

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 Sowsls (1955) [migration and habits]; Johnsgard (1965a) [complete review of behaviour]; Hochbaum (1944); Driver (1974) and Kear & Berger (1980) [species monographs].

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Family ANATIDAE wildfowl

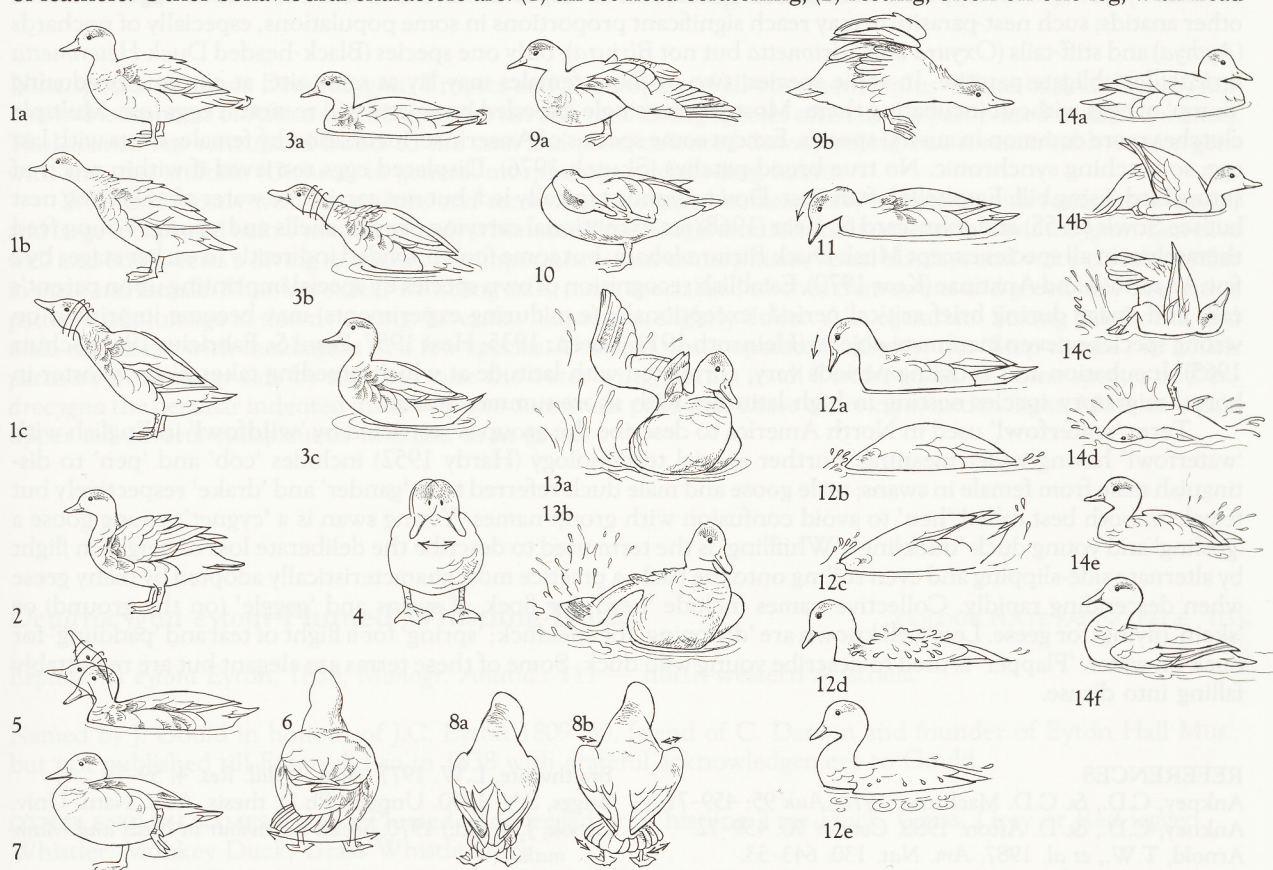
Waterbirds (some more or less terrestrial) with rather short legs and front toes connected by webs; hallux elevated and reduced. Though considerable adaptive diversity in outward appearance, size, colours of plumage, behaviour, and ecology, homogeneous in many characters, as attested by numerous, often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

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

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

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

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



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

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

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

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

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Sub-family ANATINAE ducks

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

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

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

Perching ducks and aberrant species

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

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

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

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

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

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

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

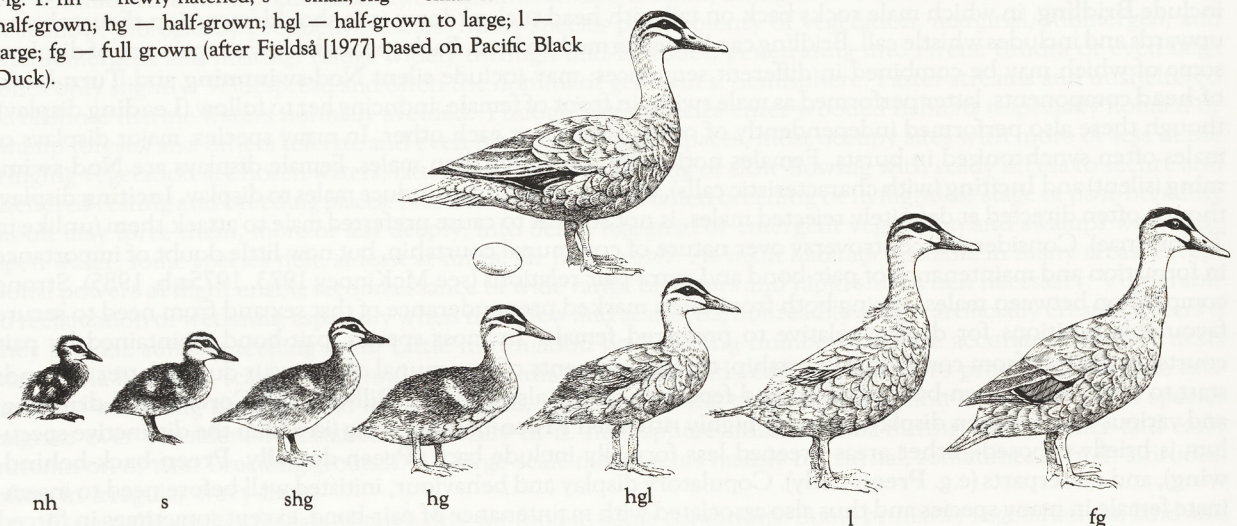
Essentially surface feeders, though dive for food in some conditions. Some primarily vegetarian, on land and

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

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

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

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



Pochards

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

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

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

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

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

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Anas superciliosa Gmelin, 1789, *Syst. Nat.* 1: 537; based on 'Supercilious Duck' of Latham, 1785, *Gen. Syn. Birds*, 3: 497 — New Zealand.

The specific name refers to the prominent pale supercilium or eyebrow.

OTHER ENGLISH NAMES Grey, Black, Brown or Wild Duck; Australian Wild Duck; Blackie; Australian or Australasian Wild Duck; Gray Duck (Phillips 1923).

The qualifier, **Pacific**, is needed to distinguish from allopatric Black Ducks *A. sparsa* in Africa and *A. rubripes* in North America. **Grey Duck** is the standard and perfectly appropriate name in Micronesia and NZ, where **Black** will probably never be accepted, any more than **Grey** will be in Aust.

MONOTYPIC

FIELD IDENTIFICATION Length 47–60 cm, of which body just over two-thirds, male averaging larger; wingspan probably 80–100 cm. Large, heavily built, dabbling duck with rather long head and bill; *unique bold head pattern*. Large dark duck with conspicuous white underwings in flight. Very widespread distribution throughout our area; even to some subantarctic islands but not Antarctica. Sexes similar but usually distinguishable on plumage details and with certainty by voice and behaviour. Small seasonal differences in plumage detectable in field. Juvenile closely resembles adult, but just distinguishable.

DESCRIPTION ADULT MALE BREEDING. Black crown; off-white supercilary eye-stripe; bold black stripe through eye; off-white to very pale yellow or cream coloured cheeks and throat (very conspicuous feature) with black malar stripe across face from corner of bill to below and behind eye. Rest of body, dark grey-brown, with scaly effect produced by pale edging to body feathering. Neck, distinctly grey, especially hindneck, which is soft grey and fluffy feathered; back and rump, almost black. Underparts, paler more uniform than flanks or mantle. Speculum, green or purple according to light; edged with black and white at front and rear. Wings, dark brown above, white on under wing-coverts and axillars. Tail, dark brown, paler on outer margins of each

feather, which gives slightly paler look to tail of swimming bird. Body-moult incompletely understood but certainly give rise to small variations in plumage, most obviously seen in hand by presence of either uniformly plain breast-feathers or bold 'chevrons' caused by drop-shaped or U-shaped markings at centres of each feather. Tertiaries, large uniformly black-brown and conspicuously covering folded wings in resting position. At distance on water appear black with light head and at considerable range head pattern is discernible. Bill, grey or grey-green with black nail; eyes, brown; feet, grey-green to dusky-orange. **ADULT MALE NON-BREEDING.** Indistinguishable but see moults. **ADULT FEMALE BREEDING.** Similar to male but distinctly more strongly marked by presence of pale buff edges to many feathers. Crown rarely so dark as in male; typically, browner and distinctly streaked. Boldly patterned tertiaries are characteristic of females (see Fig. 2). Back and rump, brown, rarely black as in male. **ADULT FEMALE NON-BREEDING.** Strictly ill-defined condition for purposes of identification, but, after breeding, females moult body-feathers so that there is often plumage less strongly marked and, most strikingly at this time, the tertiaries are replaced briefly by feathers that are uniform in colour, at least in most individuals (see details under moults). **JUVENILE.** Similar to adult but easily recognized by uniformly streaky appearance to underparts, especially breast and lower

foreneck; tertials in both sexes usually show faint pattern, as in adult females. Dark coloration of ducklings with contrasting yellow hues and pattern on face diagnostic in our region; but see Mallard *A. platyrhynchos*. No eclipse plumage in males. Moults of body feathering continuous in adults with only significant feature being appearance of tertials. These are different in males and females and at some moults the female changes pattern of these feathers (P.J. Fullagar). Post-juvenile moult at 3 months limits duration of recognizable juvenile plumages. See details under moult.

