Time budgets of breeding Mallard in northern Sweden

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Introduction

The amount of time and energy that a bird spends on different activities influences its reproductive ability. Even small differences in a time budget may influence reproductive success to the optimal advantage of the species. It follows that there exists for a species in a given environment an optimal time and energy budget. Reproduction, moulting, and migration require extra time and energy above the needs of self-maintenance. These phases are, in general, separated in the annual cycle. In northern latitudes, where summer is short, some of these phases, for instance moulting and reproduction, will intrude upon each other (Pitelka 1958).

By recording how much time is spent in different activities, it is possible to construct a time budget. No free-living avian species has yet been investigated with respect to its complete energy budget during the reproductive phase (King 1973). Many time budgets have been carried out on birds, including ducks, primarily because of ease of observation (Table 1).

Knowledge of the activity pattern of wild free-living ducks in the natural environment is, however, incomplete, particularly in northern latitudes with extreme light conditions during midsummer. The time spent by Mallard *Anas platyrhynchos* on various activities during different phases of the breeding season is quantified in this study, at latitudes of 63°–67° N in Sweden. The result of the field studies will be used as a base for an experimental study of the activity pattern of Mallard.

Study area

The study area lies at two breeding localities in northern Sweden: at Lake Hemsjön (63° 59′ N, 20° 33′ E) in the coastal area of the province of Västerbotten, and at Lake Veittijärvi (66° 3′ N, 23° 46′ E) in the coastal area of the province of Norrbotten. Both areas are restored lakes. Man has earlier regulated the water level by dam construction for haymaking. These agricultural methods were gradually abandoned and the dams fell into decay. The

Table 1. Time budget studies on ducks.

Species	Study area	Author
European Pochard *Aythya ferina*	Bohemia	Klima (1966)
Shoveler *Anas clypeata*	Minnesota Manitoba	McKinney (1967)
Tufted Duck *Aythya fuligula*	Bohemia Moravia	Folk (1971)
Teal *Anas crecca*	Camargue	Tamisier (1974)
Mallard *Anas platyrhynchos*	Manitoba	Titman (1973)
Lesser Scaup *Aythya affinis*	Manitoba	Siegfried (1974)
Gadwall *Anas strepera*	North Dakota	Dwyer (1975)
Maccoa Duck *Oxyura maccoa*	South Africa	Siegfried *et al* (1976)
Blue-winged Teal *Anas discors*	Iowa	Miller (1976)
Mandarin Duck *Aix galericulata*	Ohio	Bruggers & Jackson (1977)

lakes were reduced in area and the dried-up parts invaded by shrubs. To stimulate duck production these lakes were restored and islands built.

Lake Hemsjön is surrounded by a low belt of birch *Betula pubescens*, willow *Salix* spp, Scots pine *Pinus silvestris* and Norway spruce *Picea abies*. In places the forest reaches the shore. Along the water line there is a narrow belt dominated by sedge *Carex aquatilis* and marsh cinquefoil *Comarum palustre*. The emergent vegetation consists of water horsetail *Equisetum fluviatile*, bulrush *Scirpus lacustris*, marsh cinquefoil and cowbane *Cicuta virosa*. During spring the water level rises about 0·5–1·0 m because of the thaw, and part of the shrub area is submerged. The lake has an area of about 18 hectares and during early summer most parts have a water depth of about 0·9 m. Break-up of ice took place during the second and third week of May in 1977. A small stream crosses the lake. An observation tower is situated on a peninsula at the northeast shore. The breeding duck fauna consisted of: Mallard, Wigeon *Anas penelope*, Teal, *A. crecca*, Tufted Duck *Aythya fuligula* and Goldeneye *Bucephala clangula*.

