Growth and moult progression of White-winged Scoter ducklings

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Introduction

White-winged and Velvet Scoters *Melanitta fusca deglandi* and *M. f. fusca* consistently experience low brood survival (Koskimies 1955; Hildén 1964; Brown & Brown 1981; Brown 1981). Initially, low productivity was attributed to 1) overcrowding on brood rearing areas, 2) weak parent-young bonds that make ducklings more susceptible to predators, and 3) the ducklings' lack of tolerance to cold weather (Koskimies 1957). High mortality associated with bad weather was thought to be caused partly by exposure, and partly by predators. Later, however, Velvet Scoter ducklings were found to be very cold-hardy, owing to a high metabolic rate relative to body size requiring a readily available food supply (Koskimies & Lahti 1964).

White-winged Scoters required a relatively long growth period of 63-67 days to reach flight stage on the Delta Marsh, Manitoba (Hochbaum 1944). The significance of the long growth period and the low duckling survival was poorly understood. The purpose of this study was to determine the patterns of 1) tarsus, culmen, and wing growth, 2) weight gain, and 3) feathering rate of growing scoter ducklings, and to evaluate these patterns in relation to their energy and nutrient demands. This should provide insight into the duckling mortality in late summer and the adaptive value of the long growth period.

Methods

Hatching White-winged Scoter eggs were collected from Jessie Lake, Alberta, and Gordon Lake, Saskatchewan, in 1977-80, and transported to Gaylord Memorial Laboratory, Puxico, MO. The lack of one-day air freight service from Saskatchewan to Missouri resulted in delays of more than 72 hours. About 50% of the eggs survived the trip each year.

Ducklings were reared in three interconnected indoor pens. A 120 watt lamp was provided as a 24-hour heat source in one pen. In 1980 a heating pad was used at night to reduce the photoperiod to 16 hours per day. The brooding house was air-conditioned to maintain the temperature at about 20°C. Removable carpets were changed and pens were cleaned and disinfected daily. Two water dishes were also cleaned daily and vitamins added to the water. In 1980, 1-2-week-old (and older) ducklings were moved daily to a 2 x 6 ft. stock tank that contained a loafing island and were returned to the brooding pens each evening. Ducklings were fed commercial poultry grower, supplemented with commercially raised live crickets and wild grasshoppers.

Wing, tarsus, and culmen length, and body weight were measured weekly when possible, but there were several exceptions. Feathering rates for the head, body, tail, and wings were recorded (0 = no feathers, 1 = a few new feathers, 2 = many new feathers). All observations were recorded until the birds had fully developed primaries. The sex of ducklings was not determined. Fresh egg weights were estimated from measurements of eggs in incubated clutches (Brown 1981) by using the formula W = 0.56 x length (width)^2 of Hoyt (1979). Adult weights and measurements were obtained from breeding scoters collected in central Saskatchewan (Brown 1981).

Results

Eggs and newly hatched ducklings

The mean weight of 4184 eggs from 429 nests (Brown 1981) was 82.4 g (S.D. = 4.50 g). Weights of 22 ducklings that were 1 day old or less ranged from 49 to 59 g ($\bar{x}$ = 54.5 g).

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Weight gain

This was most rapid between 0-4 weeks of age, and then became slower and more variable (Table 1), especially about the time ducklings reached 24-45% of the adult body weight. Mean body weight declined at about the time (9-11 weeks) ducklings fledged.

Relative weight gain in scoter ducklings was slower than for 10 species of *Anas* and *Aythya* (Southwick 1953; Weller 1957; Dzubin 1959; Kear 1970; Oring 1968). At 7 weeks of age, scoter ducklings had gained about 9.5 times their hatching weight (Table 1). In comparison, 7-week-old Tufted Duck *Aythya fuligula* were 15 times their hatching weight (Kear 1970), Canvasback *Aythya valisineria* were 20 times (Dzubin 1959), and Pintail *Anas acuta* were 24 times (Southwick 1953).

Culmen, tarsus and wing growth

Culmen growth was rapid (Table 2). The culmen was about 50% of the adult length at hatching, reached 50% by 2 weeks of age, 75% by 4 weeks, and reached adult length at 10 weeks.

The tarsus was the fastest-growing structure measured. It was nearly half the adult length at hatching, at 3-4 weeks of age was about 86%, and at 7-8 weeks was nearly fully grown.

Wing growth was slow during the first 5 weeks. Between 6 and 8 weeks, when culmen and tarsus growth slows, the rate of wing growth increased dramatically. Adult wing length was attained by week 11, about the time wild White-winged Scoter juveniles are able to fly (Hochbaum 1944). The decrease in wing length after week 12 resulted from fraying of feather tips and probably does not occur in the wild.

