; 2089; 2299 respectively; during these surveys, populations concentrated in three areas: (1) dune lakes of se. SA (1983, 41-60% total numbers seen; 1984, 81-100%; 1985, 61-80%; 1987, 21-40%); (2) wetlands on floodplains at confluence of Murrumbidgee and Lachlan Rs, central s. NSW (1986, 81-100%; 1988, 41-80%); (3) wetlands and floodplains of Paroo R. and Cuttaburra Channels, nw. NSW (1983, 41-60%) (Braithwaite *et al.* 1985a,b, 1986, 1987; Kingsford *et al.* 1988, 1989). Counts in Vic. in summer surveys, 1987-89, were 7618 on 332 wetlands; 19 075 on 472 wetlands; 16 780 on 626 wetlands respectively; making up 4-6% of all ducks counted (Martindale 1988; Hewish 1988; Peter 1989). Counts in sw. Aust., 1986-88, were 2365 on 872 wetlands; 4219 on 1201 wetlands; 4554 on 1398 wetlands respectively (Jaensch & Vervest 1988a,b). Total NZ population



seems to be stable at 100 000–150 000, with about 30 000 shot annually (NZ Atlas).

S. distribution exposes species to main concentration of shooters. Pre-season counts in Vic. indicate exposure to shooting high; 61–68% of total numbers on waters open to hunting (Martindale 1988; Hewish 1988; Peter 1989). Shot much but usually form low proportion of total bag in se. Aust. (Norman *et al.* 1984; Briggs *et al.* 1985; Loyn 1987). Low proportion of Shoveler on sample of waters in Vic. harvested in 1987 open season; partly protected by wariness, fast flight and liking for central parts of large lakes (Loyn 1987). Since 1987, bag-limit for this species in Vic. reduced to two, because of low numbers and restricted distribution in e. Aust (Loyn 1989).

**MOVEMENTS** Dispersive but poorly known. In Aust. thought to be more sedentary than other ducks of the inland, in wetter areas possibly philopatric to nest-site; otherwise distribution and size of population correlated with conditions in Murray–Darling Basin (Frith 1982) and se. SA (Hewish 1988). No seasonal pattern of abundance anywhere in its range (Frith 1982; Vic. Atlas) and numbers in Vic. vary greatly between years (Hewish 1988). In NZ, highly mobile with birds banded during summer moult recovered throughout country in autumn though individuals have returned to nest-sites from as far as 800 km away.

**BANDING** Returns from NZ (NZNBS) summarized Figs 1–2. Other records:  
 33S144E 12 J M ? 221 197 ABBBS  
 36S140E 12 1+ M ? 990 071 ABBBS

**FOOD** Mostly animal matter though some contents of gizzards dominated by residual hard seeds. **BEHAVIOUR.** Food obtained by dabbling in mud or at surface where lamellae on

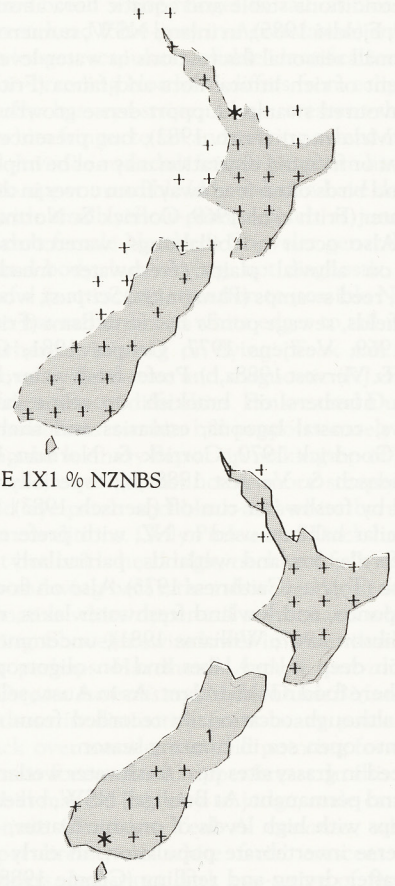


Fig. 1. 37S 175E 1X1 % NZNBS

Fig. 2. 46S 168E 1X1 % NZNBS

fringe of spatulate bill used to filter food from water. Usually swim fairly swiftly with head half or almost wholly submerged, bill moving rapidly. Occasionally upend to feed on bottom, chase prey across surface (Frith 1982) and dive: mean length of dives 8.5 s (7-10; 7 dives) in 1-2 m water (Black 1959). Small flocks often feed in V-formation, those in front disturbing food that those behind catch (Frith 1982).

**ADULT** Summarized Table 1. In w. NSW (47 gizzards; Frith 1959) animals were molluscs bivalves *Corbiculina* 2.9, gastropods *Glyptophysa* 10.6, *Isidorella* 7.4; crustaceans ostracods *Cyprinotus laena*; insects bugs 10.2, 76.7, *Agraptocorixa eurynome* 8.6, 63, Notonectidae, beetles 30.9, 100, Carabidae, *Lancetes lanceolata* 7.7% vol., *Rhantus suturalis* 6.3, *Berosus* 16.9, 73, Aphodiinae; plants, all seeds, Chenopodiaceae 3.1, 4.2, Polygonaceae 5.0, 8.4, Cucurbitaceae 0.2, 6.3, Fabaceae 1.1, 2.1, Boraginaceae 2.3, 2.1, Asteraceae 0.4, 2.1, Cyperaceae 2.2, 2.1, Poaceae 2.3 2.1, *Marsilea drummondii* 2.6, 8.4.

