REPRODUCTIVE ASPECTS, GROWTH, AND DEVELOPMENT OF GREENLAND MALLARDS

RAYMOND J. GREENWOOD
Northern Prairie Wildlife Research Center
Jamestown, North Dakota 58401

The biology of the Mallard (*Anas p. platyrhynchos*) has been well documented in North America; however, little information is available concerning the Greenland subspecies (*A. p. conboschas*). Salomonsen (The birds of Greenland, Munksgaard, Copenhagen, p. 88, 1950) summarized the literature available prior to 1950 on wild Greenland Mallards. As recently as 1956, the latter were not known to be held in captivity (Delacour, The waterfowl of the world, Country Life Ltd., London, p. 44, 1956). In 1967, Greenland Mallard stock was acquired by the Northern Prairie Wildlife Research Center, Jamestown, North Dakota, as part of a comprehensive study of the morphology and breeding biology of the Mallard. The purpose of this paper is to present the data obtained on nesting, growth, and development of captive Greenland Mallards.

METHODS

One pair of Greenland Mallards was purchased from Ripley Farms, Litchfield, Connecticut, on 30 March 1967; and another pair, on 26 March 1968. These birds were first-generation progeny of wild stock obtained in Greenland by the Copenhagen Zoo, Denmark.

The first pair of Greenland Mallards mated in 1967. In 1968, five of the female and two of the male progeny reared in 1967, plus the original male from 1967, were combined in a flock-mating. Two pair-matings were also established that year, one utilizing the pair of Greenland Mallards acquired in 1968 and the other, an additional pair of birds reared in 1967. Each breeding pen contained a small water trough, one or more nest boxes, and a sheltered feeder. The laying ration was a standard crumbled feed (protein: 19% in 1967, 18% in 1968) supplemented with crushed oyster shell. Eggs were gathered daily, washed, and stored in a cooler at 55°F and 96% relative humidity (RH). Some unincubated eggs were measured and weighed. Eggs were set periodically in a forced-air incubator at 99.5°F and 57–60% RH. In 1968, incubated clutches taken from two females were transferred immediately to the incubator.

Ducklings were removed from the incubator within 18 hr after hatching. Their sex was determined by cloacal examination and they were banded and placed in heated brooders that contained drinking water and starter feed. In 1967, 29% protein "starter" ration was fed during the first 2 weeks after hatching, then replaced with a 19% "grower" ration. Ducklings were held in brooders for those 2 weeks, then moved to a pen with a pond. In 1968, ducklings were fed a 28% protein "starter" ration for 3 weeks after hatching, then changed to 18% protein "grower" ration. Ducklings were held in brooders for only 1 week in 1968, then moved to the pen.

In 1968, ducklings were weighed and measured at hatching and weekly thereafter for 8 weeks. Measurements included the culmen length from tip of nail to the point where feathered integument of the forehead contacts the bill, the culmen width at the widest point, and the tarsus length. The tarsus was measured from the most anterior medial condyle, where it articulates with the mid toe, to the exterior portion of the skin covering and including the condyles of the tibia. The leg was bent so the foot and tibia were at right angles to the tarsus.

Data on the development of flight feathers were recorded, and fledging age was determined by lofting the ducklings into a pen. Birds were considered to be fledged when they could fly approximately 10 ft and maneuver to a soft landing. The age at which juvenile males acquired green head plumage was documented as an index to the progress of the prenuptial molt. In 1967 and 1968, when immatures were 19 weeks old, they were weighed and measured again. In addition to the three previously mentioned measurements, the tarsus width was measured at the narrowest point, and the 10th primary feather was pulled and measured. Length of the flat wing and total body length were measured by the method of Palmer (Handbook of North American birds, Vol. 1, Yale University Press, p. 5, 1962).

Throughout this paper, variation about the mean is expressed as the standard deviation. Statistical comparisons are by the *t*-test.

RESULTS AND DISCUSSION

NESTING CHRONOLOGY AND EGG PRODUCTION

In 1967 the 1-year-old female Greenland Mallard laid 20 eggs, starting on 17 April. The first 10 eggs were laid in 14 days while the pair was confined in an indoor pen. When laying ceased, the pair was moved to an outdoor pen where a clutch of 10 eggs was laid in 10 days beginning on 18 May. This clutch was left for the female to incubate.

TABLE 1. Average weekly weights and morphological measurements of eight male and seven female Greenland Mallard ducklings, 1968.

	Males				Females			
Age (wk)	Weight (g)	Culmen length (mm)	Culmen width (mm)	Tarsus length (mm)	Weight (g)	Culmen length (mm)	Culmen width (mm)	Tarsus length (mm)
hatch	39	17	10	28	37	16	10	28
1	148	28	15	41	141	27	15	41
2	275	35	17	50	268	35	17	49
3	522	40	19	55	492	40	19	54
4	804	47	21	58	752	46	21	57
5	1061	52	22	60	959	50	22	58
6	1135	54	22	60	1011	53	22	58
7	1176	57	23	60	1066	54	22	59
8	1215	59	23	60	1057	56	23	58

TABLE 2. Average weights and morphological measurements of 19-week-old Greenland Mallards. Data combined for 1967 and 1968, except for weight.

