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Waterfowl of North America: Perching Ducks, Tribe Cairinini

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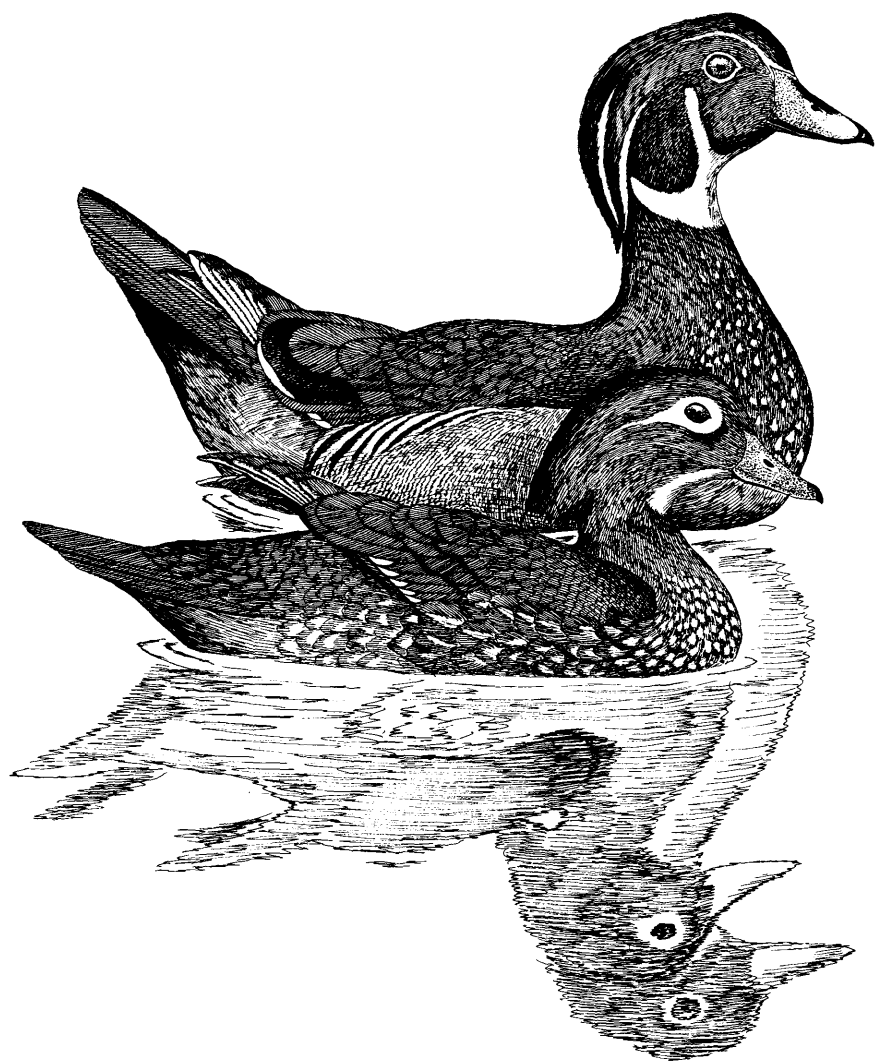
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PERCHING DUCKS

Tribe Cairinini

The perching ducks and related gooselike forms are a diverse array of some fourteen species that are largely subtropical to tropical in occurrence. Although they vary in size from as little as about a half a pound in the “pygmy geese” (*Nettapus*) to more than twenty pounds in the spur-winged geese (*Plectropterus*), all possess some common features.†These include a tendency toward hole-nesting, especially in trees; sharp claws; associated perching abilities; and long tails that presumably increase braking effectiveness when landing in trees. Nearly all species exhibit extensive iridescent coloration in the body, especially on the upper wing surface; this coloration is often exhibited by females as well as males. As a result, this tribe includes some of the most beautifully arrayed species of the entire family, of which the North American wood duck is an excellent example, as is the closely related Asian mandarin duck (*Aix galericulata*). The wood duck is the only perching duck that is native to the United States or Canada, but inasmuch as Mexico must be regarded as a part of North America, the inclusion of the muscovy duck as a North American species is fully justified.

