Body and organ weights, and carcass composition of breeding female White-winged Scoters

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Introduction

Many studies of breeding waterfowl have focused on changes in body weight during reproduction because the temporal sequence and magnitude of these changes indicates the way each species meets reproductive demands. Body weights provide an approximate index of metabolic reserves. Weight changes during the reproductive season have been documented for many waterfowl (e.g. Weller 1957; Milne 1976; Ankney and MacInnes 1978; Krapu 1981; Ankney 1984; Krapu 1981; Ankney 1984; Tome 1984 and Hohman 1986). The general pattern is one of increasing body weight before laying and of declining weight through laying and incubation. This study was conducted to determine how body and organ weights, and carcass composition change during reproduction in female White-winged Scoters *Melanitta fusca deglandi*.

Study Area and Methods

Adult females were collected on Gordon (N=18) (52° 53′N, 107° 22′W) Iroquois (N=2), and Bramble lakes (N=1), and on Lac la Peche (N=1), Saskatchewan, and Jessie Lake (N=13) (54° 25′N, 110° 75′W, Alberta), 1978–80. No more than 10% of the pairs on each lake were collected each year. Scoters were assigned a breeding status corresponding to 8 categories. These categories were: (1) prelaying – slow follicle growth. Largest follicle less than 10 mm, oviduct slightly or moderately enlarged, (2) rapid follicle growth – largest follicle 10 mm or larger, enlarged oviduct, no evidence of egg laying, (3) laying – females in the early and middle stage of laying. Largest follicle over 10 mm, ruptured follicles present, but at least 4 follicles yet to be ovulated (as judged by size), (4) terminal laying – near the end of egg laying. Ruptured follicles present, with no more than 3 follicles to be ovulated, (5) early incubation – 0–2 days after initiating incubation, determined by candling the eggs (Weller 1956), (6) mid-incubation – 10–14 days into the incubation period, (7) late incubation – 24 or more days into the incubation period, and (8) brood rearing.

Body and organ weights were recorded within four hours after collection. Internal organs, sternal muscles, and entire carcasses were weighed to the nearest 0.1 g on a triple beam balance. Contents of the digestive tract were removed. Birds were then frozen for later analysis. For the composition analysis, most feathers were removed by using a commercial sheep shear; remaining feathers were plucked by hand. Entire carcasses (minus ova larger than 14 mm because these were thought likely to be ovulated) were homogenized by passing through a food grinder at least 6 times (smallest sieve size 4 mm). Small ova that were unlikely to be ovulated (ie. <14 mm) were left in the carcass because they could supply energy or protein needs later upon resorption. The homogenate was mixed after each passage through the grinder, and any skin or bone that had been trapped on the grinder blade was removed and blended with it. A random sample of the homogenate weighing about 10% of the bird's weight was removed for analysis performed by the University of Missouri Agricultural Experiment Station Chemical Laboratories. Petroleum ether Soxhlet extraction of lipid determinations and Kjeldahl procedures for nitrogen content according to AOAC standard procedures (Horwitz 1970) were used. Percent moisture was determined by placing the sample in a vacuum oven at 100°C for 15 hours. Estimates of ash were obtained by placing dried samples in an oven and holding the temperature at 550°C for 2 hours. Duplicate samples were submitted to verify results.

Because of small sample sizes, differences between reproductive periods were investigated using a Mann-Whitney U test (Conover 1971). The level of significance for all tests was alpha = 0.05.

Results

Body weights

Body weights of females at the time of arrival are unknown, but three of the 5 prelaying females were collected between 21st and 27th May, only a week after the

Table 1. Mean body and selected organ weights for female White-winged Scoters in relation to breeding status. Collections were made in central Saskatchewan, 1978–80. Weights (g) shown are the mean ± standard error, except for brood rearing.