At **Barrenbox Swamp** (161 gizzards; Frith *et al.* 1969) animals were molluscs *Corbiculina permena* 13.4% freq., 3-4 mm, *Glyptophysa* 15.4, 24.8; crustaceans cladocerans 33.0% freq., copepods; insects odonatan 3.0, 27.0, bugs 10.7% vol. *Sigara* 19.1% freq., *Agraptocorixa eurynome* 4.8, 26.7, *Micronecta* 10.2% freq., *Naucoris* 7.6, *Diplonychus* 4.5, beetles 1.6% vol., *Berosus* 10.8% freq., caddisfly larv. 12.1, 38.2; the plants Ceratophyllaceae 1.5% vol., Fabaceae 1.5, Haloragaceae 1.9, Hydrocharitaceae 3.3% freq. (incl. *Vallisneria americana*), Potamogetonaceae 11.4% vol., Ruppiaceae *Ruppia* 6.3, 17.8, *Najas marina* 1.9% vol., *Typha* 6.9, 35.7, *Azolla* 15.8, 41.0, Cyperaceae 2.2% vol., Poaceae 1.1, *Marsilea* 4.9, 17.8.

**Other records:** in n. Qld (three gizzards; Lavery 1971) *Potamogeton pectinatus* 41% vol., Cyperaceae 26; plants gastropods *Pygmanisus* 7; in SA (1; White 1913) small insects from margins of water.

**Table 1.** Gizzard contents of Australasian Shovelers.

	volume		frequency	
	1	2	1	2
ANIMALS	76.2	46.2	100	93.6
Molluscs	21.7	14.6	32.0	53.0
Crustaceans	5.8	2.8	17.0	-
Insects	48.7	28.8	100	-
PLANTS	23.8	53.8	44.1	86.0

(1) W. NSW (Frith 1959); (2) Barrenbox Swamp, sw. NSW (Frith *et al.* 1969).

**SOCIAL ORGANIZATION** Little known; no detailed studies. Generally gregarious except when nesting (as for Northern Shoveler). Outside breeding season, in small flocks, but up to several hundred not rare in particularly good feeding areas, where most likely to congregate densely. Flocks often pack closely, birds swimming in circles or moving across area tail-to-tail, constantly filter-feeding, using typical dabbling action of bill.

**BONDS** Probably monogamous (Frith 1982) but not known how long pairs remain together.

**PARENTAL CARE** Probably brood raised by female alone, but further study required. Reported crèching of young doubtful.

**BREEDING DISPERSION** Solitary nesting. No

other useful details recorded.

**ROOSTING** Loafing on water during day commonly observed. Will haul out and rest ashore on banks or logs or other low perches, as for most dabbling ducks. Often feeds most of night and at dusk and dawn.

**SOCIAL BEHAVIOUR** No detailed studies in Aust. or NZ. Quite peaceable throughout most of year, specially in flock. Hostile pumping most obvious threat signal by both sexes. Social displays similar to those of other blue-winged dabbling ducks (P.J. Fullagar), specially the three shovelers; Northern (Holarctic), Cape A. *smithi* (South Africa) and Red A. *platatea* (South America); see McKinney (1970) for details. Following account based on observations by P.J. Fullagar. **Pre-flight signal** with obvious **Head-shaking** and vertical **Head-thrusting** from erect posture; silent.

**AGONISTIC BEHAVIOUR** **Hostile Pumping** by males characterized by rapid up-and-down pumping action of head with bill tilted slightly upwards; accompanied by calling (see Voice). Associated with territorial fighting and threatening (e.g. before chasing off other males; Robinson 1945). Fighting seems to involve same variety of interactions as those described for Northern Shoveler (BWP; Palmer 1976; McKinney 1970), but not well studied. Occurrence of **Three-bird-flights** at nesting areas, which in Northern Shoveler involves established male repelling pairs from territory, not known. For description see comparable behaviour in Grey Teal A. *gracilis*. Females use hostile pumping movements during inciting, with sideways thrusting actions.