Lake Veittijärvi has an area of about 35 hectares and lies in a flat region where large expanses of mire are interrupted by sparse coniferous forest. During late spring and early summer most parts of the lake have a water depth of 0·3–0·5 m. On the eastern shore of the lake there is an observation tower. In winter the lake freezes to the bottom. Drifting ice-floes, containing bottom material, were found as late as 21 May 1977. Shore vegetation was dominated by sedges, *Carex rostrata* and *C. aquatilis*. Submerged plants included pondweed *Potamogeton* spp. A detailed description of Lake Veittijärvi has been given by Danell & Sjöberg (1977) and Wiederholm *et al.* (1977).

Methods

Mallard were observed from May to August 1977. The observation times were picked at random in two-hour periods during four time periods of the day (0000–0600, 0600–1200, 1200–1800 and 1800–2400 hours). In the random procedure, one two-hour period was eligible only once. Two two-hour periods each day were picked at random until all daylight hours were occupied. At Lake Veittijärvi, I had to make some exceptions whereby 1–2 two-hour periods could be combined some days. Data were gathered in a one-week period in both areas during every breeding phase. During the second phase, observations were possible throughout all the twenty-four hours, while during the first and third phases only for 20 and 16 hours, respectively (Table 2).

Most observations were made from 5 m high towers, but during the first phase I made some observations from a car (Lake Hemsjön). All observations were made with a spotting scope (×25–50). The birds were normally within a radius of 250–300 m. During the first phase, while ice still covered the lakes, longer distances were accepted, although this involved some limitations in interpretation of activities. Every 30 seconds the activity of the bird or birds was recorded directly on printed cards. All calculations are based on the amount of time the birds were actually observed (not shielded by vegetation). For purposes of data analysis the breeding season was split into three phases: spring arrival and laying, incubation, and brood. The incubation phase of the Mallard has been determined to be 23–32 (27) days (Ogilvie 1975). The spring arrival and laying lasted until the third week of May, the incubation phase until the third week of June and the brood phase until the third week of August, at fledging. Activities of

Table 2. Observation hours (95) of breeding Mallard at L. Hemsjön (H) and L. Veittijärvi (V).

Phase	Periods of observation	Observation hours			
		male		female	
		H	V	H	V
Spring arrival and laying	0200–2200	11	3	10	1
Incubation	0000–2400	15	22	4	6
Brood	0600–2200	–	11	9	3

females during the laying and incubation phase does not include their time at the nest.

A bout of any particular behaviour was regarded as interrupted when the interruption lasted longer than one minute. Only bouts of behaviour longer than one and a half minutes are included in the mean bouts. Non-parametric methods (Mann-Whitney U-test) were used for statistical analysis (Elliott 1977). Statistical significance was inferred when $P < 0.05$.

Results

Seasonal changes in behaviour

The percent of time spent in different activities by male and female of Mallard, in two different breeding areas during the phases of laying (L), incubation (I) and brood (B) is presented in Figure 1. Both sexes show very similar behaviour in the two areas, for instance there is no significant difference in the feeding rate. Females spent most of their time feeding during the laying phase (37% and 75%) and incubation (62%), less during the brood phase (20% and 28%). At Lake Hemsjön the females almost doubled their feeding time from 37% during laying to 62% during incubation (Figure 1). Males also doubled their feeding time in every new phase, and this happened during the whole breeding period (16%, 30–36% and 58%).

The average length of feeding bouts, during the three phases are shown in Tables 3 and 4. Time spent in resting was inversely proportional to time spent in feeding acitivities (Figure 1). Sleeping ashore is more common than sleeping afloat. During laying the averaged length of sleeping bouts was higher for both sexes than during the two following phases. Alert posture is more frequent for males than for females during laying, 2–4% for males and 1% for females (though not

Table 3. Average length (and range) in minutes of different behaviours of male Mallard during three phases of the breeding season.