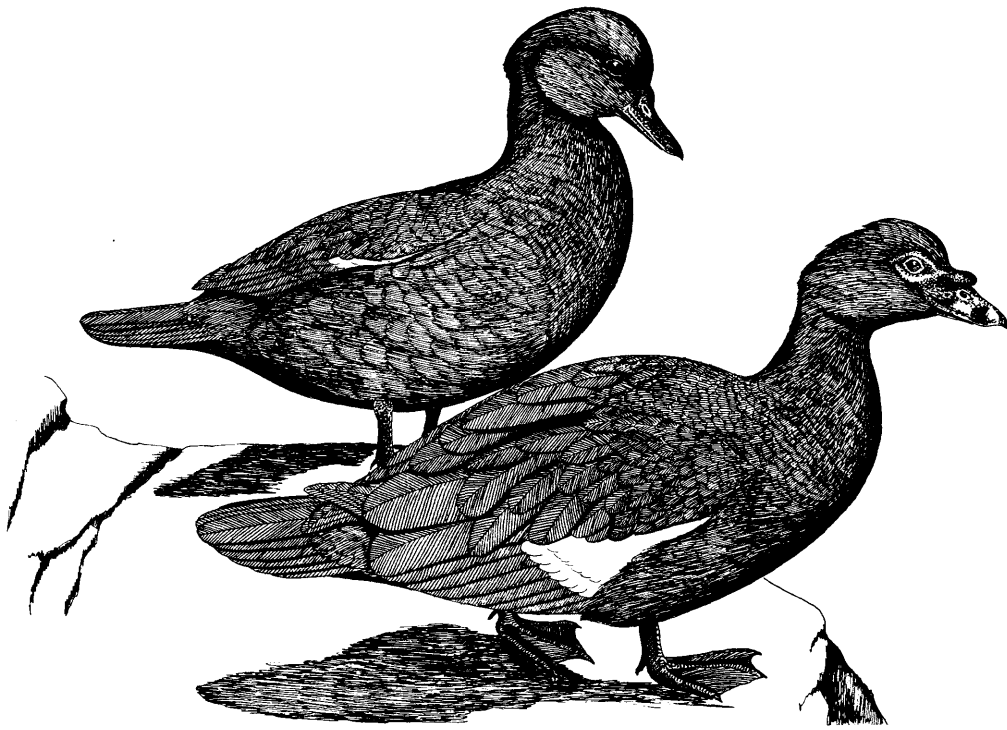
Perching ducks, together with all of the following groups of waterfowl included in this book, are representatives of the large anatid subfamily Anatinae. Unlike the whistling ducks, swans, or true geese, species of this subfamily have a tarsal scale pattern that has vertically aligned scutes (scutellate condition) above the base of the middle toe, and the sexes are usually quite different in voice, plumage, and sexual behavior. These sexual differences can be attributed to the weaker and less permanent pair bonds characteristics of true ducks, with a renewal of pair bonds typically occurring each year. As a result, pair-forming behavior tends to be more complex and elaborate in these species, as a dual reflection of the greater and more frequent competition for mates and the need for safeguards in reducing or avoiding mixed pairings between species during the rather hurried pair-forming period. In these species, the males typically assume the initiative in pair-forming activities, and

thus they are usually more colorful, more aggressive, and have the more elaborate pair-forming behavior patterns. On the other hand, the females retain a subdued, often concealing plumage pattern, associated with their assumption of most or all incubation and brood-rearing responsibilities. As a result, humans usually find it easy to recognize the distinctively plumaged males of most species, while the females of related species are often so similar that even experienced observers may find it difficult to identify them with certainty.

Following the initiation of incubation, the males in this subfamily typically abandon the females and begin their postnuptial molt, during which they become flightless for a time and usually also acquire a more femalelike body plumage. Thus, unlike the species in the subfamily Anserinae, typical ducks have two plumages, and thus two body molts, per year. In males this double molt is most apparent, since the "eclipse" plumage attained following the postnuptial molt is usually less colorful and often quite femalelike.

Although in all the species which have so far been studied the female also has a comparable summer molt and plumage, in most cases this plumage is so similar to the winter plumage that separate descriptions are not necessary. In most cases the "eclipse" plumage of males is held for only a few months, presumably to allow the male to regain the more brilliant plumage associated with pair formation as early as possible. In some cases, however, this "nuptial" plumage is not regained until well into winter (e.g., ruddy duck, Baikal teal, blue-winged teal), so that "summer" and "winter" plumages may be more or less recognizable. The situation is further complicated in the oldsquaw, which has a third partial molt in the fall (affecting both sexes but most apparent in the male) and which is restricted to the scapular region. Except in such special cases, the two major plumages of the male are referred to in the species accounts as "nuptial" and "eclipse" plumages, while the "adult" plumage of females refers to both of the comparable breeding and nonbreeding plumages.

The 115 species of waterfowl that belong to the subfamily Anatinae are grouped into a number of tribes, most of which include one or more native North American species. The only major tribe of Anatinae that is not represented in this continent is the shelduck tribe Tadornini, which has representatives in both South America and Eurasia. It is true that there are some old records of Atlantic coast occurrences for the ruddy shelduck (*Tadorna ferruginea*) and the common shelduck (*Tadorna tadorna*), as well as a few more recent sight records (*Audubon Field Notes*, 16:73; *American Birds*, 26:842; 27:41), but these are quite possibly the result of escapes from captivity.



MUSCOVY DUCK

Cairina moschata (Linnaeus) 1758

Other Vernacular Names: Musk Duck, Pato Real.

Range: From central and northeastern Mexico southward through the forested parts of Central and South America to Peru and Argentina. Nonmigratory and relatively sedentary.

Subspecies: None recognized.

Measurements (after Delacour, 1954):

Folded wing: Males 300-400, females 300-315 mm.

Culmen: Males 65-75, females 50-53 mm.

Weights: Leopold (1959) reported that wild males range in weight from 4.39 to 8.82 pounds (1,990-4,000 grams), and that females range from 2.43 to 3.24 pounds (1,100-1,470 grams). Domesticated muscovies are often much heavier, particularly males. Delacour (1959) reported weights of muscovies as 2.5 and 5 kilograms for females and males, respectively, which would be more typical of domesticated varieties.

IDENTIFICATION

In the Hand: Any large, predominantly blackish duck with a rather squarish tail measuring more than 100 mm. and with bare skin around the eyes is of this species. Domesticated varieties, which are sometimes mistakenly shot by hunters, may vary greatly in coloration, but usually are quite large and obviously of domestic origin.

In the Field: Within its Mexican range, the muscovy is largely confined to coastal rivers and lagoons, often in or near forests. Although sometimes feeding in open situations, the birds usually return to timbered areas to rest and roost. Either on land or in water the blackish body coloration is evident, with little or no white showing on the wing coverts. In flight, the white under wing coverts and the white that is usually also present on the upper wing surface contrasts strongly with the otherwise dark body coloration. In spite of their size, they fly swiftly and strongly, often producing considerable wing noise. Otherwise, muscovies are normally quite silent, both in flight and at rest.