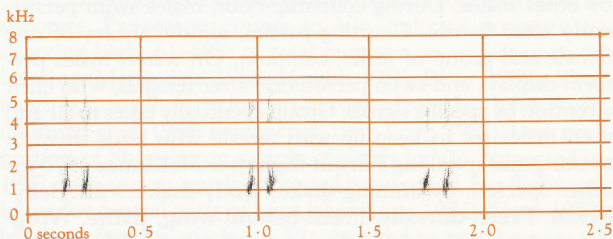
**SEXUAL BEHAVIOUR** Displays much simpler than in most other species of *Anas* and easily overlooked. Same displays performed by lone male to female; often joined by other males. During courtship-bout, males swim persistently after female. Courting parties, almost always of one female and group of males, common. On water, males perform displays and swim persistently after females, who elicit attention by specific signals. Group eventually takes to air and then males try to keep up with female who leads them in twisting and spiralling **Pursuit-flight** (see McKinney 1970 for other species). **Swimming-shake**, **Body-shake** with **Belly-Preen**, **Preen-dorsally**; **Preen-behind-wing**, **Bathe**, **Wing-flap** and exaggerated **Drinking** movements used for display signals not yet reported but probably all occur, mostly by males, as in Northern Shoveler (BWP; Palmer 1976; McKinney 1970). Stiffly executed **Wing-flaps** with loud noise from swishing pinions used by courting males (P.J. Fullagar). **Head-dip** (brief dipping of head and neck under water) and **Up-end** (rotation of whole body with immersion of front half) given by males displaying to female as in Northern Shoveler. **Lateral-dabbling** in which male, positioned in front of female, dips bill into water and filters as if feeding, paddling rapidly to hold position stiffly. Feathers of back and flanks conspicuously raised, increasing silhouette; speculum often visible. Suggestions that pairs swim in circles as form of display is discredited for shovelers in general (McKinney 1970). Male leads female using typical **Turn-back-of-head** posture common to many dabbling ducks. Single male, when following female, will utter same double-note call often used by males when displaying in groups (see Voice). **Jump-flight** most important male display. Erect posture accompanied by typical pre-flight movements; much associated calling leads to male suddenly rising from water to fly stiffly away from group before splashing down and swimming quickly back to rejoin courting party. In flight, conspicuous blue upper surfaces of wings exposed, head



lowered and wing-beats noisy. Length of flight varies; often follows semi-circular course. Jump-flights seem to be initiated by female using **Hostile Pumping** to incite response by male or males. Calling by female not recorded. Jump-flights eventually lead to **Pursuit-flights**, in which males from group take off in circling flight initiated and led by female, during which group twists and turns and rises higher and higher. Usually males drop away from party one by one until only single male following female; these two then land at some distance from where they took off. Pair-selection seems to be based on these contests. **COPULATION**. Not reported but reasonably assumed to be similar to Northern Shoveler and therefore will include pre-copulatory mutual head-pumping with male's head tilted down, typical *Anas coitus* and characteristic post-copulatory posture of male, in which head-feathers erect, bill tilted down, body positioned lateral to female, tail wagged and call given. Female bathes.

**VOICE** No detailed study. Generally silent. Many existing accounts have been confused by descriptions based on Northern Shoveler. Some descriptions particularly in error with male calls (e.g. Frith 1982; Slater 1971; MacDonald 1973; CSN 19; Pizzey 1980). Most common male call least like Northern Shoveler; most like Red Shoveler *A. platalea* and less like Cape Shoveler *A. smithi* (P.J. Fullagar). **NON-VOCAL SOUNDS** include sizzling noises while filter feeding (Hall 1909); wings make loud whistling sounds in flight. Loud noise from final beat of Wing-flap signal. Loud water splashing on landing at completion of **Jump-flights** (see Social Behaviour).

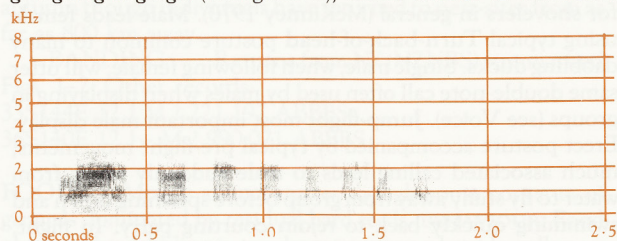
**ADULT MALE** Clear but soft double note *club-it* (sonagram A) given by courting male. Given at well spaced



A P.J. Fullagar; captive, Lara, Vic., June 1983; P35

intervals, in quick succession (fast calls) and as steady persistent series. Used in attention-seeking (courtship contests, e.g. Hostile Pumping) and for contact with partner. No details on calling during copulation and no other types of calls recorded.

**ADULT FEMALE** **Decrescendo call**, rapid series of soft sharp *quacks*; first note longer, more insistent, followed by series of 7–10 or more hurried and increasingly shorter syllables with general downward inflection *quaaag*, *gak-gak-gak-gak-gak-ga-ga* (sonagram B); seems similar to Northern



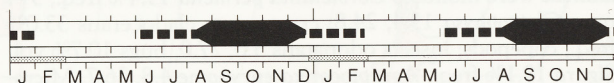
B P.J. Fullagar; Tongo Creek, NSW, Nov. 1983; P35

Shoveler's *gak-gak-gak-ga-ga* (Johnsgard 1965). Calls from female on being flushed, calling at dusk and persistent quacking of females at pre-laying not known. Repulsion calls, distraction display calls, threat calls at nest and conversation calls of females to brood and partner not described.