Measurement		Males	n	Females	n
Weight (g)	(1967)	1306.0 ± 95.5[a]	(3)	1094.8 ± 95.3	(6)
	(1968)	1480.0 ± 132.0	(8)	1306.0 ± 134.4	(7)
Culmen length	(mm)	58.3 ± 1.8	(10)	54.5 ± 2.4	(13)
Culmen width	(mm)	24.0 ± 0.8	(10)	23.6 ± 1.4	(13)
Tarsus length	(mm)	61.0 ± 1.8	(10)	58.2 ± 2.4	(13)
Tarsus width	(mm)	6.3 ± 0.7	(10)	6.2 ± 0.6	(13)
Wing chord	(cm)	28.1 ± 1.4	(10)	26.8 ± 1.3	(12)
Tenth primary	(cm)	19.6 ± 0.5	(8)	18.9 ± 0.4	(7)
Body length	(cm)	62.9 ± 1.4	(10)	57.8 ± 2.7	(13)

[a] Standard deviation.

In 1968, females in the flock-mating laid during a 26-day period beginning on 12 April. Daily egg collection records indicated that only three of the five females laid, giving a production average for the three of 16.3 eggs. Laying may have been curtailed by aggressive male behavior discussed in the section on breeding behavior.

Females in the two pair-matings in 1968 also initiated laying in April, one on the 21st and the other on the 27th. During the first portion of the laying period, eggs were gathered daily. Gathering was discontinued after the respective females had laid 7 and 11 eggs each. Fourteen days later, incubated clutches of seven and eight eggs were found in their respective nests. Salomonsen (loc. cit., p. 92), who found Mallards nesting from late May to the end of July in Greenland, reported that clutches of 8–10 eggs were common.

BEHAVIOR OF BREEDING MALES

Some Greenland Mallard males were very aggressive during the reproductive season. In 1967 a Greenland pair was confined with several Black Ducks (*A. rubripes*) during late February and March. Approximately 2 weeks before the Greenland females began laying, the drake killed one Black Duck and severely injured several others before the species were separated. In 1968 the same male harassed other Greenland Mallards in a flock-mating until it became necessary to remove him. Within several days another male assumed the dominant role and continued the harassment. Egg production may have been curtailed by the disturbances. Similar aggression has not been observed at the Ripley Farms where the stock was acquired (S. D. Ripley, pers. comm.).

EGG CHARACTERISTICS

The average measurements of 41 Greenland Mallard eggs obtained during 1967 and 1968 were: 42.49 ± 0.82 mm wide, and 58.54 ± 2.32 mm long; the average weight was 58.00 ± 4.00 g. Schiøler, as reported in Salomonsen (loc. cit., p. 91), found that 54 eggs of wild Greenland Mallards measured 40–45 (43) mm wide and 57–66 (61) mm long.

INCUBATION PERIOD

The number of Greenland Mallard eggs hatched in forced-air incubators in 1967 and 1968 was insufficient for calculating incubation time; however, six settings from 1969 and 1970 gave an average of 25 days and 15 hr. Two naturally incubated clutches hatched in approximately 26 days in 1968. One naturally incubated clutch hatched 22 days after the last egg was laid in 1967. Observations of this nest suggested that the eggs were under incubation prior to the day the last egg was laid. All eggs hatched except the last one to be laid in this 10-egg clutch.

GROWTH AND DEVELOPMENT

Sexual dimorphism in weight of Greenland Mallard ducklings was evident at hatching; males averaged 39 g and females 37 g (table 1). Sex-related weight differences continued to increase throughout the study; however, the weights of male and female ducklings did not differ significantly ($P < 0.05$) until the end of week 6. Patterns of male and female weight gain were similar. An initial 2-week period of moderate gain after hatching was followed by 3 weeks of rapid growth in which males gained an average of 262 g per week and females, 230 g per week. The rate of gain declined markedly after week 6. At hatching, sexual differences in culmen and tarsus length were less distinct than differences in weight, but they became increasingly noticeable after week 4. Tarsus growth was essentially complete by week 5, at which time male tarsi averaged 60 mm in length and those of females, 58 mm ($P < 0.05$). Culmen length and width continued to increase throughout the entire 8-week period, but growth appeared nearly complete by week 8.

The various measurements of length and width taken of 19-week-old Greenland Mallards in 1967 and 1968 were very similar; however, weights differed substantially between years (table 2). Although the average weight of males and females was nearly 200 g more in 1968 than in 1967, only the difference between females was significant ($P < 0.05$). These weight differences were probably the result of the variation in diets and rearing procedures. The 1968 grower ration contained 200 Kcal more per pound in productive energy than the 1967 ration.