AGE AND SEX CRITERIA

Sex Determination: In adults, the strong size dimorphism and caruncles on the head and bill of the male make sex determination simple. A culmen length in excess of 55 mm. and the presence of naked skin on the face are indicative of a male.

Age Determination: No definite information is available, but it is probable that the amount of white present on the upper wing surface increases with age, as does the size of the caruncles on the male's bill. Sexual maturity is attained in the first year among captive birds, but the situation in wild muscovies is not known.

DISTRIBUTION AND HABITAT

Breeding Distribution and Habitat: The natural North American breeding distribution of the muscovy duck is limited to the lowland portions of Mexico, from central Sinaloa on the west and Nuevo Leon on the east southward and eastward along both coasts with the exception of those portions of the Yucatán Peninsula that lack suitable rivers and lagoons (Leopold, 1959). There are no records of the species' natural occurrence in the United States, but unsuccessful attempts have been made to establish this species in Florida, using offspring of wild stock from South America.

The muscovy duck also extends southward through virtually all of the



lowland regions of Central America, southward over much of continental South America, especially the forested areas east of the Andes Mountains. Its southern limits are reached near Tucumán, Santiago del Estero, and Santa Fe, Argentina.

The breeding habitat consists of rivers, lagoons, marshes, and similar areas of water at relatively low altitudes that are associated with forests or heavy woodland. Slowly flowing rivers associated with tropical forests, as well as backwater swamps associated with such rivers, seem to represent their preferred habitat.

Wintering Distribution and Habitat: There are no indications of migratory movements in this species, which occurs in climates affected little if at all by seasonal temperature fluctuations. During the dry seasons the birds often move into coastal swamps or lagoons.

GENERAL BIOLOGY

Age at Maturity: Not yet established for wild birds. Domesticated muscovy ducks regularly breed in their first year of life.

Pair Bond Pattern: Current evidence indicates that the muscovies virtually lack pair bonds, the matings occurring promiscuously, and, except during the limited period of female receptiveness, there is little close association between the sexes. The few observations available on wild birds indicate such a social pattern (Delacour, 1959), and this is certainly true of captive birds (Johnsgard, 1965).

Nest Location: Nests are usually located from 3 to 20 meters high, in tree hollows or among palm leaves. Nests located among rushes at ground level have, however, been reported in Argentina (Phillips, 1923). In most cases little or almost no down is present.

Clutch Size: The normal clutch size is probably eight or nine eggs, but apparent dump-nesting sometimes results in clutches twice this size or even larger (Phillips, 1921).

Incubation Period: Incubation periods under natural conditions by wild birds have still not been determined, but a 35-day period has been reported for captive birds' eggs (Delacour, 1959; Lack, 1968).

Fledging Period: Not reported.

Nest and Egg Losses: Not yet studied.

Juvenile and Adult Mortality: Not known. Once beyond their first year, it seems possible that at least males might have a rather low natural mortality, owing to their unusual size and strength.

GENERAL ECOLOGY

Food and Foraging: Phillips (1923) summarized the information on food available at that time. Items reported taken included small fish, insects, small reptiles, and water plants. Termites are said to be a favorite food, and their nests are sometimes torn open by the birds in search of them. Muscovies have also been observed chasing small crabs, and feeding on water lily seeds and on the roots of *Mandioca*. Wetmore (1965) noted that the stomachs of two birds from Panama contained various seeds, including those of pickerelweeds (Pondeteriaceae) and sedges (*Fimbristylis*).

Captive muscovy ducks that I have seen were never observed diving and seemed to spend much time foraging on land, presumably for seeds and insects. Although fish have been reported as part of their diet, it seems unlikely that they would be able to capture them under normal conditions since muscovies are bulky and rather awkward birds.

Sociality, Densities, Territoriality: During the breeding season males are highly aggressive toward one another, and such behavior no doubt tends to disperse the breeding population. A single male is often associated with more than one female, and perhaps such females might sometimes nest in close proximity. There seem to be no estimates of breeding densities available.

Interspecific Relationships: Not enough is known of the ecology of this species to speculate on its possible competitors and enemies. The comb duck (*Sarkidiornis melanotos*) is a fairly closely related tropical forest species which also nests in cavities, but the ecological relationships between these two forms are still obscure. Comb ducks seemingly occupy more open country than do muscovy ducks and are thought to be less dependent on undisturbed forests.

General Activity Patterns and Movements: Outside the breeding season, muscovy ducks usually gather in groups ranging from a few to 50 or more birds, wandering about rather extensively (Monroe, 1968). The birds typically fly during morning and evening hours (Wetmore, 1965), often spending the warmer parts of the day resting along the shore. At night they typically retire to tree roosts, with as many as a dozen or more birds sometimes roosting in a single tree (Phillips, 1923).

SOCIAL AND SEXUAL BEHAVIOR

Flocking Behavior: Most observers report that wild muscovies are usually found in small groups of a half dozen or so birds, but occasionally in larger groups. These groups are not closely coordinated and on disturbance will often disperse in all directions. Perhaps the advantages of common roost-

ing behavior tend to maintain flocking behavior outside the breeding season; at least pair bonds and family bonds do not seem to be sufficiently strong as to facilitate such flocking behavior.