SIMILAR SPECIES Large dark duck with paler head and neck, no conspicuous pale tail (cf. Mallard female); white underwings. Confusion with female or eclipse male **Mallard**, or domestic varieties of Mallard possible. Needs to be distinguished from female or dull eclipse plumage **Australasian Shoveler** *A. rhynchos* (smaller and slimmer build, poorly defined eye-stripe, much larger bill, narrow wings set far back in flight, appearance caused by large bill; blue upper forewings); female or eclipse male **Maned Duck** *Chenonetta jubata* (small bill, brown head with head pattern vaguely recalling that of Pacific Black Duck, spotted breast and underparts, pale grey tertials, white speculum and pale-grey upper forewings); from **Freckled Duck** *Stictonetta naevosa* (uniformly spotted dark-grey plumage and characteristic shape of bill, no speculum and pale not pure white under wing-coverts); longer neck with head carried low giving more hump-backed appearance in flight and short inconspicuous tail). Downy ducklings differ from other species in boldly striped yellow face. Only similar ducklings are those of Hardhead *Aythya australis*, which have paler eye-stripe on clear yellow facial disk. Ducklings of Mallard or Mallard-derived forms and their hybrids with other similar species not easily told from those of true Pacific Black Duck.

Catholic in choice of habitat and found on all types of fresh and salt water from pools to open sea; however, most characteristic of rather deep permanent swamps with dense vegetation. Swim high on water with tail above surface, except breeding female in which tail often depressed onto surface. Young dive freely and adults occasionally do, especially when bathing. Feed by filtering at surface of water or in soft muds (suzzling) and upending in shallow water. Will strip seed heads from aquatic plants and pick up grain. Not recorded diving for food (see, e.g., Woodall 1984). Can rise swiftly from water by leaping straight up, with first wing beat into water. Fly with shallow wing beats that produce loud whistling sounds. Readily come on land and walk or run easily with nearly horizontal carriage. Gregarious, though most often seen as pairs. Female has loud diagnostic quacking calls; male has soft nasal *raehb* and soft whistles and grunts associated with displays.

HABITAT On temperate and tropical terrestrial wetlands and sheltered estuarine and marine waters. Use aquatic and terrestrial habitats; feed in shallow or deep water, often among aquatic or marginal vegetation, or out of water on wetland shores, exposed mudflats or pastures, especially where moist or flooded; rarely on dry ground (Frith *et al.* 1969; Briggs 1979; Norman *et al.* 1979; Bekle 1983). Prefer shallow productive wetlands of low salinity where areas of open water interspersed with ample vegetational cover, even tolerating wooded country with overhead canopy. Although permanent, densely vegetated wetlands may be strongholds (Frith 1982), birds can use almost any pool, puddle, drain, channel, creek or farm dam, no matter how small (Badman 1979; Frith 1982; Fjeldså 1985); numbers on small wetlands

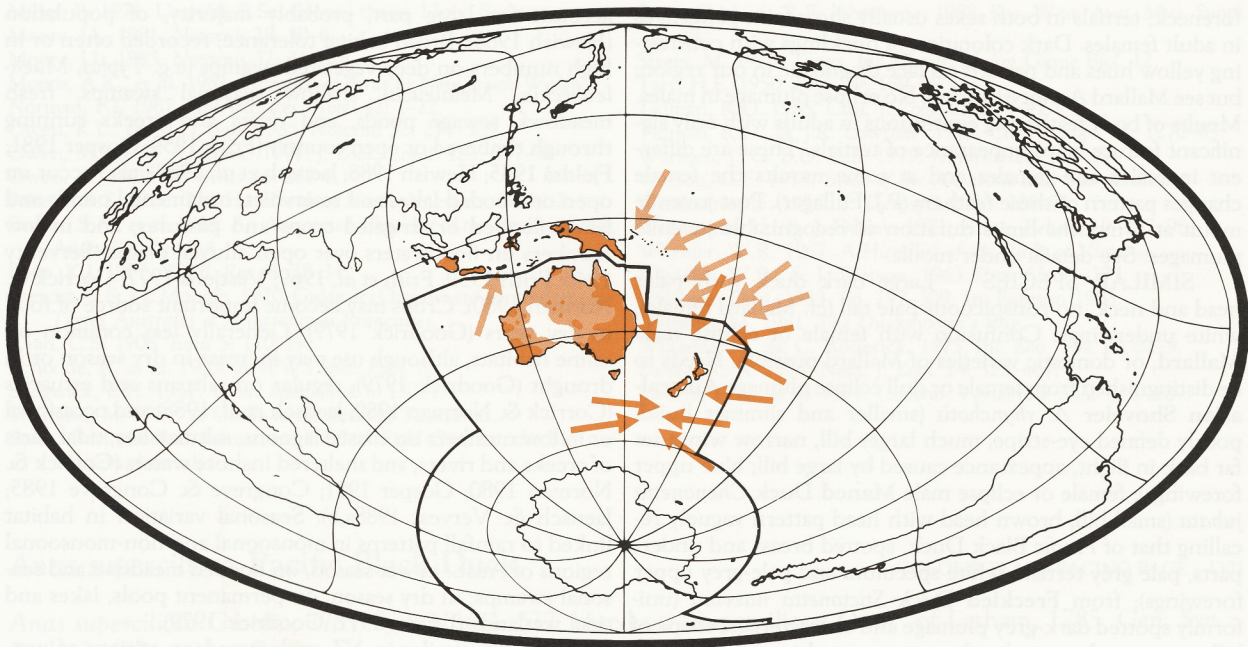
account for large part, probably majority, of population (Hewish 1988). Broad habitat tolerance; recorded often or in high numbers on deep vegetated swamps (e.g. *Typha*, *Muehlenbeckia*, *Melaleuca*), shallow seasonal swamps, fresh meadows, sewage ponds, and rivers and creeks running through timbered or open country (Frith 1959; Gosper 1981; Fjeldså 1985; Hewish 1988; Jaensch *et al.* 1988); also occur on open or wooded lakes and reservoirs, ornamental ponds and lakes, flooded or irrigated crops and pastures, and in low numbers on floodwaters over open alluvial plains (Serventy 1948; Frith 1959; Frith *et al.* 1969; Vestjens 1977; Corrick & Norman 1980). Crops may become important source of food in dry years (Goodrick 1979). Generally less common on saline habitats, although use may increase in dry season or in drought (Goodrick 1979); regular on salt pans and estuaries (Corrick & Norman 1980; Jaensch *et al.* 1988) and occasional or in low numbers on coastal lagoons, saltmarshes, tidal parts of creeks and rivers, and sheltered inshore waters (Corrick & Norman 1980; Gosper 1981; Congreve & Congreve 1985; Jaensch & Vervest 1988a,b). Seasonal variation in habitat linked to rainfall patterns in monsoonal and non-monsoonal regions of Aust.: in wet season, on flooded meadows and seasonal swamps; in dry season, on permanent pools, lakes and tidal wetlands (Lavery 1971; Goodrick 1979).

Habitats similar in NZ; widespread on variety of wetlands, including those in mountain or forested regions, with preference for productive waters with abundant aquatic and marginal vegetation. Regularly take refuge at sea during hunting season, especially off river mouths (Balham 1952; Potts 1977). Agricultural habitats and ornamental ponds rarely used in NZ, where introduced Mallard *A. platyrhynchos* now dominant in settled areas. On subantarctic islands, marine habitats accessible and regularly used, and birds inhabit beaches, tidal pools, wind-rowed kelp, and inshore waters (Bailey & Sorensen 1962; Horning & Horning 1974; Norman 1987); fresh waters may be less productive than coastal waters in subantarctic climate, and limited in extent, especially when frozen in winter. On Chatham Is, even ducklings feed in brackish pools on wave platforms, because freshwater is scarce (Horgan 1971). However, freshwater wetlands used where available, especially lowland bogs, fens and swampy herbfields and tussock grasslands (Norman 1987).

Breed throughout range. Catholic in choice of site; away from water in grassland, cropland, scrubland and forest, or in or beside almost any wetland, fresh or saline, tidal or non-tidal, permanent or ephemeral; on Macquarie I., on offshore rock stacks isolated at high tide (Costello 1981; Frith 1982; Owen & Sell 1985; Norman 1987).

Fly readily, reaching considerable heights. Loaf on open water, grassy banks and islands, mudbanks and dead trees and logs; loafing sites often partly or entirely surrounded by water (Bekle 1983; Norman *et al.* 1979). Underwater, feeding limited to depths reached by upending.

In Aust., many wetlands suitable for feeding and breeding modified or destroyed by drainage, increased salinity, clearing, grazing and burning (Riggert 1966; Goodrick 1970; Corrick & Norman 1980; Corrick 1981, 1982); but make much use of artificial wetlands (Braithwaite *et al.* 1985) and have become adapted to farm dams, drainage channels, irrigated pastures, croplands, urban wetlands in agricultural and settled areas; may depend on crops for food in dry years (Goodrick 1979). In NZ, introduced Mallards more widespread than in Aust. and dominate agricultural regions; Pacific Black Ducks increasingly restricted to few remaining



undrained swamps in undeveloped areas (Caithness 1974).

DISTRIBUTION AND POPULATION Aust., NZ and NZ islands, and Macquarie I.; numbers decline where it hybridizes with Mallards. Extraliminally: Indonesia, from s. Sumatra, Java and Sulawesi, through New Guinea, New Britain and New Ireland, the Solomon Is, New Hebrides, New Caledonia, to Caroline Is, Fiji, Tonga, Samoa, Cook and Society Is.

AUST. Throughout, except arid regions where rare vagrant or casual breeder. **Qld.** Throughout, including Torres Str. islands and islands off e. Qld (Draffan *et al.* 1983; Aust. Atlas). **NSW.** Throughout, especially Murray-Darling basin and ne. NSW (Morris *et al.* 1981). **Vic.** Throughout (Vic. Atlas). **Tas.** Throughout, including offshore islands, also King and Furneaux Is (Green 1977; Thomas 1979; White 1985). **SA.** Widespread, mostly e. SA, also Kangaroo I. (Parker *et al.* 1985). **WA.** Throughout, rare or absent interior regions (Serventy & Whittell 1976). **NT.** Throughout, mostly n. NT (Aust. Atlas).

NZ Throughout NI, SI and Stewart I. and larger offshore islands, including Great Barrier I., also Kermadec, Chatham, Snares, Auckland and Campbell Is (NZ Atlas; Falla *et al.* 1981; NZCL).