Moult progression

Juvenile feathers first appeared on the sides, and centre of the chest and belly area (Table 3). Tail feathers were completely grown by the end of the 4th week, and the belly and lower tail coverts by week 7. The period of rapid growth for primary, secondary, and tertial wing feathers began between the 3rd and 5th weeks and extended through week 10. Juvenile feathers on most other parts of the body began growing between week 2 and 3, and were completely or nearly completely grown by the end of week 9.

Discussion

Energy for growth of the embryo and maintenance of newly hatched ducklings is contained mainly in the egg yolk (Kear 1970). The proportion of yolk in anatid eggs does not vary significantly

Table 1. Weights of White-winged Scoter ducklings expressed as actual weight, relative body weight (multiples of hatching weight), and percentage of adult weight (1300 g).

Age (weeks)	Number	Weight (g) $\bar{x}$	Range	Relative weight	Adult weight %
0–1	25	50	29–79	0.9	3.8
1–2	13	128	52–180	2.3	9.8
2–3	11	225	180–280	4.1	17.3
3–4	9	320	278–380	5.9	24.6
4–5	11	333	190–460	6.1	25.6
5–6	11	406	236–522	7.4	31.2
7–8	2	517	284–662	9.5	39.8
8–9	8	678	660–697	12.4	52.2
9–10	10	758	524–880	13.9	58.3
10–11	4	812	510–964	14.9	62.5
11–12	6	760	661–802	14.0	58.5
12–13	6	812	733–885	14.9	62.5
21+	6	1226	1016–1664	22.5	94.3

Data not recorded for week 6–7

among species, but the absolute size and weight of the yolk are variable (Lack 1968). Weight of the yolk in dabbling ducks was related to egg weight, and ducklings hatched from large eggs survived starvation longer than those hatched from smaller eggs (Krapu 1979).

White-winged Scoters lay larger eggs than all other North American ducks, except the eiders *Somateria* spp. (Bellrose 1980), and their ducklings are heavier than all duck species examined by Koskimies & Lahti (1964), Smart (1965) and Kear (1970), except Common Eider *Somateria mollissima.* Newly hatched scoter ducklings require little parental care and can probably survive with little brooding, possibly because of large fat reserves derived from the yolk. The relatively large eggs and 'tough chicks' of Oxyurini, Mergini and some *Aythya* may be adaptations to assure that their young can dive for food soon after hatching (Lack 1968). White-winged Scoter ducklings feed almost exclusively by diving, presumably an energetically expensive method (Siegfried *et al.* 1976; Brown 1981). Because of their large nutrient

Table 2. Mean tarsus, culmen, and wing lengths (mm) of White-winged Scoter ducklings.

Age (weeks)	Number	Culmen	Tarsus	Wing
0–1	25	13.5	24.3	50.4
1–2	13	21.1	30.7	–
2–3	11	27.1	40.9	59.5
3–4	9	30.9	45.5	–
4–5	11	32.5	48.1	66.5
5–6	11	33.8	49.4	–
7–8	2	37.5	52.0	182.9
8–9	8	37.2	53.5	183.0
9–10	10	39.7	52.8	234.0
10–11	4	41.2	52.8	250.0
11–12	6	41.2	53.0	250.0
12–13	6	42.5	53.6	247.0
21 +	6	41.9	53.0	235.8
Adult				
Male	14	45.9	52.9	283.5
Female	35	43.4	48.5	279.4

Data not recorded for week 6–7

Table 3. Feathering progression in different feather tracts of White-winged Scoter ducklings. 0–no birds with feather growths, T–few birds with slow growth, 1–most birds with slow growth, 2–most birds with rapid growth, 3–most birds finished but some with rapid growth, C–all birds finished.

	Age (weeks)									
Area	1	2	3	4	5	6	7	8	9	10
Face and crown	0	0	R	1	1	2	2	2	3	C
Neck and throat	0	T	1	1	1	2	2	2	3	C
Upper back	0	T	T	T	1	1	2	2	2	C
Scapulars	0	0	2	2	2	3	3	C	–	–
Lower back and rump	T	1	1	1	1	1	2	2	2	C
Chest center and side	2	2	2	2	2	3	C	–	–	–
Belly	2	2	2	2	2	3	C	–	–	–
Side and flank	0	1	2	2	2	2	3	3	3	C
Primaries, secondaries, tertials	0	1	2	2	2[1]	2	2	2	2	C
Upper wing coverts	0	0	0	2	2	2	2	2	2	2
Lower wing coverts	0	0	0	0	0	1	2	2	2	3
Upper tail coverts	0	1	2	2	2	3	3	3	3	C
Tail feathers	0	0	1	C	–	–	–	–	–	–
Lower tail covers	0	2	2	2	3	3	C	–	–	–

[1] All primaries firm

reserve, ducklings of many species can walk long distances from the nest before they need to feed, allowing nests to be dispersed away from water, possibly reducing chances of nest destruction (Lack 1968). White-winged Scoters often nest more than 50 m from water (Brown & Brown 1981) and the ducklings must swim long distances (3-8 km) to reach brood areas and must dive frequently to escape gull *Larus* spp. attacks. Probably at least 36 hours elapse from the time of hatch before most ducklings can begin to feed.