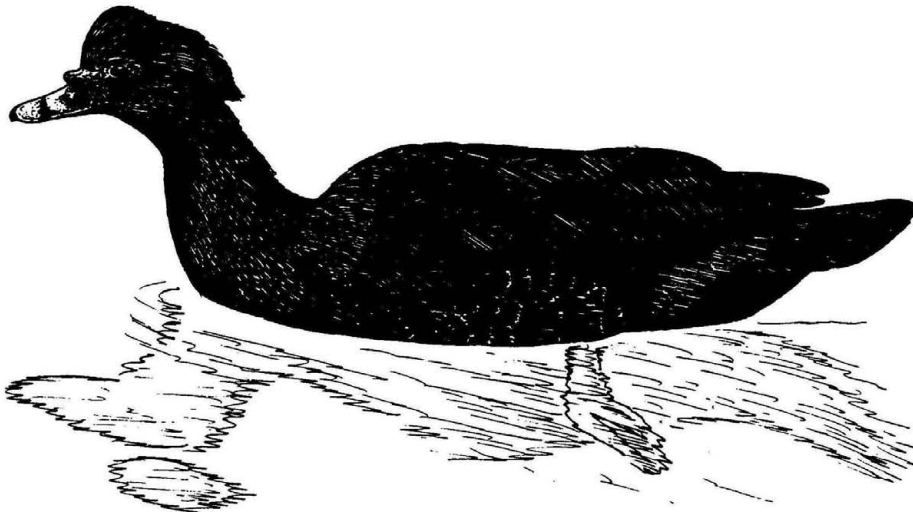
Pair-forming Behavior: Not yet studied in wild muscovies. However, no definite pair bonds have been found among captive or domestic muscovy ducks.

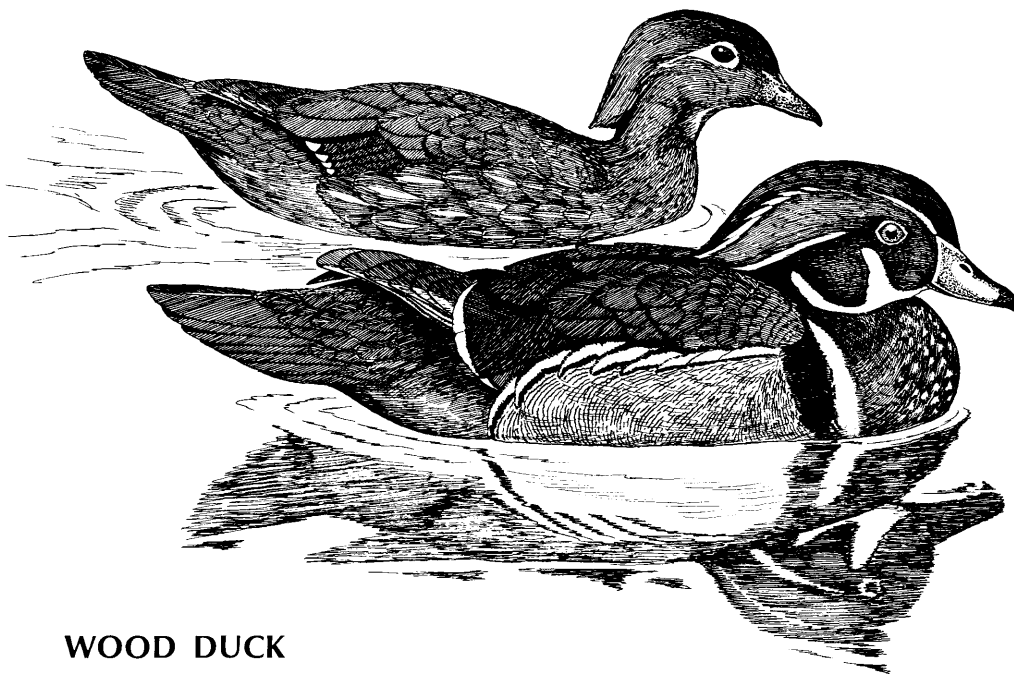
The rather simple display of the male serves both as aggressive signals toward males and as sexually oriented signals toward females. At such times he utters a soft breathing or hissing note, simultaneously raising his crest, moving his head slowly forward and backward, shaking his tail, and holding his wings slightly away from the body. Females normally respond to this display by fleeing, sometimes uttering a simple quacking note. I have never observed any female behavior that could be interpreted as inciting behavior, and no other type of apparent pair-forming behavior has been observed by me (Johnsgard, 1965).

Copulatory Behavior: According to most observers, copulation in this species normally takes the form of apparent rape, with the male chasing and eventually overpowering the much smaller female. However, during the egg-laying period the female may actively solicit copulation, assuming a prone posture on the water and waiting thus as the male performs his sometimes rather lengthy precopulatory behavior, which consists of characteristic head movements and of pecking the female's back feathers. After treading, the female bathes, but no definite male postcopulatory displays have been described (Johnsgard, 1965).

Nesting and Brooding Behavior: Not yet studied in detail, but probably rather similar to that of the wood duck.

Postbreeding Behavior: Other than the fact that considerable wandering by wild birds occurs during the nonbreeding season, almost nothing is known of this stage in the life cycle of muscovy ducks.





WOOD DUCK

Aix sponsa (Linnaeus) 1758

Other Vernacular Names: Carolina Duck, Summer Duck, Woodie.

Range: Breeds in forested parts of western North America from British Columbia south to California and east to Idaho, and in eastern North America from eastern North Dakota to Nova Scotia, south to Texas and Florida. Winters in the southern and coastal parts of the breeding range and southward into central Mexico.

Subspecies: None recognized.

Measurements (after Delacour, 1959):

Folded wing: Males 250-285, females 208-230 mm.