Behaviour	Spring arrival and laying	Incubation	Brood
Feeding	4·9 (2–18) n = 20	6·0 (2–33) n = 148	10·0 (2–58) n = 50
Resting	3·6 (2–30) n = 28	4·6 (2–21) n = 76	2·4 (2–4) n = 6
Sleeping	40·6 (12–72) n = 4	19·4 (3–75) n = 20	–
Comfort	3·7 (2–9) n = 12	3·3 (2–8) n = 47	6·0 (2–14) n = 5

Table 4. Average length (and range) in minutes of different behaviours of female Mallard during three phases of the breeding season.

Behaviour	Spring arrival and laying	Incubation	Brood
Feeding	8·6 (2–32) n = 22	7·6 (2–25) n = 69	5·5 (2–15) n = 32
Resting	5·3 (2–27) n = 12	2·4 (2–3) n = 8	4·4 (2–20) n = 41
Sleeping	49·8 (27–71) n = 3	12·3 (9–16) n = 2	12·6 (4–31) n = 9
Comfort	4·9 (3–12) n = 7	3·0 (2–6) n = 16	3·1 (2–10) n = 12

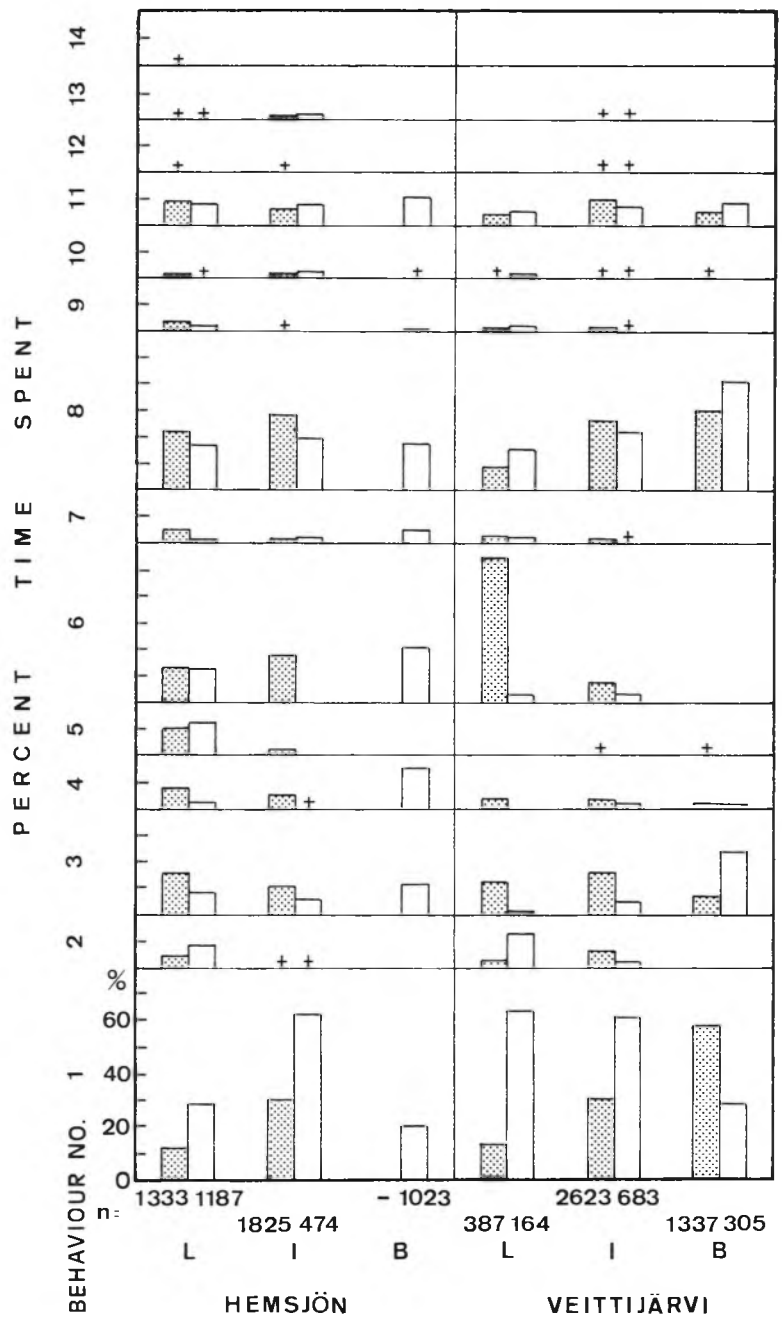

Figure 1. Percent of time spent in various behaviours by breeding Mallard at Lake Hemsjön and Lake Veittijärvi. Males crosshatched, females unshaded. Feeding on water (1) ashore (2); resting on water (3) ashore (4); sleeping on water (5) ashore (6); alert (7), swimming (8), walking (9), flying (10), comfort (11), aggression (12), three-bird chases (13), other behaviours (14). Percentages of less than 0·5 are indicated by +. n = total number of observations. L = spring arrival & laying. I = incubation. B = brood.

significantly, $P < 0.05$) (Figure 1). The percent of time spent in this activity decreases for males from 4% to 0% during the three phases; for females an increase takes place from 1% to 4%. Among locomotor activities, swimming is most recorded, for both sexes spent during the laying and incubation phases between 8% and 28% of the time. During the brood phase, females increased the time spent in swimming in Lake Veittijärvi to 41%, while in Lake Hemsjön it decreased to 17%. Time spent in comfort behaviour varies between 4–10% during all three phases (Figure 1). Aggression was observed for males only during laying and incubation phases (less than 0·5% during both phases). Three-bird chases were observed during these two phases and the number of males joining in the chase was constantly higher at Lake Veittijärvi.

Identified male and other males