The nutrient reserves of the yolk sac are also important in enabling the ducklings to withstand cold temperatures. Velvet Scoter ducklings were more cold-hardy than all other species exmained by Koskimies & Lahti (1964), except the Common Eider. The cold-hardiness of scoter ducklings resulted from a high metabolic rate relative to body size. Once the yolk sac reserves are expended, the high metabolic rate can be maintained only by consuming an adequate amount of food. The cold-hardiness characteristic is probably an important adaptation allowing White-winged Scoters to raise their young with little parental brooding on the cool waters of high latitude lakes (Koskimies & Lahti 1964).

The large duckling weight at hatching and size of nutrient reserve may be important adaptations permitting scoter ducklings to meet high energy demands in their first days of life. Large body size increases fasting endurance (Calder 1974) and may be necessary for scoter ducklings simultaneously to fuel their high metabolic rate and to endure evening temperatures near $0^{O}C$ with little brooding. Food availability (including the effects of competition from brood mates) and weather conditions are probably important factors affecting duckling survival. With a short breeding season (Hochbaum 1944; Brown & Brown 1981) weather conditions during a relatively brief period can be crucial.

Body weights of scoter ducklings became most variable about the time they reached 25% of the adult body weight. The energy demands of two other precocial species (White Leghorn Chicken *Gallus gallus* and Dunlin *Calidris alpina)* approach maximum levels at 30-50% of the adult weight and then level off during the remainder of the growth period (Ricklefs 1974). Variability in body weight of scoter ducklings during this period may be related to their high energy and nutrient demands. Stress, including captivity, would have its greatest effect on weight gain, and possibly survival, during this period of rapid growth.

At fledging, the rate of weight gain declined, and our captive scoters weighed about 800 g or 60-70% of the adult weight. Ducklings of other species also lose weight at the time of fledging (Weller 1957, Kear 1970), but the cause is not firmly established.

Rapid attainment of adult bill and tarsus characteristics, before reaching the period of maximum energy demand, is advantageous for the ducklings because their feeding niche is very similar to that of adults (Brown 1981). As the tarsus and culmen approach adult length, wing growth increases. Wing growth is delayed in Tufted Ducks (Kear 1970) and Redheads *Aythya americana* (Weller 1957) until tarsus growth is nearly complete. The rapid development of feathers in the belly and chest area is probably advantageous in increasing insulation in those areas that are constantly in contact with the water. Early development of tail feathers may aid ducklings in diving for food.

Generally, diving ducks require more time to reach the flight stage than dabblers (Weller 1957). The latter may lead a less aquatic life and may be more vulnerable to predators and thus selective pressure would shorten the growth period (Kear 1970). The development period for White-winged Scoters is longer than for any other duck species in North America (Hochbaum 1944; Weller 1957). This may spread energy demands over a long period and so reduce daily requirements, allowing ducklings to mature in a niche where energy is not readily available and the costs of foraging are high. Parasitic infection (Trethewey 1975) and frequent attacks by gulls may also stress ducklings. The period of maximum energy demand for scoter ducklings roughly coincides with the time when declines in their numbers occurred on Redberry Lake, Saskatchewan, and Jessie Lake, Alberta (Brown & Brown 1981; Brown 1981). This may result from many ducklings being unable to secure adequate nutrients during their period of maximum need.

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Summary

Captive White-winged Scoter ducklings *Melanitta fusca deglandi* were studied to determine their general pattern of growth and moult progression. The average weight of 22 newly hatched ducklings was 54.5 g. Ducklings gained weight most rapidly up to 4 weeks of age (or about 25% of adult weight). Weight gain then slowed and became more variable. The tarsus and culmen grew rapidly and both structures were more than 75% of the adult length at 4 weeks. Growth of the wing was most rapid thereafter and adult wing length was attained by week 11. Juvenile feathers first appeared in the chest and belly area and most body feathers were completely grown by week 9.

The early development of the tarsus and culmen enables ducklings to move rapidly into the adult foraging niche. The early acquisition of feathers on the ventral surface may increase the insulation for those areas in constant contact with the water. The development period is longer than for other North American ducks and may reduce the daily energy demand of growing ducklings by spreading the demand over a long period.

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