Culmen: Males 33-35, females 30-33 mm.

Weights: Nelson and Martin (1953)) reported that 248 males averaged 1.5 pounds (680 grams), with a maximum of 2.0 pounds; 163 females averaged 1.4 pounds (635 grams), with a maximum of 2.0 pounds. Mumford (1954) also reported an average weight of 1.5 pounds for 109 males, and 1.44 pounds for 99 females. Fall weights of immature and adult birds are scarcely separable; Jahn and Hunt (1964) noted that 49 fall-shot adult males averaged $1\frac{9}{16}$ pounds, while 23 immature males averaged $1\frac{1}{2}$ pounds.

IDENTIFICATION

In the Hand: Male wood ducks, even in eclipse plumage, can be recognized in the hand by their iridescent upper wing surface and long, squarish tail, which is also somewhat glossy. Unlike all other North American duck species, both sexes have a silvery white sheen on the outer webs of the primary feathers and a bluish sheen near the tips of the inner webs.

In the Field: Wood ducks sit lightly in the water, with their longish tails well above the surface. The birds are usually not found far from wooded cover. Often they perch on overhanging branches near shore and feed in fairly heavy woody cover that is flooded. The crest is evident on both sexes at a considerable distance, as is the male's white throat. The brilliant color pattern of males in nuptial plumage is unmistakable. In the air, wood ducks fly with great ease and apparent speed, the bill tilted below the axis of the body and the head often turned, giving a "rubber-necked" appearance, while the long tail is also evident. The underwing surface is speckled with white and brownish, and the white on the trailing edge of the secondaries is usually apparent, as is the white abdomen. The male has a clear whistle with rising inflection, while the female utters a somewhat catlike and owl-like sound, but no true quacking notes.

AGE AND SEX CRITERIA

Sex Determination: The tertial coverts of females are pinkish, while those of males are dark purple. Females also have large white "teardrop" tips on the secondaries, while males have narrow, evenly white tips on these feathers (Carney, 1964). In any adult plumage, the throat of the male has two white extensions up the sides of the head, the eye is somewhat reddish, and the bill is reddish at the base.

Age Determination: In males, the tertials of juveniles are pale bronze, with pointed and frayed tips, while those of adults are deep purple, with squarish tips. These adult tertials grow in during the first fall of life. In immature birds the middle and greater coverts may show a mixture of the duller juvenal feathers and the very dark purple first winter coverts. In females, juveniles may have tertials that have pointed and frayed tips, rather than rounded tips, and the tertial coverts may be the greenish yellow ones of the juvenal plumage rather than the pink ones of the first winter plumage. In immature females the iridescent coloration usually does not extend onto the second row of middle coverts, and the most proximal greater covert of immatures is greener, duller, and smaller than adjacent ones; while in older females it is greener or lighter purple than adjacent ones, but approximately the same size (Carney, 1964).

DISTRIBUTION AND HABITAT

Breeding Distribution and Habitat: To a much greater extent than would be expected from a forest-adapted species, the wood duck in Canada is largely limited to the more southern regions. Godfrey (1966) lists its breeding range as including Graham and Vancouver islands, southern British Columbia, the Midnapore area of Alberta, east-central Saskatchewan, southern Manitoba, southwestern and southeastern Ontario, extreme southern Quebec, and the Maritime Provinces. Cape Breton Island is the limit of its breeding range (*Audubon Field Notes*, 15:451), and although the wood duck regularly occurs during summer on Prince Edward Island, it is not yet known to nest there. The United States range is clearly divided into eastern and western components, with a gap in the Rocky Mountain region and western plains. The western breeding range extends from Washington to California, with the center in the western portions of Washington and Oregon and the eastern limits in northern Idaho and northwestern Montana. Except for one study in California (Naylor, 1960), this population has been investigated relatively little by comparison with the eastern population. Naylor estimated that of a total western breeding population of about 16,000 pairs in 1958, 7,500 were in Oregon, 6,000 were in Washington, 1,500 were in California, and the remaining 860 were located in Idaho, British Columbia, and Montana.

The remainder of the North American breeding wood duck populations extend from the Missouri and Mississippi valleys eastward over an area that more or less corresponds to the distribution of temperate deciduous and mixed deciduous-coniferous forests. To the west, the breeding limits occur in central North Dakota (Hibbard, 1971), eastern South Dakota (*Audubon Field Notes*, 15:420), eastern Nebraska (Rapp *et al.*, 1970), eastern Kansas (Johnston, 1965), eastern Oklahoma (Sutton, 1967), and east-central Texas (Texas Game, Fish, and Oyster Commission, 1946). Benson and Bellrose (1964) estimated that about half of a continental population of 400,000 breeding pairs in 1962 bred in the northern halves of the Atlantic and Mississippi flyways. Sincock *et al.* (1964) believed that the twelve states in the southern halves of these flyways may produce about 650,000 wood ducks annually.

The preferred summer habitat of wood ducks consists of freshwater areas such as the lower and slower-moving parts of rivers, bottomland sloughs, and ponds, especially where large willows, cottonwoods, and oaks are present (Grinnell and Miller, 1944). The presence of trees at least 16 inches in diameter (breast height), having cavities with entrances at least 3.5 inches wide and interiors at least 8 inches in diameter, appear to be minimal nesting re-



Breeding (hatched) and wintering (shaded) distributions of the wood duck in North America.

quirements (McGilvrey, 1968). Although cavities with extremely large entrances are rarely used, the height of the entrance and the depth of the cavity are not critical, nor is the direction of the entrance or its immediate proximity to water seemingly important (Grice and Rogers, 1965). The entrance should, however, be protected from weather, and the cavity must be well drained.