**YOUNG** Not described.

**BREEDING** Poorly known. No detailed studies; little published information; information compiled by J.M. Peter. Solitary nesting on ground, often near water.

**SEASON** **Aust.:** generally Aug.–Nov. (Campbell), but inland population probably breed erratically, stimulated by rainfall (Frith 1982). NSW: Sept.–Nov. at least (Aust. NRS); Vic.: Oct.–Dec. (Vic. Atlas); Tas.: Sept.–Nov. at least (Tas. Bird Reps 1974, 1975, 1981, 1982; Aust. NRS); sw. WA: Sept.–Jan. (Jaensch *et al.* 1988), but nest with eggs observed in June following cyclonic rains (Serventy & Marshall 1957). NZ: NI, no data published; SI, Oct.–Feb. (CSN 31, 34), with nuptial flights observed in Sept. (CSN 32).



**SITE** On ground in open paddocks or on low embankments (North; Hobbs 1956; Aust. NRS), usually close to water, within 100 m (Falla *et al.* 1981) but up to 200 m away (Frith 1982). Often among or under cover of long grass-tussocks or low herbage, including bullrushes, thistles, clover, reeds or crops, but occasionally in sparsely vegetated areas with little cover (Campbell; North; Frith 1982; CSN 19; Aust. NRS), in clumps of reeds or in the top of niggerheads *Carex secta* with dense canopies (CSN 19). Recorded nesting on stumps and perhaps in hollow trees (e.g. *Casuarina*, willows) (Campbell; CSN 19), but Frith (1982) never saw one in a tree hole with overhead covering. One nest recorded under a lupin *Lupinus* sp. on shingle-bank in river bed (Falla *et al.* 1981). Usually very inconspicuous. Both sexes select nest site together. No further information.

**NEST, MATERIALS** Nests not often found. Usually a depression in ground; in hollow stumps, eggs laid directly on decaying wood. Said to be lined with dry grass or made from live grass with little down or not enough to cover eggs (Campbell; North; CSN 19; Aust. NRS) but with other ducks down is usually not added till at or near end of laying. Thus probably other claims of plentiful down (Falla *et al.* 1981; Serventy & Whittell 1976) are more likely to be correct and reports of sparse down come from uncritical observations of incomplete clutches.

**EGGS** Elliptical or roundish oval (Campbell; North); close-grained, smooth and glossy; though lustrous, not so much as in other anatids (Campbell; North; Frith 1982); light creamy white, faintly tinged with blue-green (Campbell).

**MEASUREMENTS:** 50.3 (49.5–52.6; 11) x 37.6 (37.1–38.6) and 52.6 (50.0–55.4; 9) x 36.7 (36.1–37.3) (two clutches; North); 53.3 (52.07–55.4; 9) x 38.6 (38.1–39.4) (one clutch; Campbell).

**CLUTCH-SIZE** No quantified or critically assessed data. Variously claimed as 9–11 usual (North; Campbell; Frith 1982) with 12–13 maximum recorded (Stone 1912; Oliver).

**INCUBATION** Only female incubates and rears the brood (Frith 1982). **INCUBATION PERIOD.** Said to be 24 days (Delacour 1954–64); 25 days (Falla *et al.* 1981). Female sits

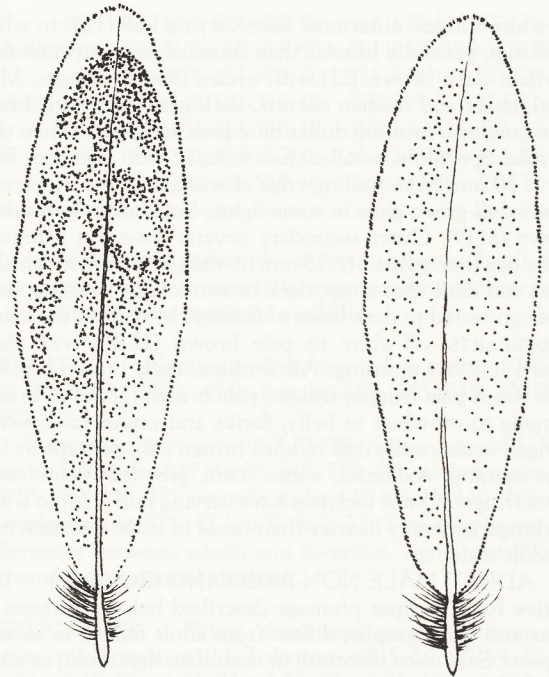
closely and will not flush easily, until nearly trodden on (North) or run over with mower (Aust. NRS). Injury-feigning by female reported (NSW Bird Rep. 1977). Eggshells left in and about nest (Aust. NRS). When flushed, birds may defecate over nest (Campbell) (see comment on similar behaviour under Pacific Black Duck). When leaving nest, female reported to pull a rough thin network of grass over eggs (CSN 19) or to cover nest with dry *Casuarina* leaves and other debris (Campbell).