Category	Prelaying	Rapid follicle growth	Laying	Terminal laying	Stage of incubation (days) 0–2	10–12	24+	Brood rearing
Body weight	1441±42	1458±25	1452±23	1408±20	1316±40	1205±26	1091±42	1096
Eviscerated body weight[a]	1242±38	1236±26	1211±17	1190±12	1162±35	1082±26	966±33	968
Organ weights								
Gizzard	35.3±3.0	30.0±1.9	26.4±1.3	25.9±1.8	21.0±1.7	21.0±0.5	19.0±2.5	18.5
Small intestine	60.0±4.8	52.4±1.2	49.1±4.6	46.6±5.5	46.0±3.3	31.7±4.4	39.5±3.3	43.2
Liver	56.0±1.5	53.3±1.0	45.3±3.0	41.8±2.4	42.2±2.0	33.1±5.6	35.7±4.9	38.2
Oviduct	3.7±0.9	22.1±4.0	35.1±2.2	38.3±5.3	9.0±0.9	2.0±0.3	1.5±0.2	1.2
Ova and ovary	3.3±0.9	27.8±4.2	49.0±3.2	31.3±4.7	1.5±0.9	0.5±0.2	2.1±0.3	1.7
Pectoral muscle[b]	137.4±4.7	140.4±1.9	138.7±4.2	141.1±2.5	140.6±3.4	130.0±4.1	111.8±4.0	103.0
Number of birds	5	8	5	3	4	4	5	1

[a]Body weight minus all internal organs except kidneys.
[b]Includes left pectoralis, supracoracoideus, and coracobranchialis muscles.

peak arrival period. Mean weight of these females was 1514 g (range 1472–1560 g), and their mean eviscerated body weight (i.e. body weight with all internal organs removed except kidneys) was 1303 g (range 1243–1351 g), the heaviest weight recorded in the breeding season.

Body weight and the eviscerated body weight (EBW) remained constant until between terminal laying and early incubation, when they declined significantly ($P<0.05$) (Table 1). Body weight declined rapidly during incubation, mostly from declines in the EBW and reproductive tract.

Changes in subcutaneous fat reserves are probably best reflected in the EBW (Table 1) which was greatest during prelaying and then declined to a low at the end of incubation. During egg laying, body weight declined about, EBW accounting for 52% (74 g) of this reduction. Of the weight lost during incubation, 87% (196 g) occurred in the EBW.

Carcass Composition.

Lipid levels did not vary significantly from prelaying through to the terminal laying stage, but the lipid level during rapid follicle growth was significantly greater ($P<0.05$) than that in the early incubation level (Table 2). During incubation lipid levels declined about 3.43 g/day. Protein remained constant until the decline ($P<0.05$) between terminal laying and early incubation (Table 2). Atrophy of the oviduct and ovary probably accounted for most of this. Protein levels declined ($P<0.05$) from terminal laying to the end of incubation; the greatest decline occurred between early and mid-incubation when females were most attentive to their nest and had greatly reduced feeding time (Brown 1981). Weight loss of the liver, small intestine, and sternal muscles occurred rapidly during incubation (Table 1)

Ash content was significantly greater

Table 2. Carcass composition (g) of female White-winged Scoters collected during the breeding season. Weights shown are means ± standard error.

Stage	Water	Lipid	Protein	Ash	No. of birds
Prelaying	923±14	138±28	337±12	65±3	5
Rapid follicle growth	896±16	175±16	337±6	65±2	8
Laying	875±18	167±22	332±6	69±5	5
Terminal Laying	904±41	129±37	343±4	82±6	3
Early incubation	824±24	145±10	304±5	60±7	4
Middle incubation	780±18	92±23	285±7	64±5	4
Late incubation	732±17	49±19	274±6	68±8	5
Brood rearing	773	27	280	71	1

($P<0.05$) during the terminal laying period than in any other breeding category (Table 2). Levels in all other categories were similar. Water content of females declined ($P<0.05$) between prelaying and laying, terminal laying and early incubation, and early incubation to late incubation.