Besides the presence of usable nesting sites, the breeding habitat must contain adequate food sources, suitable cover, available water, and suitable brood-rearing locations. McGilvrey's summary of these requirements indicates that foods should include overwintering seeds or nuts (acorns, domestic grains, etc.), native herbaceous plants, and aquatic or aerial insect life. Breeding cover should include trees, shrubs, or both. The trees should have low branches, providing overhead and lateral cover, and preferably should be flooded. Shrubs that have strong stems rising and spreading out about two feet above the water level are highly desirable, such as buttonbush (*Cephalanthus*). The water should be no more than eighteen inches deep for best foraging, should be still or slow-moving, and should be available through the incubation period. Ideal brood-rearing habitat includes a source of available foods (such as insects and duckweeds) for ducklings, water persisting through the fledging period, and dense overhead cover such as provided by flooded shrubs or dead tree tangles. The presence of herbaceous aquatic plants is highly desirable, as are resting sites for the brood, but trees are not needed at this stage.

Wintering Distribution and Habitat: Virtually the entire North American wood duck population winters within the borders of the United States; a few winter in southwestern British Columbia and in extreme southern Ontario on Lake Erie (Godfrey, 1966), and in Mexico the wood duck is only an occasional winter vagrant (Leopold, 1959). The western population of wood ducks winters primarily in California; Naylor (1960) reported that California supported most of an estimated wintering population of about 55,000 birds.

The eastern wood duck population is many times larger than the western one, but in recent years (1966–1969) has been almost entirely overlooked during midwinter surveys. Counts made in the early 1960s indicate about 100,000 birds in the Mississippi Flyway and progressively smaller numbers in the Atlantic and Central flyways. No doubt the forest-inhabiting tendencies of this species make it relatively unsatisfactory for aerial censusing. Recoveries of wood ducks banded in Wisconsin indicate that these birds move south along the Mississippi Valley to Arkansas, Louisiana, Texas, and Mississippi, and move farther east only to a limited extent (Jahn and Hunt, 1964). On the other hand, wood ducks banded in Massachusetts evidently move south along

the Atlantic coastal plain and winter primarily in the Carolinas, Georgia, and northern Florida; only a few recoveries are found as far west as Louisiana and Mississippi (Grice and Rogers, 1965). It would thus seem that the Mississippi River and its tributaries provide one migratory thoroughfare, while the Atlantic coast provides another, with uplands and mountains being avoided and providing barriers to population interchange.

Secluded freshwater swamps and marshes are the favored wintering habitats of wood ducks throughout the southern states, particularly where acorns, hickory nuts, water-lily seeds, and similar foods are readily available. Stewart (1962) noted that fall migrant wood ducks congregate where the masts of beech and oaks are available, and they also utilize interior impoundments with stands of spatterdock (*Nuphar*). Small numbers use fresh estuarine bay marshes, especially where narrowleaf cattail (*Typha angustifolia*) and white water lily (*Nymphaea odorata*) are present. Among the estuarine river marshes, the largest spring and fall populations are found in fresh or slightly brackish water, especially where arrow arum (*Peltandra*) is common.

GENERAL BIOLOGY

Age at Maturity: A one-year period to maturity is well established for wood ducks. Ferguson (1966) noted that 19 of 24 aviculturists reported breeding by captive birds in the first year, while the remainder reported second-year breeding. Many studies, as summarized by Grice and Rogers (1965), have reported that birds marked as juveniles often returned the following year to the same area for nesting. Of an estimated 95 marked wild females believed alive as yearlings, 30 were found by Grice and Rogers to be nesting that year. Since many birds were not accounted for, the actual percentage of nesting by wild yearling birds is no doubt much higher.

Pair Bond Pattern: Apparently pair bonds are renewed yearly, since males normally desert females at the beginning of incubation and the females rear their young alone (Grice and Rogers, 1965). On occasion, however, males have been seen in company with females and broods, and there is at least one record of a male incubating (Rollin, 1957).

Nest Location: A number of studies on natural nesting cavities of wood ducks have been made, and several general characteristics of cavity requirements have emerged. McGilvrey (1968) summarized the optimum natural cavity as having a height of 20 to 50 feet, an entrance 4 inches in diameter, a cavity bottom of 100 square inches, a cavity depth of 24 inches, and a tree diameter of 24 to 36 inches. There appears to be a preference for high cavi-

ties and those with small entrances, which raccoons are unlikely to be able to enter (Bellrose *et al.*, 1964; Weier, 1966). Apparently there is also a preference for nesting in rows or clusters of large trees of similar size, rather than in isolated large trees (Grice and Rogers, 1965). Open stands are also preferred over dense woods. At least in the case of artificial cavities (nest boxes), those situated over water are greatly preferred to those on land. Cavities with entrances only slightly larger than the minimum possible ($3\frac{1}{2} \times 4$ inches) are preferred, as are those with cavity depths of less than 50 inches (Bellrose *et al.*, 1964).

Clutch Size: Estimates of clutch size are often confused by dump-nesting involving several females, which tends to inflate estimates of clutch size. Naylor (1960) estimated that 13.8 eggs represented a normal complete clutch, while dump nests averaged 28.5 eggs per nest. Similarly, Cunningham (1969) noted that the average clutch size of "single" nests ranged from 13.5 to 15.9 during three years, while that of dump nests averaged about 28 eggs. The incidence of dump-nesting was related to population density. Leopold (1966) reported an average clutch of 13.9 eggs for early nests. He noted that of 297 potential "egg days," only 13 were missed; thus the egg-laying rate is essentially 1.04 days per egg. Renests usually average smaller (Leopold, 1966), and as many as two renesting attempts have been noted (Grice and Rogers, 1965). A few instances of double brooding have also been found (Rogers and Hansen, 1967).