LORD HOWE I. Vagrant, casual breeder; possibly first recorded Dec. 1852, listed 1882, later recorded 1934, 1941-45 (several breeding), 1952, 1956-57 (flock of 100 which gradually decreased), 1962-63 (breeding attempted), 1972 (bred) (Fullagar *et al.* 1974; Hindwood 1940; Hindwood & Cunningham 1950; McKean & Hindwood 1965; Ramsay 1882). Population since 1975 mostly hybrid or Mallard-type (P.J. Fullagar).

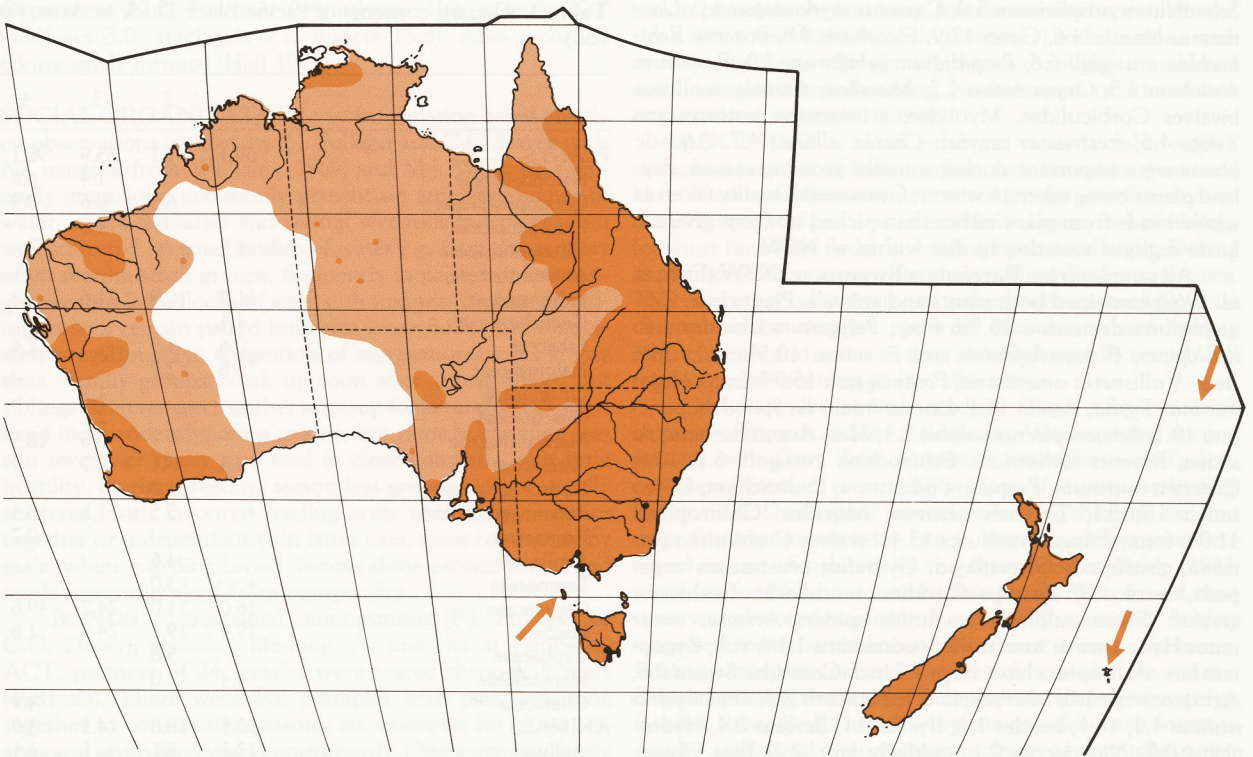
NORFOLK I. Originally vagrant, casual breeder; first recorded 1804-05; with breeding first recorded 1909; several records in 1960s-70s included breeding; now uncommon resident and regular visitor, mostly hybrid and Mallard-type (Bassett Hull 1909; de Ravin 1975; Hermes 1985; Iredale 1911; Ramsay 1888; Schodde *et al.* 1983; von Pelzeln 1860).

MACQUARIE I. Winter records suggest resident population, but numbers may be supplemented by visitors (Warham 1969; Watson 1975), mostly hybrids (Norman 1987).

POPULATION Indices of abundance from annual aerial survey (transect counts) of e. Aust. wetlands 1983-88 were 67 474; 163 492; 20 752; 17 878; 15 514; 10 052 respectively (Braithwaite *et al.* 1985a,b, 1986, 1987; Kingsford *et al.* 1988, 1989). Counts in Vic. in summer surveys, 1987-89, were: 22 837 on 332 wetlands; 32 970 on 472 wetlands; 40 781 on 626 wetlands respectively; making up 11-13% of all ducks counted (Martindale 1988; Hewish 1988; Peter 1989). Counts in sw. Aust., 1986-88, were: 14 245 on 872 wetlands; 39 129 on 1201 wetlands; 33 300 on 1398 wetlands respectively (Jaensch & Vervest 1988a,b). Estimated 15 000 at Bool Lagoon, se. SA, Dec. 1980 (Parker *et al.* 1985). Maximum 2000, Townsville area, n. Qld, 1959-63 (Lavery 1970a). In NZ, total population estimate of 1.5 million in 1970, declining to 1.2 million by 1981, corresponding with increase in Mallards and hybridization between the two species; in 1960, Pacific Black Duck formed 95% of *Anas* population, but less than 20% in 1985. Same threat occurring in se. Aust. and Norfolk I. as Mallard spreads (NZ Atlas; Haddon 1984; Hermes 1985; Parker *et al.* 1985; NSW Bird Rep. 1983; Vic. Atlas).

Pre-season counts in Vic. indicate exposure to shooting high; 68-72% of total numbers on waters open to hunting (Martindale 1988; Hewish 1988; Peter 1989). Shot much and usually form high proportion of total bag in se. Aust.; favoured target, selectively taken by shooters (Norman *et al.* 1984; Briggs *et al.* 1985; Loyn 1987). High proportion of Pacific Black Ducks on sample of waters in Vic. shot in 1987 open season, but in that year most of population probably secure on inland waters (Loyn 1987).

MOVEMENTS Dispersive from inland areas in summer but largely sedentary on permanent water or in well-watered regions. Reporting rate in Vic. highest spring and summer (Vic. Atlas) when varying numbers move SE from inland



(Frith 1963) though at least part of population sedentary. Also considered sedentary se. Qld where counts in Oct. showed little annual variation and no correlation with rainfall (Woodall 1985); monthly counts on Hunter and Richmond Rs, n. NSW, show seasonal influx to coast, Mar.-Oct. (Gosper 1981) with little variation between years (Gosper *et al.* 1983). On New England Tableland, NSW, numbers positively correlated with rainfall, temperature and water-level, numbers generally fewer in winter (Whyte 1981) and congregate on permanent water during drought (White 1987). In n. Qld, apparently sedentary on permanent waters (Draffan *et al.* 1983; Garnett & Bredl 1985) but much movement during dry season, probably crossing Torres Str. Birds from elsewhere in n. NT appear to congregate in area of Alligator Rs in dry season but some may also come from s. Aust. (Morton *et al.* 1989). Similarly most records from near Darwin, NT, July-Oct. (Crawford 1972) and at Ord R. Irrigation Area, Sept.-Dec. (Gowland 1988). In NZ, few data on movements but banding returns widely scattered (see Banding). At Waimea Inlet, n. SI, numbers peak in Apr. falling again by June (Owen & Sell 1985). Apparently sedentary Macquarie I. though original stock probably arrived from Aust. (Norman 1987).

BANDING Dispersive movements more obvious from banding recoveries: 23% of 396 recoveries from Griffith, NSW, 320 km from banding place with six travelling to Tas. and two to n. Qld (Frith 1959); 49.0% of 1312 recoveries > 100 km from banding place in Vic.; 7.4%, >400 km, with 42 reaching Tas., two, Qld and one, Otago, NZ. Birds banded Serendip, central Vic., tended to move W to w. Vic., E to Gippsland lakes or N to Murray R. and tributaries with no evidence of return to near site of banding (Norman 1973); birds banded SA tended to move E or NE and also showed no evidence of return (Norman 1971). Similarly, disperse widely round NZ (NZNBS; Fig. 1).

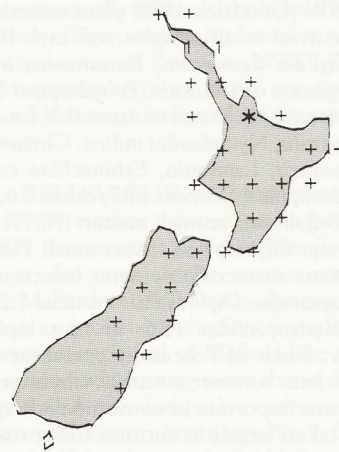


Fig. 1. 37S 175E 1X1 % NZNBS

FOOD Mostly plant material, particularly seeds of aquatic and waterside vegetation, though animal matter, particularly aquatic insects and crustaceans such as freshwater crayfish, probably underestimated in gizzard samples. **BEHAVIOUR.** Food obtained by dabbling at surface, up-ending to reach submerged food and grazing, seed heads often being swallowed whole. Also recorded diving in shallow water (Sedgwick 1958) and flocks recorded herding shrimp into shallows (Hall 1909). Sometimes steals food from Hardhead *Aythya australis* and conspecifics (Woodall 1984). Most feeding at night, when 63.5% time spent feeding; during day 36.5% (25 h observations; Bekle 1983).

ADULT Summarized Table 1. Plants in samples from w. NSW (Frith 1959) incl. *Myriophyllum* 3.8% vol.,

Scleroblitum atriplicinum 5.0, *Cucumis myriocarpus* 4.0, *Certhamus lanatus* 4.6, *Carex* 12.9, *Eleocharis* 0.8, Poaceae *Echinochloa crus-galli* 6.6, *Paspalidium jubiflorum* 2.0, *Paspalum distichum* 3.5, *Oryza sativa* 2.2, *Marsilea*; animals: molluscs bivalves Corbiculidae, Mytilidae; crustaceans notostracans *Triops* 1.5, freshwater crayfish *Cherax albidus* 4.7. Aquatic plants were important during summer growing-season; dry-land plants being taken in winter. Grass seeds usually taken as whole heads from plant rather than picked up from ground. Little regional variation in diet within w. NSW.