**YOUNG** Precocial, nidifugous. Downy when hatched: crown, neck and back, dark brown; broad yellow stripe above eye; dark eye-stripe from base of bill to back of head; dark line below ear; cheeks, chest and underparts, pale yellow tinged with brown; trailing-edge of wing yellow; yellow spot on each side of back; bill and legs, olive-brown to black. By 14 days, bill has become spoon-shaped and very large in proportion to duckling (Frith 1982). Fledging said to be at 8-10 weeks old; sexually mature at 1 year old.

**SUCCESS** No information. In NZ, unconfirmed reports of 50% mortality rate of juveniles, compared with 44% adult mortality rate; females have higher adult mortality rate.

## PLUMAGES

**ADULT MALE BREEDING** Definitive alternate. Attained in first year. Sexually mature at 1 year old. **HEAD AND NECK.** Forehead, chin and front of lores, black-brown (c119). Bold white crescent with black speckling runs from centre of lores to sides of upper throat; feathers, white with grey-black (82) shaft-streak widest at tip. Hindmost area of lores, brown (119B). Crown, mottled dark brown; feathers, black-brown with thin buff (124) fringes. Centre of throat, black with indistinct white streaks; feathers, black-brown (c119) fading to dark brown (119A) with wear with white fringes broadest at edges. When fresh, rest of head and neck, grey-blue with turquoise gloss restricted to feather tips. Turquoise gloss lost with wear and brown flecking develops. Feathers, dark brown (121) merging to light brown (119C) base, with grey-blue ends that have turquoise tinge at tip. **UPPERPARTS.** Mantle, black-brown with buff scalloping. Feathers, black-brown (19) with thick cream (54) fringes and sometimes with cream (54) markings near centre. Back, similar but scalloping less distinct; feathers, black-brown (19-119) with trace of green iridescence, and narrow cream (54) tip. Most scapulars, black-brown with bold buff and white scalloping; feathers, cream (54) to white, with varying black-brown (19) central wedge and broad subterminal fringe. Longest two scapulars, pale blue with velvet-textured white shaft-streak. Third longest scapular, dark greenish brown with white shaft-streak. Rump, black (82-89) slightly glossed green, with pair of white spots at sides. Upper tail-coverts, brown-black. **TAIL.** Rectrices, dark brown (20) with thin pale-brown (223D) fringes; outermost have small buff (124) to white markings in centre of webs (cf. tail of Northern Shoveler in which outermost rectrix, t7, white with brown wash or mark near shaft) (Fig. 3). **UPPERWING.** Marginal, lesser, median and inner secondary coverts, pale blue; marginal coverts near carpal joint sometimes have narrow buff (124) fringes and chevrons. Outer secondary coverts have grey-black (82) proximal half and white distal half; sometimes minute grey-black (c82) spots near tip. Primary coverts, brown (28) with slight pale-blue (c88) tinge to outer edge. Tertiaries, black (c82) with dark blue iridescence. Secondaries, dark-brown (21) inner webs and 1 cm tips to outer webs; rest of outer web, bright iridescent green in all



3a Australasian Shoveler

3b Northern Shoveler

Fig. 3 t7 of female shovellers

lights, forming speculum. Primaries, dark brown (121) with narrow pale-brown tip. **UNDERPARTS.** Uppermost breast, mottled black-brown and buffish; feathers, black-brown (19) fringed and barred cream (54). Most of central breast, red-brown scalloped black; feathers, red-brown (c32) with black-brown (119) subterminal fringes and broad central wedges. A few birds have some white feathers with black-brown (119) markings on sides of upper breast. Lower breast, belly and flanks, red-brown with irregular black spots; feathers, red-brown (32) with thick irregularly shaped black-brown (c119) bars. White spot on lateral under tail-coverts joins white spot at extreme sides of rump; other under tail-coverts black (c89) with slight green gloss at sides. Axillaries white. **TAIL.** Below, feathers brownish grey (79, 80) with narrow white tips. **UNDERWING.** Remiges and greater coverts, grey (c84) reflecting paler (86) in direct light; primaries have dark glossy grey-brown (c79) tegmen. Marginal coverts, dark greyish-brown (c121), usually fringed white. Other under wing-coverts, white.

**ADULT FEMALE BREEDING** Definitive alternate. Probably attained in first year. Sexually mature in first year. **HEAD AND NECK.** Forehead and crown, black-brown scalloped pale brown; feathers, black-brown (c119) with cream (54) fringes. Hindneck, light grey-brown (c119C). Lores, chin and throat, off-white with slight dark-brown speckling. Feathers, off-white with narrow dark-brown (121) proximal shaft-streaks. Face and sides of neck, streaked off-white and dark-brown; feathers, dark brown (121) with broad off-white edges. Pale edges narrower in eye-stripe, giving this area dark appearance contrasting slightly with paler face and supercilium. **UPPERPARTS.** Mantle, scapulars and back, dark brown with buffish scalloping. Feathers, dark brown (129-21) with cream (54, 92) fringes. Rump, dark brown (21). Upper tail-coverts, as back. **TAIL.** Rectrices, black-brown (19) with