During the later part of the incubating phase, a male identified by damaged plumage and belonging to the Lake Hemsjön population was observed for a total of 7 hours. It spent 35% of time feeding, which is a significant difference from other males, 26%, while for the other activities there was no significant difference (Figure 2).

Lone male and paired male

Lone males and paired males spent 36% and 28%, respectively, of time feeding during the incubation phase. Lone males spent 16% of time sleeping, paired males only 1% (Figure 3). Alert posture was more frequent for the paired males than for the lone males (1·8% and 0·9% respectively). Time spent in comfort activities was 6% for lone males and 14% for paired males (a significant difference) and for aggression 0·03% and 1·1% respectively.

Behaviour of female with her brood

Females spent most time feeding during the incubation phase (Figure 4), significantly less during the brood phase.

Daily activity pattern

During the laying phase feeding activity gradually increased through the day and reached a maximum during the periods 1200–2400 (for males 27%, for females 55%) (Figure 5), significantly more than in period 0600–1200. Both sexes mainly sleep during the periods 0000–0600 and 0600–1200 (male 67–70% and female 61–76%). Locomotor activity is low during period 000–0600 (male 5% and female 3%) and reaches a maximum during period 1200–1800 with 30% and 26% of time respectively.

During incubation the feeding activities are no longer concentrated towards the end of the day. Males feed during the first three periods (56%, 34%, 33%) but significantly less (12%) during period 1800–2400. Females feed during all periods.

Activity and resting

During laying the most active periods are 1200–1800 (maximum for males 71%, females 92%) and 1800–2400, and a minimum during the first period 0000–0600 (both sexes 13%). During the incubation phase males reach their maximum (87%) 0000–0600, but females are more than 90% active all the day. Males have their activity minima during period 0600–1200 (65%). During phase B males are active more than 90% of the time all the day, females 60–70% (Figure 6).