All samples from **Barrenbox Swamp, w. NSW** (Frith *et al.* 1969) contained both plants and animals. Plants incl. *Ceratophyllum demersum* 26.5% freq., *Polygonum aviculare*, *P. hydro Piper*, *P. lapathifolium* and *P. minus* 10.5% vol., 36% freq., *Vallisneria americana*, *Potamogeton* 15.9% freq., *Najas marina*, *Typha*, *Azolla* 14.1, *Lemna minor* & *Spirodela punctata* 19.1, *Schoenoplectus validus* 7.3, 22.6, *Avena barbata*, *A. sativa*, *Bromus catharticus*, *Echinochloa crus-galli* 5.7, 10.6, *Critesion murinum*, *Paspalum dilatatum*, *P. distichum*, *Oryza sativa* 5.7, 8.1, *Triticum aestivum*, *Marsilea*, *Chlorophyta* 11.0% freq.; animals: molluscs 13.4: bivalves *Corbiculina permena*, gastropods *Glyptophysa*, *Gyraulus*; crustaceans copepods, ostracods, shrimps *Caridina mccullochi*, freshwater crayfish *Cherax albidus*; arachnids spiders *Arctosa*, water mites *Hydracarina*; insects 41.3: odonatan 1.1% vol., *Zygoptera* larv. *Anisoptera* larv., bugs 7.7 incl. *Corixidae* *Sigara* 0.8, *Agraptocorixa* 1.0, *Micronecta* 0.1, *Naucoris* 2.3, *Diplonychus rusticus* 4.3, 14.1, beetles 1.2, *Ilybius* 0.1, *Berosus* 0.4, *Hydrophilus* 0.7, *Notomicrus* 0.1, caddisfly larv. 2.2, flies *Chironomidae* larv. 0.2.

In **coastal NSW** (Goodrick 1979) plant material, almost entirely seeds, occurred in all samples and incl. *Nymphaea capensis*, *Ceratophyllum demersum*, *Ranunculus inundatus*, *Polygonaceae* *Polygonum attenuatum*, *P. hydro Piper* 5.8% vol., *P. minus* 2.0, *P. orientale*, *P. praetermissum* 0.3, *Ludwigia peploides*, *Cuscuta australis*, *Nymphoides indica*, *Cirsium vulgare*, *Potamogeton*, *Eleocharis*, *Lepironia*, *Echinochloa colona* 6.9, *Phalaris* 1.9, *Pseudoraphis spinescens* 14.5, other 2.6, 4.9 (incl. *Amaranthaceae*, *Trifolium*); animal matter (76.7% fr.) incl. molluscs 25.2% freq.: *Glyptophysa*, other small Planorbidae, *Plotiopsis*; crustaceans ostracods; spiders; insects odonatan larv., bugs Belostomatidae *Diplonychus rusticus* 7.2, beetles, *Dytiscidae* 18.2, *Hydrophilidae* 10.1, fly larv. lepidopteran larv., caddisfly larv. Seeds of Poaceae, Cyperaceae and *Polygonum* important late summer-autumn when grassy flats flooded; swamp plants important late autumn to early summer and lagoon plants taken largely in autumn and spring to early summer, variation in diet following seasonal flooding and drying. In dry spring also noted feeding in harvested grain fields where seeds of maize and barley predominated in contents of oesophagus and gizzard.

In **n. Qld**, gizzards contained almost entirely plant material, principal foods being Cyperaceae (wet season 81.2% vol., 81% freq., n=26; dry season 29.3, 61, 2346, incl. *Eleocharis dulcis*, *Scirpus litoralis*) with *Polygonum* also important in dry season (Lavery 1966, 1970b, 1971). Other plants incl. *Nymphaea*, *Ceratophyllum demersum*, *Nymphoides indica*, *Echinochloa colona* with most animals being insects, though in estuarine environments also taking the mollusc *Neritina ovalis* 0.66 cm (0.32, 11; Lavery 1972).

In **NZ** (56; Turbott 1946) mostly seed with some vegetable matter and animal remains; plants incl. *Polygonum*, *Rumex*, *Myriophyllum*, *Ludwigia repens*, *Coprosma*, *Gallium*, *Alisma plantago-aquatica*, *Elodea canadensis*, *Ottelia ovali-*

Table 1. Gizzard contents of Pacific Black Duck in Aust. (% vol.).

	1	2	3	4
PLANTS	69.5	81.2	85.9	96.1
Nymphaeaceae			1.4	6.8
Ceratophyllaceae		6.6	0.6	0.9
Ranunculaceae			4.8	
Chenopodiaceae	5.2			
Amaranthaceae			+	
Polygonaceae	11.7	10.8	21.6	9.3
Cucurbitaceae	4.4			
Fabaceae	0.6	1.9	+	2.6
Haloragaceae	3.8	2.7		
Onagraceae			1.2	
Cuscutaceae			2.1	
Menyanthaceae			0.6	16.5
Asteraceae	2.5	3.1	0.7	
Hydrocharitaceae		1.0		
Potamogetonaceae	+	5.5	1.1	0.4
Rubiaceae				0.7
Azollaceae		4.6		
Lemnaceae	+	3.0		
Cyperaceae	16.0	11.0	24.7	49.6
Poaceae	19.4	19.1	24.9	1.6
Typhaceae		5.0		
Marsileaceae	4.4	2.0		
Characeae				4.9
ANIMALS	30.5	18.8	14.1	3.9
molluscs	13.2	5.1	+	1.1
insects	10.5	12.2	+	2.2
crustaceans	6.3	+	0.6	
No. gizzards	832	283	916	2372

(1) Frith (1959). (2) Frith *et al.* (1969). (3) Goodrick (1979). (4) Lavery (1971).

folia, *Valisneria spiralis*, *Triglochin*, *Potamogeton cheesmanii*, *P. pectinatus*, *Ruppia maritima*, *Zostera*, *Baumea rubiginosa*, *Carex*, *Eleocharis*, *Scirpus lacustris*, *Echinochloa crus-galli*, *Nitella*, *Sparganium subglobosum*; animals: molluscs *Planorbis*, *Potamopyrgus antipodorum* and insects bugs *Corixidae*, flies *Chironomidae* larv., caddisfly larv. At Taiakatahuna and Himintangi (4 stomachs, 387 seeds; Balham 1952) *Ranunculus repens* <1% vol., 4.1% no., 50% freq., *R. spp* <1, 2.8, 50, *Polygonum persicaria* <1, 0.3, 25, *Rumex conglomeratus* <1, 1.0, 50, *Trifolium repens* 18, 22, 31.8, 25, *Trifolium sp.* 53, 46.0, 50, *Carex* 25, 13.2, 75, *Scirpus fluviatilis* <1, 1.5, 25; insects caddisfly larv. <1, -, 50.

Also recorded: plants *Muehlenbeckia cunninghamii* leaves, flowers (Vestjens 1977), *Cleome viscosa* seed (Gowland 1988), *Solanum americanum*, *Coprosma*, Cyperaceae (Merton 1970), *Avena sativa*, *Digitaria sanguinalis*, (Rose 1973), *Echinochloa* (Gowland 1988), *Paspalum dilatatum* (Rose 1973), *Sorghum*, commercial sorghum, commercial maize (Gowland 1988), commercial rice (Ellis 1940; Gowland 1988); gastropods *Physa* (Rose 1973); crustaceans shrimps, freshwater crayfish (Hall 1909); spiders (Merton 1970); insects mayflies *Caenidae* (Rose 1973), orthopterans *Tettigoniidae* (Gowland 1988), *Teleogryllus commodus* (Rose 1973), beetles *Anoplognathus* (Rose 1973).

YOUNG In n. Qld took similar food to adults (49 gizzards, 0-15 weeks; Lavery 1971): plants 72.3% vol. (*Nymphaeaceae* 9.4, *Menyanthaceae* 7.1, *Polygonaceae* 6.8,

Cyperaceae 27.0, Poaceae 10.4, others 11.6), animals 27.7 (molluscs 3.0, arachnids 9.2, insects 15.5). Also recorded taking small shrimps (Hall 1909).

SOCIAL ORGANIZATION Information based mostly on observations in Aust. by P.J. Fullagar and C.C. Davey with NZ material from Williams (1969) and M.J. Williams. Generally gregarious; commonly present on any large bodies of water, rivers, estuaries and coastal wetlands but pairs often well scattered on small bodies of water e.g. farm dams. Most often seen in small groups, frequently in pairs, but can congregate into large flocks of several thousands. Outside breeding season, remain paired but form loose flocks and moderately gregarious. No suggestion of segregation by sex at any time. Family groups break up soon after young fledge, but siblings often remain together as group for several weeks after. Feed independently, often as pair, but outside breeding season several or many may feed in close company with little hostility. During breeding season less gregarious and usually scattered, with favoured feeding areas used by pair either together or independently; in latter case, most commonly by male; when guarding brood, female alone escorts brood and tends to remain aloof from conspecifics.

BONDS Sustained monogamous (P.J. Fullagar & C.C. Davey); probably life-long. At one site at Canberra, ACT, partners of 24 females were traced through 5 years (1981-85). There were five examples with pair remaining together in consecutive seasons; six examples for three seasons and seven for 4 years continuously. One instance of male switching to another female between consecutive seasons (P.J. Fullagar & C.C. Davey). No examples of divorce have been observed in wild. Bigamous temporary associations have been observed, but this appears to be simultaneous polygynous behaviour, not fully understood. No clear evidence of polyandrous matings (P.J. Fullagar & C.C. Davey) but extra-pair copulations may occur in some circumstances, see McKinney *et al.* (1983). Pair-formation takes place late summer or early autumn, in s. Aust.; mainly involves young of year, but also unpaired adults that have lost partners, or broken pair-bond, which is rare. Pair-bond then maintained indefinitely and partners remain in close contact at all times except during rearing of brood, and often, apparently, during wing-moult. Female incubates; no parental care by male though remains in loose contact with female and brood during rearing and tolerated by female, unlike any other congeners. No crèche formation. Family group breaks up after fledging though siblings may remain together for few weeks but often disperse independently soon after attaining flight. Typical of *Anas* ducks, male disperses more widely than female (P.J. Fullagar).