Salomonsen (loc. cit., p. 91) reported wing lengths for adult Greenland Mallards of 29.2 cm for males and 27.2 cm for females; however, he did not describe his method of measuring.

PRIMARY FEATHER MATURATION AND FLEDGING

The primary feathers of Greenland Mallards began clearing shortly after the ducklings were 6 weeks old. As the feather shaft cleared, the blue, pulpy rachis became translucent and hard, capable of supporting flight (see Weller, Wilson Bull. 69:22, 1957, for complete description of the clearing process). At 7 weeks of age, all birds in the experimental group had four proximal primaries in some stage of clearing (pulpy vascular tissue receding); however, none of the birds

had fledged. Six female ducklings fledged at 54 ± 4 days, and had an average of five primary feathers clear (rachis translucent); and six males fledged at 56 ± 3 days, and had six primary feathers clear ($P > 0.05$).

PRENUPTIAL MOLT

The first prenuptial molt of Greenland Mallard males began shortly after fledging and was nearly complete at the time head plumage was replaced. Several males showed indications of green head-feathering at 75 days of age. All eight males in 1968 acquired completely green heads in an average of 118 ± 16 days (range 98–134).

SUMMARY

Captive Greenland Mallards, one generation removed from the wild, nested during mid-April in North Dakota. Forty-one eggs averaged 42.49 mm wide, 58.54 mm long, and 58.00 g. Artificial incubation to hatching occurred in an average of 25 days and 15 hr. Ducklings grew most rapidly during the 3rd through 5th weeks after hatching. Tarsus growth was nearly complete by week 5; however, culmen growth continued through week 8. Females fledged at an average of 54 days and males, at 56 days. Males acquired green head plumage when an average of 118 days old.

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SEASONAL PREDATION ON MOLES BY THE RED-TAILED HAWK

JOHN C. HAFNER
Museum of Vertebrate Zoology
University of California
Berkeley, California 94720

On 10 March 1972, a known pair of Red-tailed Hawks (*Buteo jamaicensis*) were sighted at 133 m elevation 2 km N of Clayton, Contra Costa County, California. At 08:45 the male dove and landed on the ground. After 5 min on the ground, the hawk flew toward the female, clutching a western mole (*Scapanus latimanus*). Perching beside his mate, the male regurgitated a pellet, then began to feed on the mole held in its talons. Both the mole (a juvenile) and the regurgitated pellet were collected. The pellet contained remains of an adult mole.

Significantly, it appears that moles occur as prey of Red-tailed Hawks exclusively during winter and spring (Austing, The world of the Red-tailed Hawk, J. B. Lippincott Co., Phila., 1964; Fisher, Bull. U.S. Dept. Agri., Div. Ornithol. and Mammal. 3:48, 1893; Roest, J. Mammal. 33:110, 1952; pers. observ.). This seasonal vulnerability is apparently related to their reproductive period. During breeding and dispersal of the young, moles temporarily abandon their burrows (Arlton, J. Mammal. 17:349, 1936), and only then are readily available as prey. The ability of "general feeders" such as adult Red-tailed Hawks to utilize other species when rodents tend to be scarce could explain the occurrence of moles as prey (Craighead and Craighead, Hawks, owls and wildlife, Dover Pub., New York, 1969).

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THE INHERITANCE OF CLUTCH SIZE IN THE GREAT TIT (*PARUS MAJOR* L.)

C. M. PERRINS AND P. J. JONES[1]
Edward Grey Institute of Field Ornithology
Department of Zoology
South Parks Road, Oxford, England

It is fundamental to theories concerning reproductive rates and population regulation (Lack 1954; Wynne-Edwards 1962) that the clutch sizes of birds have evolved through natural selection, and are therefore, at least in part, genetically determined. While this is now generally accepted, the role of inheritance in the determination of clutch size has not yet been demonstrated.

Several factors associated with egg production in poultry are known to be genetically determined because it has been possible to improve production by artificial selection (Nordskog et al. 1967), but since the eggs are not normally laid in clutches, it has not been possible to investigate factors affecting clutch size. Among wild birds, the clutch sizes of many species are constant, and it may be argued that this is an inherited characteristic. However, since in such cases there is no observable intraspecific variation, the extent to which the clutch size of the offspring is determined by inheritance from the parents cannot be estimated. Other species, for instance, tits of the genus *Parus*, which lay relatively large clutches, show considerable variation in clutch size between individuals of the same species. A wide range of geographical variation occurs in the Great Tit (*Parus major*), clutch size increasing with increasing latitude (cf. Hoogerwerf 1949; Heim de Balsac 1952; Balat 1970; von Haartman 1969). Since this variation is associated with subspecific differences in size and plumage characteristics, which are presumably inherited, it seems reasonable to suppose that the clutch-size difference might also be inherited. However, it becomes possible to test this assumption only where a high degree of intraspecific variability in clutch size occurs within the same population.

[1] Present address: ODA Quela Investigations Project, PMB 1082, Maiduguri, N.E. State, Nigeria.