Discussion

Mallard are early breeders among ducks; laying starts shortly after spring arrival. At this time ice still mainly covers the lakes. They do not have much time for building up a metabolic reserve, such as is required to produce 8–10 eggs. In Anseriformes, egg production requires 50–70% above the daily energy requirement (King 1973). In other more southerly areas or for late breeding ducks there is, after migration, a period of varying length that can be split into spring arrival and prenesting phases (Bengtson 1972; Dwyer 1975) when females can feed intensively. These phases are, however, practically non-existent in

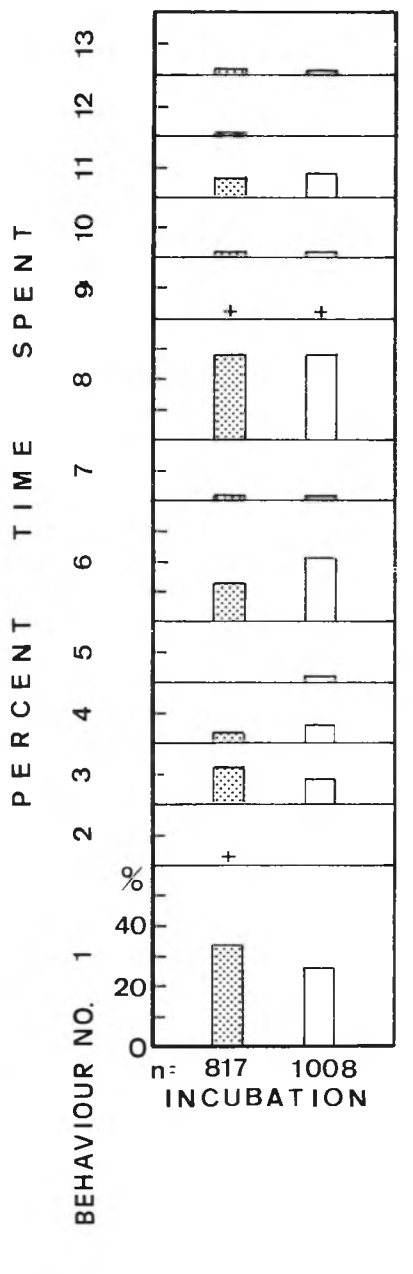

Figure 2. Percent of time spent in various activities during incubation phase as determined for an identified male (crosshatched) **and for all other males** (unshaded) **at Lake Hemsjön.**

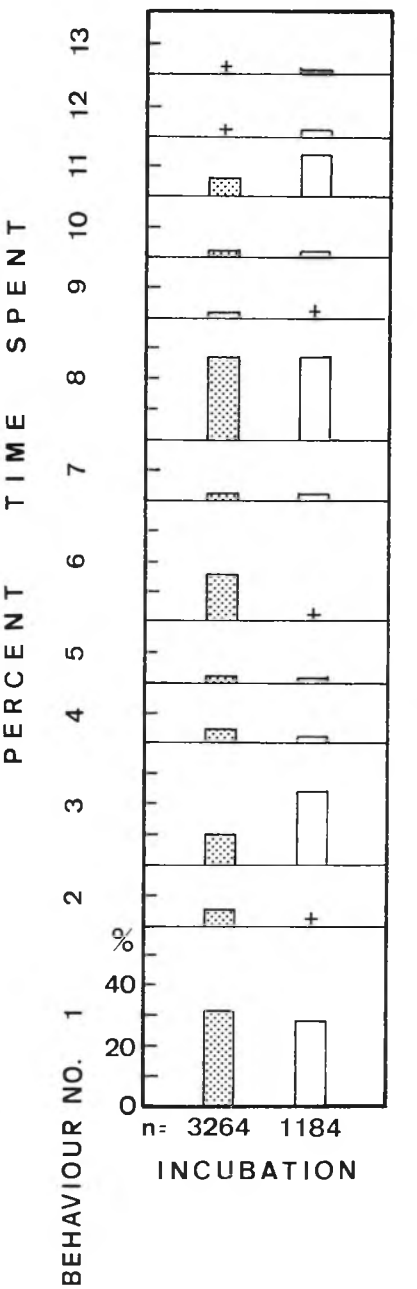

Figure 3. Percent of time spent in various activities by lone males (crosshatched) **and paired males** (unshaded) **at both lakes during incubation phase.**