BREEDING DISPERSION Solitary nesting, but nest-sites often close and crowded if location provides enough favourable sites. No accurate measurement of distances between nests in fully natural conditions, but densities of 11 to 38 nesting attempts per season, in seven seasons, in 2.5 hectares have been observed (average 23) in semi-natural wetlands with artificial nest-sites and nesting boxes at Canberra, ACT (P.J. Fullagar & C.C. Davey). Essentially non-territorial. Approaches to nest-site defended loosely by male from time of site-selection to early, later or whole period of incubation. Hostile to other pairs; male on guard often attempts to escort them away from small critical area. Effectiveness appears highest during laying and early incubation (probably reflecting mate-guarding function) and usually diminishes as incu-

bation proceeds. At hatching, female extremely protective of small area round brood (moving territory) and she alone continues to maintain this protected area throughout early and middle stages of brood-rearing. No indication of other forms or periods of territorial activity.

ROOSTING Loaf either on water or ashore often using low perches of fallen timber, tree branches, posts and like. Often loaf in loose unstructured groups, save for obvious close company of partners of established pairs, and of siblings for short time after fledging. Loafing by day and night. During incubation, characteristic for male to loaf close to nest-site. This can be a good indicator of nesting activity. Loafing cycles determined by weather patterns, disturbance and feeding requirements and varies in time although usually found loafing from mid-morning to late afternoon.

Circadian activity little studied. Some information on patterns of diurnal activity at Serendip, Vic., reported in comparison with Grey Teal *A. gracilis* and Chestnut Teal *A. castanea* (Norman *et al.* 1979). Most of day spent loafing. Pacific Black Duck spent more time feeding than did teal, but most feeding was early or late in day. No differences were found in use of habitats by the three species. Bekle (1983) watching for 25.5 hours at site near Perth, WA, found most time was devoted to feeding, especially at night. Loafing increased towards midday and dominant in early afternoon. Loafing was again common for several hours before sunrise. Regular evening departures from daytime loafing sites within flooded River Red Gum *Eucalyptus camaldulensis* forest to nearby creeks and lignum swamps observed throughout year at Booligal, NSW. Night mostly spent in feeding with return to daytime roosts usually taking place before dawn (P.J. Fullagar & C.C. Davey). This pattern also found at rice paddies early in rice-growing season in Riverina, NSW. Ducks arrive after dark, feed intensely and then loaf if not disturbed but return to creeks and swamps before daylight and here spend day (C.C. Davey).

SOCIAL BEHAVIOUR Most detailed account by Williams (1969); further information in Johnsgard (1965) and Frith (1982); this account based on detailed observations by P.J. Fullagar; for most similar species with detailed information see Mallard in BWP. Easily observed and conspicuous social signals and courtship displays. Signals mostly diagnostic of sex. Repertoire typical of Mallard-like group of dabbling ducks which include, among more than a dozen species, very similar Spotbill *A. poecilorhyncha*, endemic Philippines Duck *A. luzonica* and North American Black Duck *A. rubripes*. Social signals directed towards establishing and maintaining pair-bonds and asserting dominance but no evidence of more general integration of flocks, though Pre-flight signals and Alarm signals may be interpreted within flock. **Pre-flight** signal typical of genus. Head raised rapidly in repeated jerky movement, usually irregular, before almost vertically springing into air with first wing-beat onto surface if rising from water.

AGONISTIC BEHAVIOUR Little evidence of protective behaviour extending far beyond small space round individual and by female round her brood; male very defensive of area near nest and there aggressive to conspecific males. **THREAT. MALE.** Body-posture of hostile or dominant male, distinctive. Head held high, wings raised at elbow creating long straight back and increasing lateral profile, with largest tertial conspicuous. **Forward Threat** posture and **Chases** used in hostile encounters by and between both sexes (see

female later). Noisy **Raehb-Raehb** displays (see Voice) often called **Raehb-Raehb Palavers**, used to challenge other males in asserting dominance or to drive intruding male away from partner (see females for Inciting). Hostile **Wing-Flaps** used by aggressive male usually as deliberate triple Wing-flaps in upright posture on water with loud non-vocal swishing sound of pinions, followed by exaggerated lateral tail-wags on settling; used to challenge a company of males or draw attention. Other deliberate, clearly attention-seeking actions are: **Heavy Landing** on water and conspicuous **Jump Flight**. **Down-up** display with whistle (see Voice) also used in hostile disputes between males, often performed synchronically, leading to more direct threats and chases or switching between these and advertising displays directed at a female. **THREAT. FEMALE. Inciting** display with loud rasping call (see Voice) used to reinforce pair-bond by directing attention towards hostile intruders and often leading to partner driving away rival in loud Raehb-raehb encounter. Repulsion used in threatening situations *i.e.* when conspecifics too close, attention by male other than partner. **Repulsion**: bristly looking posture with feathers raised and fluffed out, neck withdrawn, head sunk into shoulders and tilted up with bill wide open while calling; associated with loud, more deliberate call that seems to be derived from Inciting call (see Voice). Characteristic of female from about start of laying to any time during incubation; also typically given when guarding brood. **FIGHTING**. Conflict between adults can take form of fights in which contestants rotate on water attempting to grasp each other at wing or neck. Rapid chases across water with aim of driving rival into flight. Hostile encounters between rival males often culminate in short **Pursuit Flights**. Near nest-site, hostile encounters between male and intruding pair often lead to aerial chases, a **Three-bird-flight**, in which male directs attack at female of intruding pair and follows her in a flight away from sensitive area often with mate of the pursued female; sometimes other males join the flight. Chasing male soon breaks off and returns to resume guard near nest-site. **ESCAPE**. Dives to escape. Only female has well-developed injury-feigning, distraction displays used when guarding brood, at least in early life of ducklings. Mobbing of predators similar to methods used by other waterfowl.

SEXUAL BEHAVIOUR **ADVERTISING**. Only aerial display is brief **Jump Flight** by courting male. **PAIR-FORMATION**. Displays, communal; take place on water, except in rare and aberrant circumstances. Several stereotyped displays involve much bill-dipping and play with water. **COURTSHIP**. Repertoire complex; based on many sexually specific and few shared postures. Infectious and performed in clear bouts of intense activity spaced by periods of manoeuvring and apparent idleness; new wave of activity signalled by gradual increase in intensity of preliminary signals. Catalyst to display can be any number of single events including: disturbance of highly motivated individuals; forced congregation, which apparently creates social stress, leading to release by display; most importantly, presence of females but especially if female solicits courtship display in some way. Displays by male, used as preliminaries to courtship display, include: (1) **Head Flick**, (2) **Head Shake** and (3) **Introductory Shake**; sequence then follows: (4) **Grunt-whistle** with call, (5) **Head-up-tail-up** with call, followed by (6) **Nod-swim** leading to (7) **Turn-back-of-head** and (8) **Leading Away** if attention of female obtained; if not, then sequence reverts to preliminary stages or independent Grunt-whistles, which is usually repeated several times. Alternatively, whole sequence repeated.

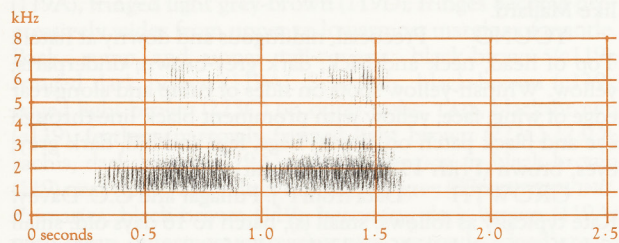
Independent Nod-swim often follows short series of **Raehbs** when head erect and bill opened widely. Independent **Bridle** display very rare or non-existent (but see copulation). Note also that **Down-up** contests between males will be integrated with sexual advertising displays. Courting displays of female include Nod-swim and Inciting. (1) **Nod-swim** display used to elicit response from courting males. (2) **Inciting** display and call typical of genus. Used to reinforce pair-bond and indicate hostility towards rival male. **PAIR-BOND MAINTENANCE**. Maintained by (1) **Preen-behind-the-wing** and (2) **Preen Dorsally** gestures and frequent contact calls from both sexes (see Voice). Additional maintenance signals include: (3) **Persistent Quacking** by female, which also used to indicate intention to leave and, at other times, possibly to test area near potential nest-site for predators by calling attention to herself; (4) **Decrescendo** call by female used to gain attention of males and in paired birds acts as long distance contact from female (see Voice); equivalent male contact signal **Raehb**, given with head held high and conspicuous lowering of lower mandible on calling, used softly or as loud long-distance signal when can act as alarm; comparable female alarm, loud quack, often repeated several times quickly. Male and female use sexually specific soft contact-calls when close (see Voice). (5) Extraordinary **Wing-rubbing** display by male may be mechanical sound or vocalization (see Voice) and seems to signify anger. No seasonal variations in character of courtship displays. Advertising most common in late summer and early autumn in s. Aust. These displays not indicative of any immediate intention to breed and mostly function to form or reinforce pair-bonds. **GREETING**. Signalled by (6) **Forward Stretch** in both sexes, male Raehb and contact-calls from both sexes. No allopreening. **COPULATION**. Only on water. (1) Pre-copulatory **Mutual Head-pumping** leads to mounting. **Head-pumping**: head moved up and down with equal speed but with short pause in erect position and dipping of bill in water at lowest position. Initially pumps of equal intensity but female slows first and flattens into prone position with head stretched forwards and shoulders flattened. Male mounts usually from side, grasping nape of female in bill. Treading accompanied by series of tail-wags by male of increasing exaggeration culminating in sudden downward lunge and cloacal contact. One such tail-wag-lunge sequence per copulation normal but two or three occasionally. Dismount followed by strong Bridle and then immediately Nod-swimming by male. (2) **Bridle**: rocking back and flinging breast well clear of water. (3) **Nod-swimming**: swimming in broad semi-circle about female but without rapidly repeated nods. Both bathe and **Wing-flap**, latter conspicuous in male. **Mutual Preen-behind-the-wing** displays usually follow. Copulation often seen long before start of laying. Probably most frequent with pairs in pre-laying period.

RELATIONS WITHIN FAMILY GROUP Incubation by female with close attendance by male near nest-site; at least in early stages up to 2 weeks, but often throughout period. Guarding male loafs near nest-site and joins female at each of her recesses. No parental care by male, who remains in loose contact with female and brood; male not aggressive to ducklings of own or other broods; tolerated by female near brood unlike any other congener. Female very defensive of brood against all other ducks and quickly recognizes and attacks alien, newly hatched, downy ducklings; will kill latter by grasping, shaking and dunking. Female remains with brood until fledging. Ducklings respond to female alone; communicate using typical repertoire of contact postures and calls and

female has range of brooding calls (see Voice). Family group of female with ducklings breaks up at time of fledging and ducklings soon disperse independently. Pair rapidly reunites on loss of brood or following fledging, especially if succeeding clutch to be laid. Siblings may remain together for few weeks after fledging but often disperse independently soon after attaining flight. Typical of *Anas* ducks, males disperse more widely than females (P.J. Fullagar). Regrettably there seem to be few data analysed to show this fact.