Discussion

The pattern of weight change in White-winged Scoter females is difficult to interpret because little information is available for the wintering period. The mean for 15 females (Bellrose 1980) was 1179 g, and Nelson and Martin (1953) reported a mean weight of 1125 g for 19 females. The ages and dates of collection for these birds were unknown, although they were probably killed during the fall and winter hunting seasons. The mean weight of 10 adult females collected during winter in Kachemak Bay, Alaska, was 1732 g (range 1566–1946 g) (Sanger and Jones 1981), and two adult females from Prince William Sound weighed 1577 and 1480 g on 18 February and 24 March, 1978 (D. V. Derksen, Pers. comm.). These weights are similar to those in our earliest collected females, suggesting that females are at or near their heaviest weight upon arrival at breeding areas.

The lack of change in body weights before and during egg laying suggests that females met most of their needs through their diet. Declines in body weight during incubation suggest that females then relied upon endogenous reserves in part to meet energy needs. During laying and incubation, females lost about 25% of their maximum body weight. Females near the end of incubation had the lowest weights recorded during the study. One brood rearing female collected about 4 days after hatch, also had an extremely low weight.

Female European Eiders *S. m. mollissima* at Forvie, Scotland (Milne 1963) declined as much as 30% in weight from egg laying to the end of incubation. Common Eiders *S. m. dresseri* in Quebec and Maine lost more than 30% of their body weight during laying and incubation (Cantin *et al.* 1974, Korschgen 1977).

Weight losses in various muscle tissues have been reported for several species of wildfowl, and may result from the use of tissue protein to support metabolic and egg laying needs, from a change in diet, or from both. Changes in the diet of White-winged Scoters from bivalves on wintering areas (e.g. Grosz and Yocom 1972; Sanger and Jones 1982; Vermeer and Bourne 1982) to soft-bodied invertebrates on breeding areas may be responsible for the decline in gizzard and other digestive organ weight, because gut morphology is known to vary with volume of food eaten and with fibre content (Miller 1975; Ankney 1977). After incubation began, the decline in digestive organ weight probably resulted from a combination of tissue protein use and lesser consumption of food. The total time spent feeding during incubation probably increased as incubation progressed, because females were less attentive in later stages of incubation (Brown 1981). Greater feeding time near the end of incubation may account for the observed increase in small intestine weight.

Where female White-winged Scoters obtained their lipid reserve is unknown, because no birds were known to be collected within two weeks of arrival. Females collected in April in Kachemak Bay, Alaska, had low fat reserves (Sanger and Jones 1982). After arrival, females spent 58–62% of their time feeding for about three weeks before initiating egg laying (Brown 1981). However, lipid levels did not change significantly until incubation began.

Scoters used little of their peak lipid reserve to lay their eggs. The long egg laying interval of 1.43–1.60 days per egg (Koskimies and Routamo 1953; Vermeer 1969; Brown and Brown 1981) probably allows females adequate feeding time to acquire nutrients for egg formation (Brown 1981). Also, the mean weight of the high quality invertebrate foods consumed increases about the time egg laying begins (Brown 1981). These factors may help females preserve their endogenous reserves for use during incubation.

Protein and lipid levels declined as incubation progressed, with much of the early decline in protein associated with resorption of the reproductive organs. Between early and late incubation, declines in sternal muscle weight and protein levels may have resulted from the use of tissue protein to produce energy. Lipid levels dropped markedly during incubation as they were used to meet energy needs. Endogenous lipid reserves seem most important for partially defraying the metabolic needs of incubating females. About 17% of the peak lipid weight was expended during egg laying, whereas 55% was spent during incubation. As endogenous reserves are expended during incubation, so recess time was increased (Brown 1981). Though most energy and nutrients needed for laying and incubation were obtained from the diet, endogenous reserves may have played an important role in meeting daily energy requirements during laying and may be necessary for successful incubation.

Summary

The weight and carcass composition of 35 breeding female White-winged Scoters *Melanitta fusca deglandii* from central Saskatchewan and east-central Alberta were determined. Body weights were statistically similar between prelaying and laying, but declined 22.5% ($P<0.01$) from the end of laying to the end of incubation. Weight loss resulted primarily from absorption of the ovary and oviduct at the end of laying, and the use of fat and protein reserves during incubation. Female White-winged Scoters relied upon their diet to meet most protein and energy requirements during egg laying, whereas stored reserves were needed most to defray energy needs during incubation.

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