Incubation Period: The incubation period averages about 30 days, with reported extremes of 25 and 37 days (Grice and Rogers, 1965). Leopold (1966) noted that about half the clutches hatch in 30 days and two-thirds in the interval between 29 and 31 days, with pipping starting two days prior to hatching.

Fledging Period: Grice and Rogers (1965) noted that about 70 percent of the juveniles studied were capable of flight (after being thrown into the air) at sixty days of age, before their primaries were fully grown.

Nest and Egg Losses: A large number of studies of wood duck nests have been made, and most indicate fairly high success rates. Weller (1964) summarized three studies (mostly from artificial nesting boxes) that totalled 1,648 nests and averaged a 66 percent nest success. Leopold (1966) reported a 94 percent nesting success for 281 nests, and a 75 percent hatching success for 2,860 eggs. In the majority of studies, the single most important predator is the raccoon, and by the construction of relatively raccoon-proof nesting boxes, the nesting success is generally quite high (Grice and Rogers, 1965). In areas where starling populations are high 20 percent or more of the nests

have sometimes been destroyed, but starlings' use of wood duck nesting boxes can be reduced by constructing boxes with cavities that are too well lighted for these light-intolerant birds (Bellrose and McGilvrey, 1966).

Juvenile Mortality: Grice and Rogers (1965) determined that of 135 broods studied over a three-year period, brood size was reduced from an average of 12.5 at hatching to 5.8 at the time of fledging, or a loss of approximately 50 percent of the young during the 70-day fledging period. They found that early-hatched broods had the lowest mortality, while late-hatched young had an average brood size of 9.9 at hatching and only 2.2 at fledging. Jahn and Hunt (1964) also calculated an average brood size of 5.8 young for birds near the flight stages, based on six different studies. Estimates of first-year mortality rates for birds banded as juveniles range from 61.7 percent to 82.5 percent, with an average of three New England studies being 76.7 percent (Grice and Rogers, 1965).

Adult Mortality: Studies of banded birds in three New England states have provided estimated annual adult mortality rates of 51.7 to 63.7 percent, with an average of 58.9 percent (Grice and Rogers, 1965).

GENERAL ECOLOGY

Food and Foraging: A considerable number of food analyses (Martin *et al.*, 1951) of wood ducks have consistently pointed toward a high usage of fruits and nuts of woody plants, such as dogwood and elm trees, including beechnuts, acorns, hickory nuts, as well as a substantial consumption of the seeds of floating-leaf aquatic plants (*Brasenia*, *Numphaea*, *Nuphar*). Additionally the seeds and vegetative parts of other aquatic plants such as wild rice (*Zizania*), pondweeds (*Potamogeton*), arrow arum (*Peltandra*), duckweeds (*Lemna* and others), and bur reed (*Sparganium*) are consumed in large quantities. Stewart (1962) found that in the Chesapeake Bay area, wood ducks feeding on river bottomlands fed mostly on beechnuts and acorns, while birds in the estuarine river marshes predominantly consumed the seeds of arrow arum. Among the oaks, species that produced fairly small acorns are used more by wood ducks than those with large acorns, particularly in bottomland soils that are occasionally flooded (Brakhage, 1966). These include such species as pin oak (*Quercus palustris*), water oak (*Q. nigra*), willow oak (*Q. phellos*), and Nuttall oak (*Q. nuttallii*). Wood ducks may search for such acorns among the forest litter, or sometimes pluck them from the branches before they have fallen. When on water, they tip-up but only rarely dive for food; indeed only female wood ducks have so far been observed performing foraging dives (Kear and Johnsgard, 1968). Preferred foraging habi-

tat is water no more than 18 inches deep, the approximate limit a duck can reach by tipping-up.

Sociality, Densities, Territoriality: During most of the year the wood duck is found only in small flocks of a dozen birds or less, with larger aggregations occurring only during the nocturnal roosting period. Both on the wintering grounds and during migration such social roosting is typical, and roosts sometimes support hundreds of birds. Hester (1966) noted that roosts vary in size from less than an acre to several acres, and the numbers of birds using them range from less than a hundred to several thousand, with one recorded roost of 5,400 birds.

On arrival at their nesting grounds, wood ducks are usually in small groups of up to a dozen birds, and usually already in pairs. Once established on their nesting areas, pairs do not seem to restrict their movements to a particular territory or defend an area as such, but rather the males simply protect their females from attentions by other males (Grice and Rogers, 1965).

Breeding densities are apparently determined by the availability of suitable nesting cavities, which are usually fairly limited unless supplemented by artificial nesting boxes. In one study where boxes were not used, 37 of 67 cavities on 442 acres were used during one year (Bellrose *et al.*, 1964), or about 12 acres per nest. Examples of high nesting densities achieved with nesting boxes include 41 nests on an 8-acre pond, 95 nests on a 150-acre refuge, and 37 nests on 100 acres (McGilvrey, 1968).