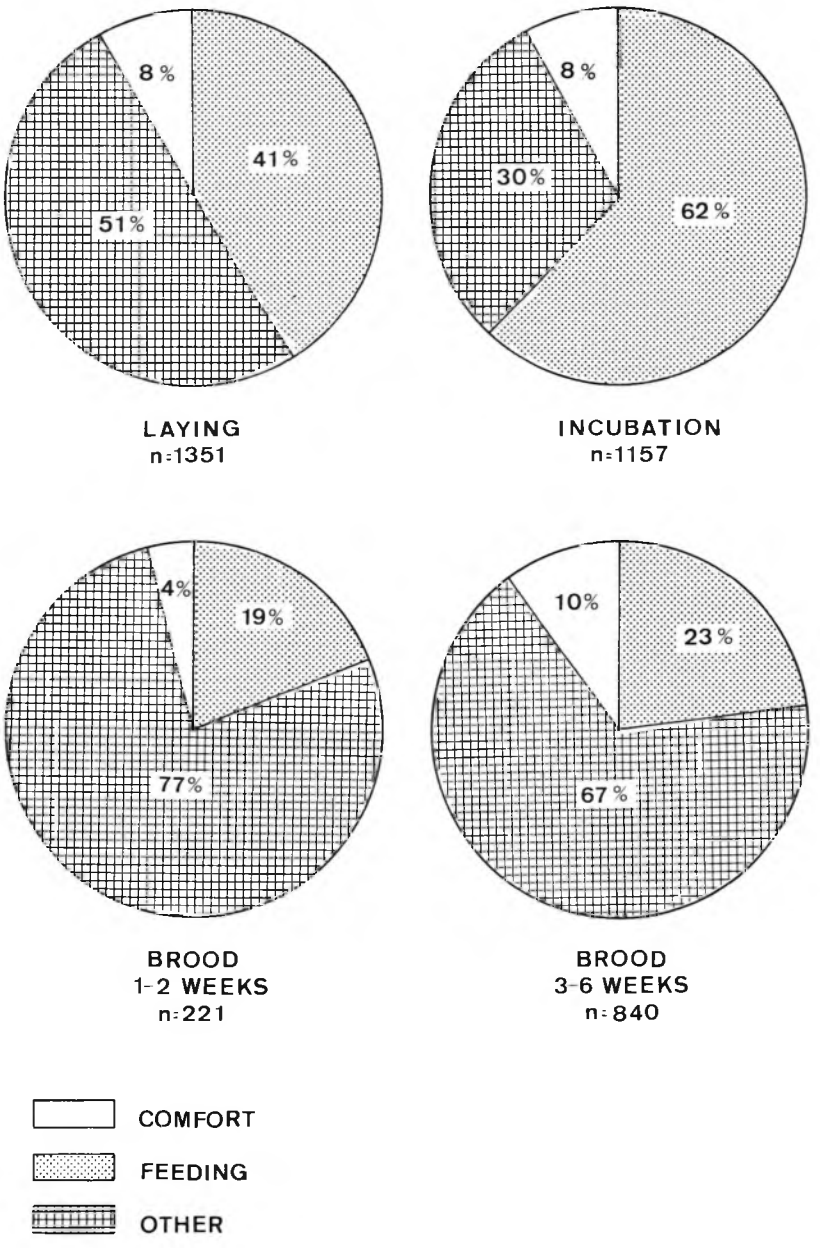

Figure 4. Percent of time spent in activities by females at both lakes during laying, incubation and escorting broods of different ages.

these northerly breeding localities. However, Mallard can be seen in the fields a short time prior to their appearance in the breeding localities and perhaps this indicates that their feeding rate is then high.