VOICE No detailed studies; some descriptions in Johnsgard (1965), Williams (1969) for NZ and in Frith (1982) with sonagrams; this text based mostly on observations by P.J. Fullagar and C.C. Davey. Most conspicuous call, **Decrescendo**, loud rapid quacking of female. Male has equally distinctive **Raehb** call but not so loud and both sexes have other signal-specific sounds. All calls sexually diagnostic. Female's generally loud and raucous; male's softer, mostly wheezy, calls or sharp whistles and deep resonant sounds. Individual differences not studied but similar calls known to be individually different in allied species e.g. for Mallard see Klint (1980), Lockner & Phillips (1969). Repertoire identical to that of Mallard and probably several other allied species, but few have been sufficiently well studied (see Johnsgard 1965; 1971). No regional variations. Non-vocal sounds include: whistling of wings in flight; several water-splashing sounds produced during display by males and mostly accompanying vocalizations; low frequency *reeeeep* sound made by males; said to be produced in Mallard by rubbing bill across quills at base of remiges from behind wing in Preen-behind-wing display; in Pacific Black Duck this sound, like noise of finger nail rubbed across teeth of comb, rarely heard and function not properly understood. Probably a more complex sound than mechanical component of its own (P.J. Fullagar).

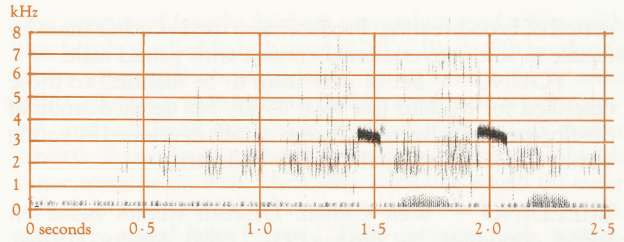
ADULT MALE (1) **Raehb** call (also written Raeb, Rab, Rhaab and Rhabh) used in various circumstances and of varying intensity according to purpose of signal. As **Alarm** call, loud rather more drawn out and purposeful *Raaaeuhb* (sonagram A). **Contact** call, similar but more clipped and



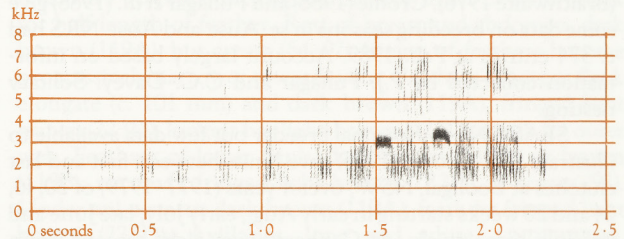
A P.J. Fullagar; Canberra, ACT, June 1984; X076

sounding less drawn-out. **Conversation** call, very soft 'hissey' version used for short range communications, usually with partner. (2) **Grunt-whistle**. High-pitched whistle call followed by deep resonant grunt given with **Grunt-whistle** display (sonagram B); whistle given alone with **Down-up** display (sonagram C, successive calls by two males), **Head-up-tail-up** and post-copulatory **Bridle**.

ADULT FEMALE (1) Most calls based on loud and familiar duck *quack*. Single drawn out *quacks* used in mild **Alarm** and as **Contact** call to partner. Much louder and rhythmically repeated steady quacking, **Persistent Quacking** used in various circumstances (Social Behaviour), mostly when female ambivalent; e.g. sometimes just before take-off

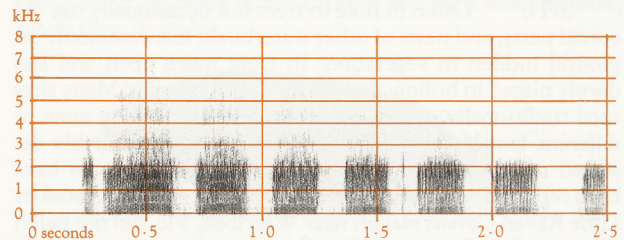


B P.J. Fullagar; Canberra, ACT, July 1983; X076



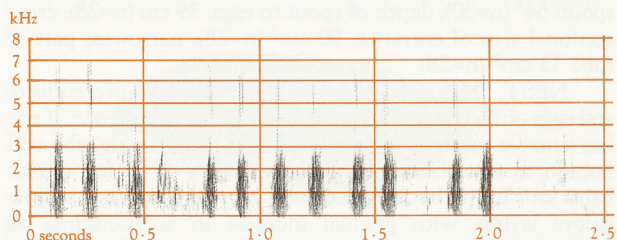
C P.J. Fullagar; Canberra, ACT, June 1983; X076

when signaling intention by alternating **Persistent Quacking** call and Pre-flight visual signal. (2) **Decrescendo** call. Loud **Advertising** and **Contact** signal. Structured as sequence of rapidly repeated *quacks* with initial explosive quality, varying in length and declining in amplitude along with slight decrease in pitch (sonagram D). Much variation between indi-



D E. Slater; Canberra, ACT, May 1985; private, 56

viduals so that some examples readily discernible to human ear. (3) **Inciting** call, harsh and more rapid than other quacking calls and readily distinguished from them (sonagram E).



E E. Slater; Canberra, ACT, May 1985; private, 56

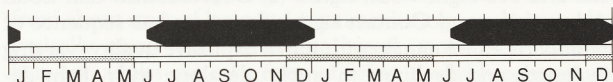
Associated with distinct signal action (see Social Behaviour). (4) **Repulsion** call even more harsh than Inciting and rendered best as rapidly uttered *queg-queg...* or *gag-gag, gag-gag-gag...*; often in rhythmic triplets with emphasis on first of each trio of calls. Again, given only at time of distinctive signal posture (see Social Behaviour). (5) Range of vocalizations of indeterminate structure but resembling very soft quacks used in contact with ducklings from time of hatching; can be heard at nest-site from before eggs pip and continued throughout

period of brood-rearing. Probably also used at other times by female in soft conversational contact with paired male.

YOUNG Set of calls seem to be identical to those described for Mallard (see Kear 1968). No detailed study of development of calls but full range of calls developed by young within 6 months of hatching (P.J. Fullagar).

BREEDING Well known. Detailed studies based on gonad condition by Frith (1957, 1959) Lavery (1970a), Braithwaite & Frith (1969) and experimental manipulations (Braithwaite 1976). Crome (1986) and Fullagar *et al.* (1988) give some data on breeding seasons in se. Aust. and Aust. NRS had c. 374 entries at Feb. 1989. Account largely based on information collected by P.J. Fullagar and C.C. Davey. Solitary nesting.

SEASON Seasonal breeder but few data available to illustrate this. Crome (1986) gave limits between first and last clutches at Booligal, NSW, over 4 years (1977-1979) of 20, 16, 24 and 20 weeks starting in early Aug., early July, late June and late July respectively. At Canberra over eight seasons (from 1981) earliest start was mid-June and length of laying period varied between 11 and 32 weeks (18, 32, 32, 17, 11, 21, 26, 27 respectively). No other quantitative data.



SITE Often in hole in trees but occasionally use old corvid nests, and nests of other waterbirds; less commonly on ground hidden in vegetation. In trees more open and less deeply placed in hollow than Grey Teal *A. gracilis*. Many sites used traditionally, others intermittently. Reused by same or different females in one season. Readily adopts suitably designed nest boxes. No associations with other species have been reported. One aberrant record of four eggs incubated by Little Raven *Corvus mellori* near Werribee, Vic. did not hatch (Klapste & Klapste 1982). Female selects site, usually accompanied by partner at time of inspection, but male does not normally go to site. Sites in River Red Gum *Eucalyptus camaldulensis* at Angora Swamp, Booligal, NSW (L.W. Braithwaite): height of entrance above base of tree: mean 290 cm (10-822; 32); trunk circumference: 310 cm (n=30); angle of spout: 54° (n=30); depth of spout to eggs: 39 cm (n=28); cross sectional area of entrance: 90 cm² (n=28); narrowest part of tube 33 cm² (n=28).

NEST, MATERIALS Materials not prerequisite and eggs often laid in hollow surrounded only by down. If site has suitable material within reach of sitting female, she will fashion a nest about her (see McKinney 1953 for similar behaviour in Mallard). Female will start by forming a hollow before laying, with gradual increase in surroundings as incubation continues. Pluck copious down from about time of laying of penultimate egg.

EGGS Elliptical; fine textured, glossy and greasy (Campbell); close grained, smooth, and more or less lustrous (North). Pale cream or creamy-white. Sometimes with distinct greenish tinge (Campbell; North; Frith 1982). **MEASUREMENTS:** 58 (51-63; 188) x 41 (37-45) from 21 nests (Frith 1982).

CLUTCH-SIZE Claimed as 10-12 usually, 15 maximum (Campbell) and 7-14 with 8-10 commonest (Frith 1982). Clutches of between three and 14 distributed as follows: 2; 4; 11; 21; 26; 38; 43; 35; 20; 6; 1; 1 (Frith 1982).

Largest clutch successfully incubated, 23 (P.J. Fullagar) caused by dumping (see elsewhere) involving at least three females. Clutches above 12 always suspect as cases with dumping and most small clutches result of incomplete laying and most not incubated. Critical data on clutch-size obtained at Canberra, 1981-85 (P.J. Fullagar & C.C. Davey) gave a mean of 9.1 (7-12; 60). One female laid a third clutch following success in raising two broods earlier in season.

LAYING Data almost all from P.J. Fullagar and C.C. Davey. At daily intervals in early morning. In high-density nesting areas, dump-laying often recorded. At least nine of 88 clutches at Canberra, ACT, over four seasons included one or more dumped eggs. Mean number of extra eggs was 4.7 (1-10). Simultaneous use of same site was always suspected with no suggestion that incubation was shared nor any indication that dumping was deliberate strategy by some females to offload eggs. When clutches hatched synchronically the incubating female accepted large brood. Largest clutch successfully incubated was 23 (20 hatched). Large broods of 14-17 ducklings, reported at Chatham Is (14-17 ducklings) by Horgan (1971) probably explained in this way. Shortest interval between hatch of lost brood and relaying was 14 days (n=11) and 56 days after hatching of successfully reared brood (n=6). Shortest interval between loss of brood and relaying was 12 days (26-32; n=37). Earlier brood on wing at least 5 days before female started next clutch (in four observations). In two other cases female abandoned broods of two and four at between 4 and 5 weeks old. Ducklings then had no parental care (*c.f.* Grey Teal). Two broods certainly reared in a season six times of 88 broods over four seasons.