off-white fringes; outermost have varying buff (124) to white markings, generally heavier than those of male. **UPPERWING.** Tertiaries, dark brown (21) with cream (54–92) fringes. Marginal, lesser and median coverts, dark grey (c83) with broad blue-grey tips, forming duller blue-grey wing-patch than that of male. Speculum, smaller than in male, with posterior border c. 20 mm from trailing-edge of wing, and less iridescent; shows dull-green gloss in some lights, but usually looks dark brown (c119). Outer secondary coverts have less extensive white tips than in male (c. 25 mm in male, <15 mm in female); bases and dark spot at tip, dark brown (c121). In some, dark spot connected to dark bases of feathers by narrow dark line. **UNDERPARTS,** off-white to pale brown (223D) with dark brown (c119A) mottling. All feathers, dark brown (c119A) with broad pale fringes; fringes, pale brown (223B) in breast, merging to off-white in belly, flanks and under tail-coverts. Fringes, occasionally dull reddish brown (38), perhaps by ferrous staining. Axillaries, white. **TAIL,** grey (80) below with white fringes. Outer rectrices have varying buff (124) to white markings, generally heavier than those of male. **UNDERWING,** as adult male.

**ADULT MALE NON-BREEDING (ECLIPSE)** Definitive basic. Eclipse plumage described below, on basis of skins and photographs, differs from adult female in several respects. Said to be identical, in nominate *rhynchotis*, to adult female, but no such birds found in museum collections; all eclipse males probably differ from females in wing-pattern. Many males in breeding plumage have head-pattern intermediate between eclipse and breeding plumage. This implies rather protracted head moult; variation may be related to supplemental plumage akin to that described for Northern Shoveler (BWP). Differences from adult female breeding: **HEAD AND NECK.** Front of lores, dark brown (121); feathers have off-white bases, sometimes partly exposed to give slightly speckled appearance. Hindlores to upper throat, off-white with slight dark-brown (121) speckling; also applies to female, but in male contrast with dark feathering in front gives appearance of muted facial crescent. Face, dark brown with less distinct off-white streaking than in female; feathers, dark brown (121) with off-white fringes, broadest in centre of feather and do not extend to base. Sides of neck and supercilium, similar but appearing slightly paler because off-white fringes broader. No trace of eye-stripe. Many have grey-blue tinge at sides of nape and upper neck. **UPPERPARTS,** as adult female. **TAIL,** as male breeding. **UPPERWING.** Tertiaries as breeding adult female; rest as adult male breeding. **UNDERPARTS.** Breast, belly and flanks, mostly patterned as breeding male, but ground-colour duller reddish brown (38). In lower flanks, at base of tail, feathers, white barred dark brown (121), giving appearance of muted flank spot. **TAIL,** as male breeding. **UNDERWING,** as adult male breeding.

**ADULT FEMALE NON-BREEDING** Basic. Age attained, unknown. Observed in five skins, three collected in winter and two without date of collection. Differences from breeding female: mantle, back and scapulars appear to have slightly more extensive pale brown scalloping than adult female breeding. Feathers, dark brown (129–21) with cream (54–92) fringes and cream (54) chevrons. Tertiaries have broader cream (54–92) fringes than adult female breeding, and broad broken horseshoe-shaped cream (54–92) marking near shaft. In some (possibly birds in first basic), marginal, lesser and median coverts have narrow buff (124) fringes, and broader buff (124) chevrons; these markings broadest near carpal joint. In other respects these feathers as adult female breeding.

**DOWNY YOUNG** **HEAD AND NECK.** Crown and hindneck, dark brown (21). Face, throat, sides of neck, and broad (c. two eye-widths) supercilium, light cinnamon-brown (39) or buff-yellow (53), fading paler in older chicks. Narrow dark-brown (21) to black-brown (c19) eye-stripe begins at top of upper mandible and extends far behind eye, meeting dark hindcrown in younger ducklings. Dark brown (c121) to black-brown (c19) rectangular spot in lower ear-coverts begins at level of hind-edge of eye and extends back almost to hind-neck, meeting it in some birds. **UPPERPARTS,** dark brown (c21), looking slightly paler (119A) in upper back because shafts are yellow-brown (123C). Four small cream (54) to white spots; one pair at base of wing-pad and one pair at extreme sides of lower rump. **TAIL,** dark brown (21). **WING-PADS,** dark brown (119A) with buff (124) or paler trailing-edge, which can be lost with wear. **UNDERPARTS,** cream (54) to off-white, tending to be yellower in upper breast, which has orange-buff (118) wash in smallest ducklings. Emergent underdown can make underparts of older ducklings look grey-white.

**JUVENILE MALE** Plumage lost at c. 3 months. Differences from adult female: **HEAD AND NECK.** Crown more uniform, paler brown than in female; feathers, brown (121A) with thin light-brown (121C) tips. **UPPERPARTS.** Feathers of mantle, back and scapulars, narrower than in female; dark brown (129, 21) with narrow buffish fringes. **TAIL-feathers** notched. **UPPERWING,** similar to adult female breeding, but secondary coverts, dark brown (c121) with white tips, mostly narrow but broad on outer webs of outer secondary coverts. Secondaries have narrow white tips, probably lost with wear. **UNDERPARTS,** chiefly off-white with extensive fine light-brown mottling, darker near uppermost breast. Feathers of upper breast, brown (119A–119B) with broad pale-brown fringes; of lower breast, paler generally; light brown (119c) with broad off-white fringes. **UNDERWING,** as adults.