After their arrival the pairs develop territorial behaviour. This defended area is called an activity centre (Titman 1973). At Lake Hemsjön, a paired male, when the female was away, spent most of his time at the same place. From this place he attacked intruding pairs. The aggression was always directed towards the female of the intruding pair. When his female was

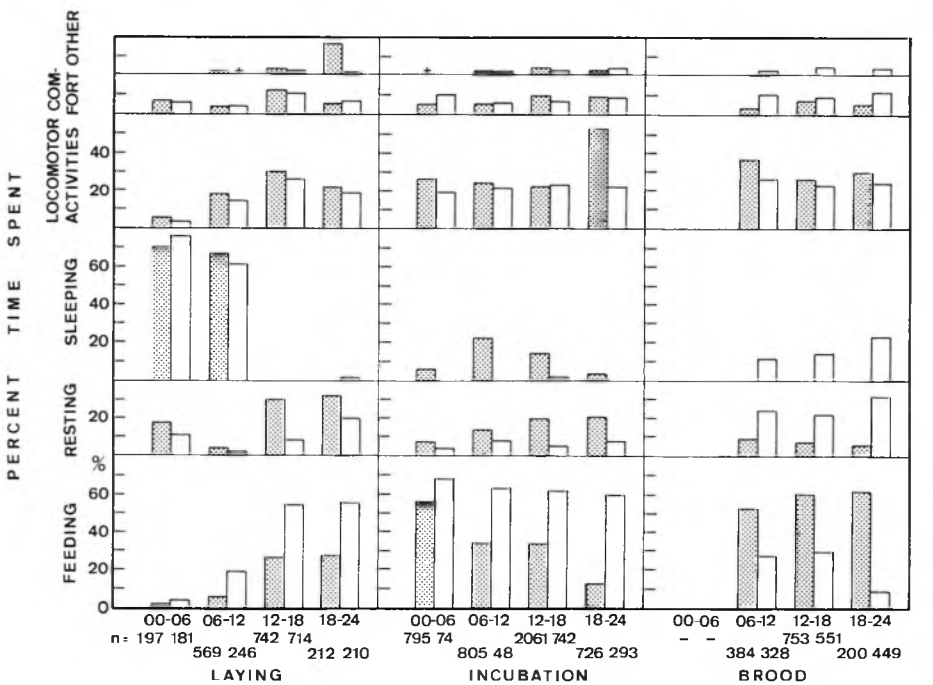

Figure 5. Percent of time Mallard spent in various activities at both lakes during laying, incubation and brood phases. Males crosshatched, females unshaded.

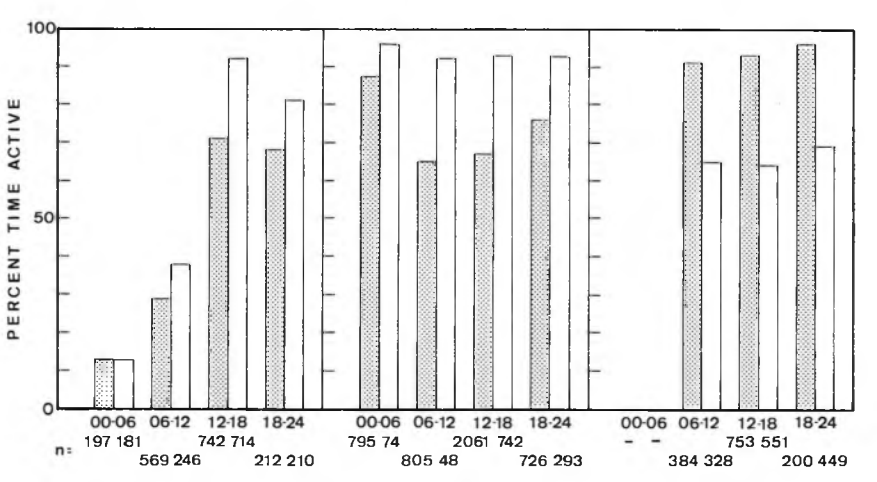

Figure 6. Percent of time Mallard are active at both lakes during laying, incubation and brood phases. Males cross-hatched, females unshaded.