INCUBATION All data from P.J. Fullagar and C.C. Davey. **INCUBATION PERIOD:** 29 ± 3 days (26-32; n=37) based on accurately determined start of incubation and day of departure from nest. Unhatched eggs abandoned on completion of hatch. By female alone. Total daily length of recess 116 min with no pattern of variation throughout. Typically leave eggs twice a day; early morning and late afternoon. Strong tendency to sit tight for last 36 to 48 h before completion of hatch. No disposal of egg shell. Behaviour at hatching exactly like Mallard.

YOUNG Precocial, nidifugous and downy at hatch. Top of head, neck and back, dark grey-brown; underparts, yellow. Whitish-yellow spots on sides of rump and along rear edge of wing; face, yellow with prominent black line through eye and black patch on cheek. Legs, feet and bill, dark grey; eyes, brown (Frith 1982; P.J. Fullagar).

GROWTH Data from P.J. Fullagar and C.C. Davey. Rate typically as follows: small (s), hatch to 16 days old; small to half grown (shg), 16 to 32 days; half-grown (hg), 32 to 39 days; half-grown to large (hgl), 39 to 46 days. large (l), 46 to 65 days; full-grown (fg), 65 onwards. Capable of flight at 58 days; shortest 52 days and longest 66 days from 13 broods (P.J. Fullagar & C.C. Davey). No data on weight gains nor any other changes in body measurement during development.

PARENTAL CARE Ducklings leave nest-site when fully dry; usually early to mid-morning. Brood entirely depends on female for parental care who is aggressive to other ducklings (see Social Behaviour) and will use injury-feigning if threatened. Ducklings when threatened seek hiding places and freeze even at late stages (l & fg). Like other ducklings will 'flapper' noisily if disturbed during penultimate stages of growth and before old enough to fly. Females sometimes deposit foul smelling excreta when startled from nest but function as anti-predator behaviour highly questionable (see

Kear 1963). Ducklings usually led from nest early in morning; much less often at any other time; fall from elevated sites by floating down (Robinson 1950); not carried despite claims to contrary e.g. Chapman (1951) and Miles (1950). Pair-bonds formed at c. 6 months and individuals capable of breeding in first year.

SUCCESS Only data from Canberra, ACT (P.J. Fullagar & C.C. Davey). In four seasons (1981-84) from 401 eggs laid, 359 young hatched and 80 young fledged; total success of 20% (n=41 clutches incubated to hatching). Additional nine clutches completed but deserted before hatching and 11 incomplete clutches not included. See Grey Teal for similar data. Mean number ducklings reared per brood, 5 (1-9; 18 broods), excluding total loss of broods. Mean number of five ducklings per successful pair or 21% of clutches started. Sixty per cent of all total losses occur before 10 days and 40% of all duckling losses occur before this age in broods with at least one duckling surviving to fledge (P.J. Fullagar & C.C. Davey). Chick taken by Laughing Kookaburra (Aston & Aston 1988).

PLUMAGES

ADULT MALE BREEDING Age of first breeding 1 year (Lavery 1966; P.J. Fullagar). **HEAD AND NECK.** Forehead, crown and nape, black-brown (119), fringes of feathers dark brown (119A); fringes on crown and nape produce moderately streaked appearance; feathers long on hindcrown. Hind-neck, brown (119B) with faint cream (92) shade to feathers. Broad black-brown (119) eye-stripe, narrowly encircles eye and extends to ear-coverts. Upper margin of eye-stripe bordered by narrow white supercilium; lower margin bordered by broad band of white loreal feathers, tapering to ear-coverts. Lower margin of loreal feathers, bordered by narrow dark-brown (119A) malar stripe, extending upwards from gape to ear-coverts. Chin and throat, white. Foreneck, cream (92). Ear-coverts and rest of malar feathers, cream (54-92), tipped dark brown (119A). Sides of neck, cream (54-92) with brown (119B) shaft-streaks on feathers, imparting streaked appearance. **UPPERPARTS.** Feathers of mantle, dark brown (119A), fringed light grey-brown (119D); fringes become progressively wider from upper to lowermost margins of mantle. Back, rump and upper tail-coverts, black-brown (c119), fringed dark brown (119A). Scapulars, black-brown (c119), edged light brown (223C) on outer webs. **TAIL,** black-brown (c119), feathers narrowly fringed light brown (223C-223D); rachis, dark brown (219A) at base, merging to black-brown (119) near tip. Underside of tail, brown-grey (80). **UPPERWING.** Primaries, black-brown (119), becoming dark brown (119A) with wear; outermost primaries very narrowly edged cream (92) on outer web; rachis, dark brown (219A). Greater primary coverts and alula, dark brown (119A); rachis, black-brown (119). Marginal coverts, dark brown (119A), feathers fringed light brown (223D). Some marginal coverts on outer wing, close to leading-edge, may be white with small dark-brown (119A) patch at base of outer web. Marginal coverts on radius-ulna, dark brown (119A), narrowly fringed pale grey (86). Lesser coverts, dark brown (119A), narrowly fringed light grey-brown (119C). Median coverts similar but narrowly fringed light brown (223D). Greater coverts, dark brown (119A) with distal quarter of feather, black (89); black (89) tips progressively widen towards inner wing. Tertial coverts, dark brown (119A), narrowly fringed light brown (223D). Secondaries, dark brown (119A) on inner web. Outer web of secondaries, glossy green (63), bordered distally by black (89) for

one quarter of length; feathers narrowly tipped white, with tips faintly washed light brown (223D). Black (89) bordering glossy green (63) on secondaries, forms speculum; in some lights, speculum glossy purple (172A); confined to s1-8 inclusive, and bordered uppermost by black (89) tips to greater coverts. Secondaries of inner wing, dark brown (119A) with outer margins on web, black (89), narrowly edged on outer web, light brown (223D). Longest tertials, black-brown (119), narrowly edged light brown (223D) on outer web. **UNDERPARTS.** Upper breast, dark brown (119A), feathers fringed cream (54-92); concealed light grey-brown (119D) shaft-streak for half length of feather. Rest of breast and abdomen, dark brown (119A), but cream (54-92) fringes of feathers become progressively narrower towards vent. Feathers of upper flank elongate (c. 101 mm) and dark brown (119A), fringed light brown (223D); longest has light-brown (223D) streak on outer web. Feathers of lower flank, dark brown (119A) or brown (119B), narrowly fringed light brown (223D) or cream (92). Under tail-coverts, dark brown (119A), feathers fringed light brown (223D). Axillaries, long and white. **UNDERWING.** Greater primary coverts, white; rachis, white tipped dark brown (119A); tips longer on innermost coverts. Rest of coverts, white with pale dark-brown (119A) shaft-streak.

ADULT FEMALE BREEDING Like adult male breeding but tertials, black-brown (119) with varying light-brown (223C) crescent-shaped streaks on outer webs; streaks discontinuous, or connected, varying in extent (P.J. Fullagar & C.C. Davey) (see Fig. 2). In most, crown appears more streaked (cf. all black of most males) and back less uniformly black than in males.

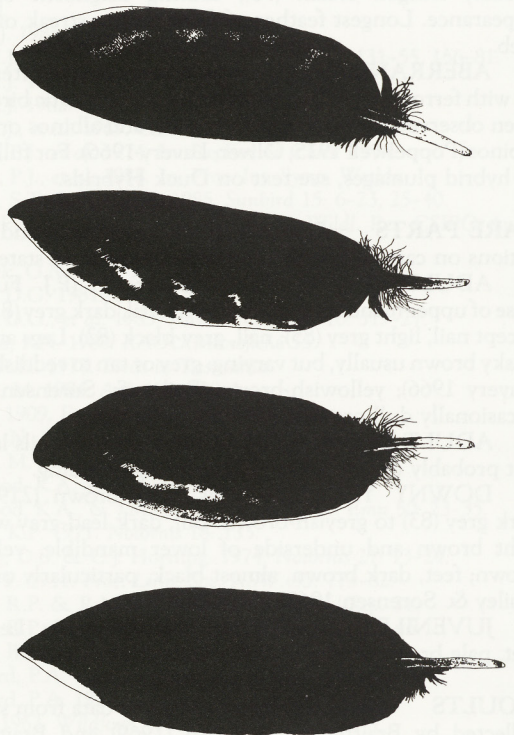


Fig. 2 Pattern of tertials of female

ADULT FEMALE AND MALE NON-BREEDING (ECLIPSE) No male eclipse. In both sexes plumage similar to breeding but females have all black tertials (see Moults).

Note: Feathers on upper sides of breast anterior to folded wing vary in shape and pattern and probably indicate moult and plumage sequences but have not been studied in sufficient detail (P.J. Fullagar & C.C. Davey); probably similar to those described for American Black Duck *A. rubripes*, for which an excellent account given in Palmer (1976)

DOWNY YOUNG **HEAD AND NECK.** Crown, hind-neck and eye-stripe, dark brown (119A). Malar stripe broken with short dark-brown (119A) stripe from gape, ending below or before eye; another small patch of dark-brown (119A) down at ear-coverts. Rest of head and foreneck, yellowish cream (92). **UPPERPARTS,** dark brown (119A); down on back, hair-like and tipped light brown (26); paler light brown (c26) on mantle. Small single oval-shaped dull-white patch on either side of rump. Similar patch on either side of middle of back, where wings are folded. **TAIL,** downy, hair-like and dark brown (119A). **UPPERWING,** dark brown (119A); trailing-edge on radius-ulna, dull white, merging with dull-white down on middle of back when wings folded. **UNDERPARTS,** yellowish cream (92). Under tail-coverts and vent, dark brown (119A). **UNDERWING,** yellowish-white. Details of plumage development to juvenile in Lavery (1966).

JUVENILE Capable of breeding at about 6 months old (Lavery 1966). Similar to adult non-breeding, differs in: **HEAD AND NECK.** Crown feathers narrowly tipped light grey-brown (119C). Fewer brown (119B) shaft-streaks on side of neck. **UPPERPARTS.** Scapulars fringed light brown (223D) rather than edged on outer web; longest scapular may have faint light-brown (223D) streak on outer web. **TAIL.** Rectrices notched. **UNDERPARTS.** Breast-feathers, dark brown (119A), broadly fringed cream (92), causing diagnostic streaked appearance. Longest feather of flank has no streak on outer web.