Interspecific Relationships: Because of their specialized nesting adaptations, competition for nest sites between wood ducks and other duck species is extremely limited. The common goldeneye is the only other cavity-nesting duck species that has an overlapping breeding range, and this occurs only near the northern edge of the wood duck's range. A study in New Brunswick (Prince, 1968) indicated that competition between the two species was limited because of site- and cavity-preference differences, as well as differences in their preferred foraging and loafing areas. Wood ducks also used areas with somewhat larger trees and ones that were more varied in outer dimensions. Cavities used by the two species were similar in their entrance sizes, but goldeneyes evidently preferred cavities which were less deep and of a fairly definite inside diameter as compared with wood duck cavities.

Competition for cavities may also occur with other species. McGilvrey (1968) noted that other competitors include starlings, squirrels, bees, hornets, hooded mergansers, screech owls, and sparrow hawks. At least in some areas, squirrels may be serious competitors for nests, especially where only natural cavities are available.

Predators of eggs are numerous, but the most important is the raccoon.

In the southern states various snakes may also be important, and locally or occasionally fox squirrels, minks, opossums, or rats may also pose problems. Duckling predators include minks, turtles, fish, snakes, bullfrogs, predatory birds, and other predatory mammals (McGilvrey, 1968).

General Activity Patterns and Movements: The evening roosting behavior of wood ducks is well known and has been frequently studied as a population index technique. These flights are usually most pronounced during fall and winter. A study by Martin and Haugen (1960) indicated that the morning flights lasted for about 45 minutes and usually ended by 15 minutes after sunrise. Early evening flight activity mainly occurred during the last 50 minutes before sunset, but both morning and evening flights gradually occurred nearer the periods of darkness and were made during a shorter period of time as the fall season progressed.

Stewart (1958), using color-banded birds, studied local movements of broods and families. He found that at the age of about two weeks, broods moved away from their natal sites into new habitats and often merged with other wood ducks. Some of such brood movements were quite long, with a maximum record of 3.5 miles. When leading broods, females continued to make their morning and evening feeding flights and started gathering into small groups when the ducklings were about six weeks old. At the age of eight weeks, when the young fledged, additional congregation occurred, with some segregation of adult and young birds. In early October, the ducks moved from ponds and lakes to rivers and creeks, usually at distances of under fifteen miles, and by late October the fall migration had begun.

SOCIAL AND SEXUAL BEHAVIOR

Flocking Behavior: Judging from changes in numbers of birds at roosting sites, two periods of social flocking seem to be prevalent. Hartowicz (1965) found an early peak of numbers at roosting sites in mid-June, which he believed might represent nonbreeders, unsuccessful breeders, or males that have deserted their females prior to molting. A similar peak occurred in September, which presumably represented both young and old birds. Stewart (1958) noted that in late-summer concentrations, the morning flights away from the roosting sites consisted of larger flocks than did the evening flights back to the roost, which usually numbered from one to twenty birds.

Pair-forming Behavior: Pair formation evidently occurs on the wintering grounds, since birds arrive at their nesting areas already paired (Grice and Rogers, 1965). The pair-forming displays of wood ducks are numerous and

complex (Johnsgard, 1965), but an integral feature of pair formation is the performance of inciting by a female toward a specific male. In effect, the female incites a particular male to attack other birds, usually other males. This inciting behavior is highly ritualized and rarely leads to attacks. Instead, the "preferred" male responds to inciting by swimming ahead of the female and turning the back of his head toward her. This combination of inciting and turning-of-the-back-of-the-head display seems to be a fundamental feature of pair formation in nearly all true ducks (Johnsgard, 1960).

Copulatory Behavior: Unlike other North American surface-feeding ducks, copulation in wood ducks is preceded by the female assuming a prone position well in advance of treading. I have seen no preliminary mutual displays by the pair prior to the female's assumption of this posture, in which she lies flat on the water with her head low and her tail tilted slightly upwards. The male typically swims around her, making drinking or bill-dipping movements and sometimes pecking gently at her. Mounting then occurs, and after treading is completed the male usually first swims rapidly away from her while turning-the-back-of-the-head, then he turns and faces the bathing female (Johnsgard, 1965).

Nesting and Brooding Behavior: Leopold (1966) reported that mated pairs begin to look for nests shortly after they arrive in late March, spending several mornings investigating possible sites. The male accompanies the female, but does not enter the nesting box. After five or six days of such behavior, the first egg is laid. Egg-laying occurs in early morning, while the mate waits nearby, after which the birds leave until the following morning. Down-picking begins with the fourth to eighth egg. While the last few eggs are being laid, the female may spend the night in the box, presumably picking down. Incubation begins with the last egg, and during the incubation period two rest periods are normally taken daily, during early morning and late afternoon hours. The male usually accompanies the hen on such flights, until he deserts her for his postnuptial molt. During first nestings the male usually attends the female into the fourth week of incubation. The female remains in the nest during the four- to six-hour hatching period, and the family usually spends its first night in the nest. The next morning the female usually takes her rest flight, then returns to the nest and calls the young from the cavity with a series of low *kuk* notes. The young jump from the nest in rapid succession, and the family then walks to the nearest water.

Stewart (1958) noted that newly-hatched broods went to water areas that were nearest the hatching place, provided that vegetative cover was present. For the first two weeks of life little brood congregation occurs, although

lost individual ducklings may attach themselves to other broods. Because of such brood merger, age differentials among ducklings in broods are not uncommon.

Postbreeding Behavior: Following their desertion of the females, male wood ducks evidently move to secluded woodland ponds or swamps, where they are rarely seen. Females undergo their molt later than males; they probably normally leave their broods and begin to molt between six and eight weeks after the young have hatched. Like the males, they then inhabit the thickest possible cover and are almost never seen (Grice and Rogers, 1965). Shortly after regaining flight, the young and the adults begin to congregate in preparation for their fall migration.