**JUVENILE FEMALE** Differences from juvenile male: **UPPERWING.** Marginal, lesser and median coverts, dark brown (c121) with narrow grey-blue fringes; form predominantly dark brown shoulder patch with grey-blue scalloping.

**IMMATURE MALE** First basic. Apparently similar to eclipse male (Williams 1981).

**ABERRANT PLUMAGES** Female in MV shows partial albinism.

**BARE PARTS** Based on photographs in Pringle (1985), NZRD and unpublished.

**ADULT MALE (BREEDING, ECLIPSE)** Iris, yellow (55) to light yellow (157); captive breeding male had brown (121B) iris. Bill, grey-black (82) to black (89), sometimes with grey-brown (91) tinge to nail of lower mandible. Tarsus and tops of toes, mandarin-orange to orange-buff (153); webs, grey-black (82); claws, black (89). Soles, dirty white to orange with grey-black (82) tips to webs.

**ADULT FEMALE** Iris, dark brown (121A); orange-brown also recorded (ANWC). Upper mandible, dark grey tinged olive (greenish 80–greenish 79) with small irregular grey-black (82) spots or blotches; in many, culmen and tip, grey-black (82). In some, small dull yellow-orange (c106) patch at base of tomlia. Underside of lower mandible mostly mandarin-orange with grey-black (82) spots or blotches; tip, dark olive-grey (greenish 80–greenish 79); nail of lower mandible, grey (84). Feet and legs, brownish orange (not greenish grey, *contra* Frith 1982) with dark-grey (83) soles and webs.

**DOWNY YOUNG** Iris, dark brown (c20). Bill, dark

grey (83) with light pink (pale 7) tomtia and orange-pink (c6) nail; colour of underside of lower mandible, unknown. Feet and legs, dark brown (c129), with light pink (pale 7) edges to toes, and dark grey (83) webs.

**JUVENILE** Iris, dark brown (121A); that of male passing through light grey-brown (c119C) before becoming yellow at c. 4 months. Bill, as adult female, but some have slightly more yellow-orange at base of tomtia. Feet and legs, brown (c 119B), attaining adult colour at c. 4 months (Frith 1982).

**MOULTS**

**ADULT POST-BREEDING** Pre-basie. Complete; primaries simultaneous. In Aust., primary wear of ducks collected on opening days of shooting season (Feb.-Mar.) (Braithwaite & Norman 1974, 1976; Norman *et al.* 1984) suggests that most moult wings in mid-summer or early summer. Most have completed moult at time of open day in early Mar.; most adults still in moult are females. In NZ, remiges moulted from late Jan. to mid-Feb., with flightless period of 3 weeks. Adults moult in large numbers at some lakes; large samples caught in Feb. have consisted mostly of males, which suggests females moult at different time (Williams 1981).

**ADULT PRE-BREEDING** Pre-alternate. Partial, involving most or all body-feathers and perhaps lesser and median upper wing-coverts. Probably occurs in late summer or autumn; some males collected on opening days show moult of head and breast (MV).

**POST-JUVENILE** First basic. Partial; body-feathers and some or all rectrices moulted 2-3 months after hatching (MV).

**MEASUREMENTS** Nominat *rhynchotis*. (1) Aust., adults, skins (ANWC; HLW; MV). (2) Aust., adults, recently dead (Frith 1982).

	MALES	FEMALES	
WING	(1) 248 (6.11; 235-259; 14)	231 (6.11; 223-242; 9)	**
	(2) 239 (210-261; 74)	238 (210-297; 102)	
8TH P	(1) 159.2 (5.73; 150-172; 14)	149.2 (3.89; 144-158; 9)	**
TAIL	(1) 78.6 (4.26; 68-85; 15)	76.2 (2.31; 73-80; 9)	
BILL	(1) 61.9 (1.95; 56.9-64.5; 16)	58.5 (2.65; 55.0-64.7; 8)	**
	(2) 61 (56-67; 72)	60 (57-62; 69)	
TARSUS	(1) 37.6 (1.02; 36.0-39.0; 16)	35.4 (1.47; 32.0-37.9; 8)	**
TOE	(1) 50.9, 51.6, 56.1		

Subspecies *variegata*. (1) NZ, adult, skins (NMNZ). (2) NZ, adults, live; wing = flattened chord, width of bill taken at junction of tomtia and feathering, other methods as HANZAB (combined measurements of M.J. Williams, T.A. Caithness, W.J. Pengelly, NZ Wildl. Serv.). (3) NZ, juveniles, live; methods as in (2) (combined measurements of M.J. Williams, T.A. Caithness & W.J. Pengelly).