present, aggression could be directed towards an intruding male that invited his female. The defensive actions can include 'threat' (Titman 1973) or 'Kinnheben' (Lorenz 1941). Sometimes three-bird chases arose and the defending male pursued an intruding female followed by her mate. In this study territorial behaviour represents in time a very small part of the budget (less than 0·5%). Much higher percentages have been reported for other ducks, where from a maximum during spring arrival, a decline takes place as the season progresses (Titman 1973; Dwyer 1975). These costs are small in the energy budget of early breeding Mallard at northern latitudes. Defence of the activity centre, however, was of great importance in allowing undisturbed feeding by females. During laying and incubation females spent 41% and 62% of their time feeding. For Blue-winged Teal *Anas discors*, Miller (1976) has recorded 35% and 60% during the same phases. Feeding activity of Mallard, in my study, shows especially great conformity with behaviour of dabbling ducks in those areas where spring arrival and prenesting activity is to be found. Apparently Mallard is one of the dabbling ducks that show little synchrony in changing phases. Dwyer (1975) has described quite different feeding activities (74%) of Gadwall *Anas strepera* during laying. But Gadwall is the only dabbling duck that frequently nests in dense colonies (Duebbert 1958). It also shows more synchrony in the start of nesting than most ducks (Duebbert 1958; Oring 1969). During the incubation phase Mallard males begin to gather in flocks; first of a few individuals and later of increasing size. At Lake Hemsjön males were seen together for the first time on 25 May; at Lake Veittijärvi on 3 June. Hilden (1964) has reported males in flocks as early as 2–12 May in Finland in the same latitudes. These differences could be due to the population density. Similar conclusions have been drawn by Bezzel (1959).

During the incubating phase no defending activities were shown. Another kind of three-bird chase or rather 'multiple-bird' chase appeared. These aerial pursuits arose very often at Lake Veittijärvi, and once no less than eight males were seen pursuing a female. Such chases disturbed the feeding females very much and mostly took place 1–2 minutes after their arrival.

Soon after flock formation, males start the wing-moult. During the laying period, males spend 16% of their time in feeding, rising to 34% and 58% as the season progresses. This indicates that males prior to moulting build up a metabolic reserve. A significant increase in wieght of Mallard has been reported by, for example, Folk *et al.* (1966). The first moulting male was observed on 6 June at Lake Veittijärvi. The start of early summer moult is badly synchronized. Differences in feeding activities between the last two phases indicate the percentage of the population that is prepared for moulting. In southern Finland moulting males appear at the end of May; about 50% of the population have moulted by the end of June (Raitasuo 1964).

Activity of Mallard shows differences in intensity during a twenty-four hour period. During laying activity is high in afternoon and evening. Also feeding is intense at these times. During incubation, when it is light all the time, Mallard show high activity all day. The activity possible depends upon the light conditions. Activity dependence of light-dark change for ducks has been suggested by, among others, Weidmann (1956) and Klima (1966). Szijj (1965) states that the distribution of activity is subjected to seasonal changes and sunrise and sunset have a synchronizing effect on feeding activity. Female Mallard in northern breeding localities do not have much time for building up metabolic reserves before laying. During incubating they exploit the whole day, for food supply drastically increases in consequence of the concentrated emergence of chironomids (Danell & Sjöberg 1977). This indicates that female Mallard probably take in more food.

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Summary

Time spent in different activities by breeding Mallard *Anas platyrhynchos* was studied in two restored lakes in northern Sweden. As soon as females arrived, egg-laying started. Aggression between pairs consumed less than 0·5% of time during the laying and ceased during incubation. Females spent more time in feeding than males during laying and incubation. Prior to moulting, males began to spend more time in feeding.

Flocks of males were first observed on 25 May. These flocks disturbed the feeding females. Female Mallard in northern breeding areas does not have much time for building up metabolic reserves before laying. During incubation phase they exploit the whole day and the drastically increased food supply.

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