ABERRANT PLUMAGES Underparts often stained with ferrous oxide (Lavery 1962, 1966). Leucistic birds have been observed (skins at MV; ANWC); and albinos or partial albinos (Poppelwell 1915; Oliver; Lavery 1966). For full details of hybrid plumages, see text on Duck Hybrids.

BARE PARTS Based on photos in NZRD and observations on captive and wild birds, except where stated.

ADULT BREEDING Iris, brown (P.J. Fullagar). Base of upper mandible, and round nostril, dark grey (83); rest, except nail, light grey (85); nail, grey-black (82). Legs and feet, dusky brown usually, but varying: grey or tan to reddish-black (Lavery 1966); yellowish-brown (Bailey & Sorensen 1962), occasionally dull orange (P.J. Fullagar).

ADULT NON-BREEDING Precise details lacking, but probably duller on legs than during breeding.

DOWNY YOUNG Iris, dark brown (219). Bill, dark grey (83) to greyish-brown. Bill, dark lead-grey with tip light brown and underside of lower mandible, yellowish brown; feet, dark brown, almost black, particularly on webs (Bailey & Sorensen 1962).

JUVENILE Iris, brown. Bill, slate grey. Legs and feet, pale brown-flesh.

MOULTS Few studies in Aust. Most data from samples collected by Braithwaite & Frith (1969) and Braithwaite (1976), concerning timing of wing-moult and description of wear of plumage; Braithwaite (1971) gives some important information from birds studied in captivity. Braithwaite & Norman (1974) examined wing-moult of birds collected during annual duck-shooting season. Study of processes underlying

wing-moult (in captive birds) concluded that moults were driven by inherent annual rhythm associated with condition of gonads (Braithwaite 1971, 1976). Information here based mostly on observations in se. Aust. by P.J. Fullagar and C.C. Davey.

Studies in the wild and captivity (P.J. Fullagar & C.C. Davey) have shown that most birds in se. Aust. are not in moult and have fresh plumage at the start of breeding season in July-Aug. By Sept.-Oct., plumage becoming worn and replacement of body-feathers starts. Most active body-moult occurs between Dec. and Mar. and wing-moult takes place then; in breeding birds, flightless period earlier in males than females. By Apr. most birds finishing body- and wing-moults and have fresh plumage. By June some worn feathers seen but these replaced during brief body-moult before the start of breeding. Generally, moult of most feather-tracts continuous but intensity varies. Body-, tail- and tertial-tracts moult independent of wing surfaces and remiges. Tertial follicles moult three times a year. Most females have dark tertials following moult between Dec. and Feb. These replaced by patterned tertials (Fig. 2) in May-June and again by patterned tertials about Sept. (P.J. Fullagar & C.C. Davey). Loss of remiges occurs in less than 2 days. Moult of remiges takes 29 days for males; 34 days for females (Braithwaite 1971). Flight regained when p6-p10 still retain sheaths, at 20-23 days from time of loss for males; 24-27 days for females. Replacement gradual, from innermost secondaries to outermost primaries. Average daily rate of growth for first 20 days is c. 5 mm. Few birds had new plumage less than 3.3 months after moult. Deterioration of plumage occurs rapidly; birds failing to moult for 12 months had class-4 wear (see Braithwaite 1971). Moult of remiges affected by timing of breeding; in floods, moult of remiges and maturation of gonads may overlap. Males have peak body-moult, Dec.-Feb., but generally moult all year, except June-Aug. Females moult slightly later, in Feb.-May but generally all year, except Aug.-Sept.; timing of moult associated with breeding activity.

ADULT PRE-BREEDING Partial; involves head, neck, body and tail, but not wings; most obvious change being uniformly dark tertials, lacking pattern on outer webs, replaced by patterned feathers (see elsewhere).

POST-JUVENILE Incomplete, but most tracts replaced except wings. Occurs at 15-20 weeks.

Birds can postpone a moult, for as long as biologically possible, if faced with severe conditions, but few do so. Time of moult well separated from that of potential breeding. Change of daylength suppresses gonadal activity of birds moulting in summer; development of gonads takes place at end of, or after, moult of remiges; change of daylength may be important in determining level of gonadal development but details conflicting and much more study required. Further details on development of gonads in relation to moult in Braithwaite & Norman (1974).

MEASUREMENTS (1) NZ, live adults; methods unknown (M.J. Williams). (2) NZ, methods unknown (Balham 1952). (3) Bathurst, NSW, Aust., live birds, status unknown; methods unknown (ABBBS). (4) SE. Aust. (Braithwaite & Miller 1975).

	MALES	FEMALES
WING	(1) 263.2 (8.10; 250-283; 40)	251.3 (7.81; 230-265; 48) *
	(2) 261.0 (0.8; 241-282; 97)	248.0 (0.7; 235-275; 121) *

	(3)	263.8 (9.56; 245-282; 22)	259.0 (9.63; 235-285; 34)
BILL	(4)	265.0 (1.2; 230-290; 100)	250.0 (1.3; 200-280; 100) *
	(1)	53.1 (2.34; 48.5-57.4; 40)	49.3 (2.52; 43.2-59.4; 49) *
	(2)	52.0 (0.2; 47-58; 101)	50.0 (0.2; 42-59; 120) *
	(3)	51.3 (3.15; 41.8-56; 26)	50.4 (3.02; 46-58; 53)
TARSUS	(4)	51.0 (0.2; 45-57; 100)	49.0 (0.2; 44-56; 100) *
	(1)	44.4 (1.60; 40.9-49.2; 40)	42.3 (1.71; 38.5-47; 50) *
	(2)	46.0 (0.3; 41-52; 99)	44.0 (0.2; 39-51; 120) *
	(3)	55.7 (1.65; 50.9-59; 26)	54.8 (2.25; 47.8-60; 54)
TAIL	(1)	88.0 (3.72; 81.1-99; 39)	85.8 (4.95; 73-94.5; 46) *
TOE	(1)	60.1 (2.62; 50.7-65.6; 40)	57.3 (2.63; 50.4-63.3; 49) *

Additional measurements in Amadon (1943) and Frith (1982).

WEIGHTS (1) NZ, adult live birds (M.J. Williams). (2) NZ, (Balham 1952). (3) Bathurst, NSW, live birds; status unknown (ABBBS). (4) Braithwaite & Miller (1975). (5) Aust., recently dead birds, status unknown (Frith 1982).

	MALES	FEMALES	
(1)	1063.9 (95.50; 920-1340; 32)	958.6 (88.83; 700-1138; 38)	*
(2)	1089 (105; 765-1276; 112)	981 (108; 624-1276; 120)	*
(3)	1059.2 (105.86; 900-1300; 26)	1013.8 (92.50; 850-1200; 54)	
(4)	1133 (110; 800-1400; 100)	1015 (180; 600-1400; 100)	*
(5)	1114 (870-1400; 131)	1025 (805-1280; 207)	

No data on seasonal changes.

STRUCTURE Wing, short and broad. Eleven primaries: p9 usually longest, p10 0-3 mm shorter, p8 5-6, p7 15-16, p6 27-28, p5 38-41, p4 54-56, p3 70-71, p2 85-92, p1 98-104, p11 minute. P10 emarginated on inner web; p9 on outer and inner; p8 slight on outer and inner. Fourteen secondaries, four of tertial form. Tail, slightly pointed; 18 (sometimes 20) rectrices, t1 longest, t6 28-38 mm shorter. Under tail-coverts c. 8 mm short of tip of tail. Bill, slender, concave and with moderately robust nail. Tomia edged with coarse lamellae. Legs, slender with tarsus rounded in cross-section. Feet, webbed. Outer toe c. 97% of middle, inner c. 76%, hind c. 26%.

GEOGRAPHICAL VARIATION At best, three poorly defined races sometimes accepted: nominate *superciliosa* (NZ region); *rogersi* (Aust., New Guinea & Indonesian region); *pelewensis* (islands in sw. Pacific) (see Amadon 1943). Oustalet's Duck *A. oustaleti* Salvadori, 1894, of some Micronesian islands (Guam, Saipan & Tinian) considered here as unstable hybrid between *A. platyrhynchos* and *A. superciliosa*; see Kuroda (1941-42), Yamashina (1948), Williams & Roderick (1973) and Scott (1988). NZ and Aust. birds do not differ in size or plumage (*contra* Amadon [1943] who states they are paler in NZ; P.J. Fullagar). *A. superciliosa* forms super-species with *A. luzonica* and *A. poecilorhyncha* (Peters).

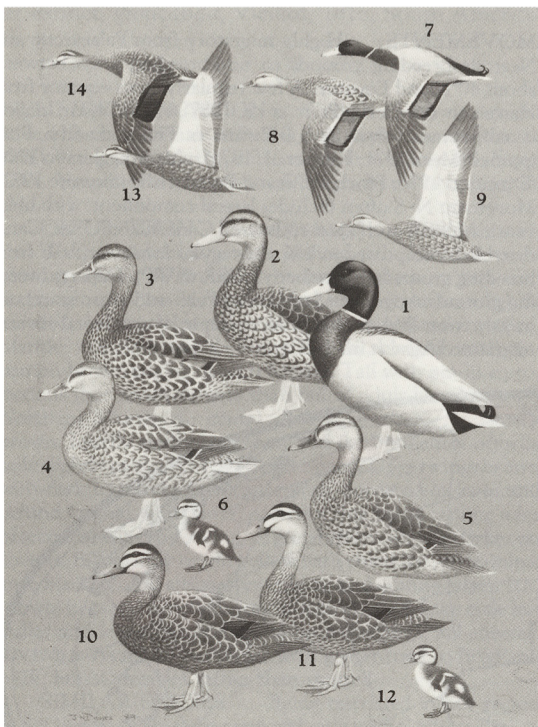
RMO

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Mallard *Anas platyrhynchos*

1. Adult male breeding
2. Adult male non-breeding
3. Adult female breeding
4. Adult female non-breeding
5. Juvenile
6. Downy young
7. Adult male breeding
8. Adult female
9. Adult female

Pacific Black Duck *Anas superciliosa*

10. Adult
11. Juvenile
12. Downy young
13. Adult
14. Adult

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