	MALES	FEMALES	
WING	(2) 245.5 (5.53; 230-258; 46)	230.5 (5.80; 214-241; 23)	**
	(3) 235.3 (8.24; 215-254; 45)	221.5 (5.56; 209-233; 33)	**
8TH P	(1) 157, 161, 164	153.4 (9.10; 148-169; 5)	
TAIL	(2) 84.8 (2.81; 78-92; 43)	79.9 (3.80; 73.3-87; 22)	**
	(3) 81.6 (4.82; 71-89; 41)	77.3 (3.95; 71-86; 32)	**
BILL	(2) 62.1 (2.45; 56.0-67.3; 46)	56.8 (2.45; 52.7-60.5; 23)	**

	(3)	61.2 (2.90; 54.4-67.8; 45)	56.8 (1.75; 54.3-60.7; 31)	**
BILL W	(2)	18.3 (0.63; 16.8-19.9; 47)	17.2 (1.178; 15.0-19.6; 22)	**
	(3)	17.6 (0.70; 15.7-19.0; 43)	17.1 (0.58; 16.4-18.6; 29)	**
TARSUS	(2)	36.5 (1.39; 31.2-39.0; 47)	35.7 (1.04; 34.0-37.3; 21)	**
	(3)	36.3 (1.24; 32.5-38.0; 44)	35.2 (1.34; 32.6-38.6; 33)	**
TOE	(2)	52.7 (2.21; 49.2-62.7; 46)	51.2 (2.43; 48.0-58.6; 21)	*
	(3)	52.4 (1.98; 46.8-59.9; 44)	49.9 (1.59; 46.5-53.6; 33)	**

Juvenile has significantly shorter wings and tail than adult. Both subspecies seem to be same size, but no large series of comparable measurements available.

**WEIGHTS** Nominat *rhynchotis*: adult males 667 (570-852; 76; Frith 1982); adult females 665 (545-745; 70; Frith 1982).

Subspecies *variegata* (NZ Wildl. Serv. data, M.J. Williams): adult males 637 (46.88; 540-750; 43), adult females 614 (46.20; 530-708; 32), juvenile males 610 (65.71; 440-740; 42), juvenile females 571 (47.1; 500-660; 33). Sex differences, and differences between adults and juveniles, significant. No information on seasonal changes.

**STRUCTURE** Wing, short and pointed. Eleven primaries; p9 longest, p10 1-7 shorter, p8 5-10, p7 14-22, p6 26-39, p5 45-55, p4 61-73, p3 73-92, p2 86-107, p1 102-121; p11 minute. Outer web of p9, and inner webs of p9 and p10, slightly emarginated. Seventeen secondaries, including five tertials. Tail, slightly rounded, 14 feathers; t1-t7 c. 25-30. Rectrices pointed in adults, notched in juveniles. Bill, elongate (longer than head), looking spoon-shaped from above; bill, considerably deeper than broad at base but distal end flattened, broad and rounded. Culmen, straight to slightly concave; distal ends of upper tomtia obscure tip of lower mandible. Upper tomtia lined by long lamellae, visible from sides; narrow nail, about one-sixth maximum length. Tarsus, short, laterally compressed; scutellate in front, reticulate elsewhere. Middle toe longest, outer 80-90%, inner c. 70%, hind c. 25%.

**GEOGRAPHICAL VARIATION** Two subspecies have been recognized: *rhynchotis* from Aust. and *variegata* from NZ. Claimed that only adult-male breeding plumages differ but differences probably spurious (P.J. Fullagar). Claimed differences in *variegata* are: white facial crescent with less black speckling than in *rhynchotis*, even none; centre of throat, in fresh plumage, blue-grey with thin white streaks and blue-grey tips to feathers, which are lost with wear, giving appearance identical to *rhynchotis*; upper breast, white mottled black-brown (119) by subterminal fringe to feathers, sometimes with buff (124) tinge to tips; varying amount of white on breast, in some only on sides and then little difference from *rhynchotis*, in others, over whole upper breast; folded wing, partly covered by lateral breast-feathers to give impression that scapulars predominantly white; flanks said to have fewer dark markings than *rhynchotis* (Madge & Burn 1988). Sibson (1967) suggested that variation of coloration in NZ males was caused by hybridization with vagrant *rhynchotis*. Captive *variegata* develop 'complete' eclipse (Delacour 1954-64), presumably identical to adult female. Two skins (NMNZ) have head pattern of adult female, but rest of plumage similar to eclipse of *rhynchotis*.

DIR

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Volume 1 (Part B), Plate 95

Northern Shoveler *Anas clypeata*

1. Adult male breeding
2. Adult female
3. Adult male breeding (flight), ventral
4. Adult male breeding (flight), dorsal
5. Adult female (flight), dorsal

Australasian Shoveler *Anas rhynchos*

6. Adult male breeding, subspecies *rhynchos*
7. Adult male breeding, subspecies *variegata*
8. Adult male non-breeding
9. Adult female
10. Juvenile female
11. Juvenile male
12. Downy young
13. Adult male breeding (flight), ventral
14. Adult male breeding (flight), dorsal
15. Adult female (flight), dorsal

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