Behaviour and Body Weight fluctuations of the Eurasian Red Squirrel (*Sciurus vulgaris*) in the Mating Season

TSUNG HUNG LEE

SHU-TE University, Department of Leisure, Recreation and Tourism Management, Number 59 Hun Shan Rd., Hun Shan Village, Yen Chau, Kaoshiung, County, Taiwan; E-mail: thlee@mail.stu.edu.tw

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One female squirrel was studied in Nopporo Forest Park (43°20′N, 141°30′E), in west Hokkaido, Japan. During the pregnancy, she moved from a main nest to the breeding nest and then built a few new nests (5 spherical dreys). In lactation stage, she departed from her den later in the morning than during the pregnancy period. When other male squirrels were in proximity, she attacked them. She carried her litters and moved to other dreys about 30-days after parturition. Her body weight was weighed ranged from 371 g to 397 g at the pregestation stage, increased steadily during the pregnancy period, and attained the maximum, 504 g, just before parturition. After parturition, her body weight decreased abruptly about 12% (from 504 g down to 443 g). Her daily change rate of body weight (DCBW) was 2.91 % in the pregestation period, 3.03 % in the pregnancy period, and 6.93 % in the lactation period.

Key Words: Eurasian Red Squirrel, *Sciurus vulgaris*, weight fluctuation, pregnancy, lactation, Japan.

Body weights of tree squirrels fluctuate seasonally according to the changes in food consumption and reproductive states (Short and Duke 1971; Knee 1983). Weights are also correlated with litter size and survival in some non-hibernating rodents (Myers and Master 1983; Sauer and Slade 1986). In the Eurasian Red Squirrel, *Sciurus vulgaris* L., the body weight can be positively related to dominance order and reproductive success (Wauters and Dhondt 1989). Thus, the larger (heavier) the female, the more safely she overwinters and the earlier she comes into estrus, enabling her to have two litters within a season. She can also nurse her litter(s) successfully depending on abundant high energy food that she hoarded in her home range (Wauters et al. 1995). Wauters and Dhondt (1989) suggested that females of the Red Squirrel weighing < 300 g do not come into estrus, and that body weight is the best predictor of fertility. The body weight, therefore, is a useful measurement and indicator for size, physical condition, and reproductive state of the Red Squirrel.

In this study, one female squirrel was auto-weighed in the breeding season to show the body weight changes in detail, and her breeding behaviour was described.

Materials and Methods

Research was conducted in Nopporo Forest Park (NFP), with an area of 2051 ha (43°20′N, 141°30′E), which is situated in west Hokkaido, 11-15 km east of Sapporo, Japan. This forest has become completely isolated from other areas of lowland forest as a result of the spread of both by agriculture and urbanization. It consists mainly of natural forests and partly of plantations of coniferous trees, and is designated as a natural monument and recreational forest, and a wildlife protection area (Tatewaki and Igarashi 1973). One female red squirrel, which was observed starting on 20 June 1996 and which became habituated to the author was selected as the target animal. She was trapped by the live-trap (60 × 15 × 15 cm) baited with a mixture of sunflower seeds, Walnuts (*Juglans ailanthifolia*) and seeds of Korean Nut Pine (*Pinus koraiensis*), and then was equipped with color-coded radio-telemetry collars (5.5 g in weight, Maeda Technical Laboratory, Japan).

From 10 February to 28 May, her behaviour (including nest use and building, interaction with other squirrels, and feeding) was traced by visual observation and/or radio telemetry through each day. To monitor her body weight changes in detail in different stages of the breeding season, pregestation, pregnancy, and lactation were divided by calculating back from the known parturition date, assuming a 39-day gestation period (Yamatani 1969; Takaragawa 1996). To measure her body weight easily and frequently, I placed the auto scale on the runways. When she got closer to the scale, about ten sunflower seeds were put on it to invite her, then if the squirrel climbed onto the scale I recorded its body weight directly (Figure 1). Her body weight was measured in field two to five times a day (each measurement separated by at least 2-hour intervals) from 27 February to 28 May 1997, for a total of 142 times for 42 days. I calculated the daily change rate of body weight (DCBW) by the following formula: DCBW (%) = 100 (maximum body weight-minimum body weight) / (average body weight).

Results

Behaviour was characterized as follows: In the early pregnancy, she moved from a main nest (spherical drey) to the breeding nest (den). In the mid-pregnancy, she built a few new nests (5 spheri-

FIGURE 1. Measurement of the body weight by an auto scale.

cal dreys). In the late pregnancy, she took longer rests in trees. I identified parturition by a sudden drop in her body mass, the presence of elongated nipples and matted fur, later departure from her den, faster movement and eating, and more food consumed than during the pregnancy period. Later morning departure from the den than during the pregnancy was characteristic of the lactation period. When other male squirrels were in proximity, she attacked them. She carried her litter and moved to other dreys about 30-days after parturition.

Her body weight ranged from 371 g to 397 g during the pregestation stage, increased steadily during the pregnancy period, and attained the maximum, 504 g, just before parturition (Figure 2). After parturition, her body weight decreased abruptly about 12% (from 504 g down to 443 g) and then linearly down to 392 g at the fifth day after parturition. Thereafter, her weight recovered slightly and fluctuated in the range of 415 g to 480 g. Moreover, her daily rate of change rate of DCBW was 2.91% in pregestation period, 3.03% in the pregnancy period, and 6.93% in the lactation period. Clearly, the daily body weight fluctuations were greater during lactation than pregnancy, and both were greater than the pregestation period.

Discussion

Although body weights of squirrels can be taken in the field when trapping by using a Pesola spring-balance (Wauters and Dhondt 1989, Wauters et al. 1993), squirrels may not be trapped and weighed frequently during pregnancy as this can produce undue stress and even lead to death of the squirrel. A scale placed on the runways could monitor the body weight of one red squirrel accurately and frequently in the field during pregnancy and lactation periods without the stress of handling.

The body weight of several tree squirrels varies both between individuals and seasonally (Short and Duke 1971; Wauters and Dhondt 1989). The means of the female, but not male, body weights are at the maximum value subsequent to the mating (Short and Duke 1971) due to the effects of pregnancy and lactation for one or two litters.

Body weights of respiratory disease-free cats (*Felis cattus*), change with an increase per week steadily in the gestation period, but decrease during lactation (Loveridge 1986). However, the Red Squirrel studied here showed the same phenomenon during gestation, but not during the lactation. The increase of the body weight was mainly due to the development of the embryos. However, after parturition, i.e., during lactation, the body weight was still at the higher level with fluctuations of up to 10% within one day. Red Squirrel juveniles are weaned when 10 weeks old (Gurnell 1987). Litter size, juvenile body weight and survival are positively affected by the mothers' body weight during lactation (Wauters and Dhondt 1989; Wauters et al. 1993). Juvenile diet depends nearly exclusively on the mother's milk before wearing. Thus, the mother must eat, digest, absorb, and use large amounts of nutrients to produce sufficient milk of adequate composition to support the growth and development of their pups. Therefore, energy requirements of lactating squirrels are much higher than in those not lactating (Havera 1979; Smith 1968). The energy requirement or energy level of the lactating period also is much higher than that during pregnancy in captive mammals such as Bank Vole (*Clethrionomys glareolus*), cat, and rat (*Rattus norvegicus*) (Kaczmarski 1966; Loveridge 1986; Prado et al. 1997). Finally, that owing to nursing her litters successfully, the mother squirrel has a higher food intake which results in an increase of her body weight; while subsequent feeding of her litters results in a decrease. In lactation period, a rich-energy food intake is particularly important to maintain a female's weight.

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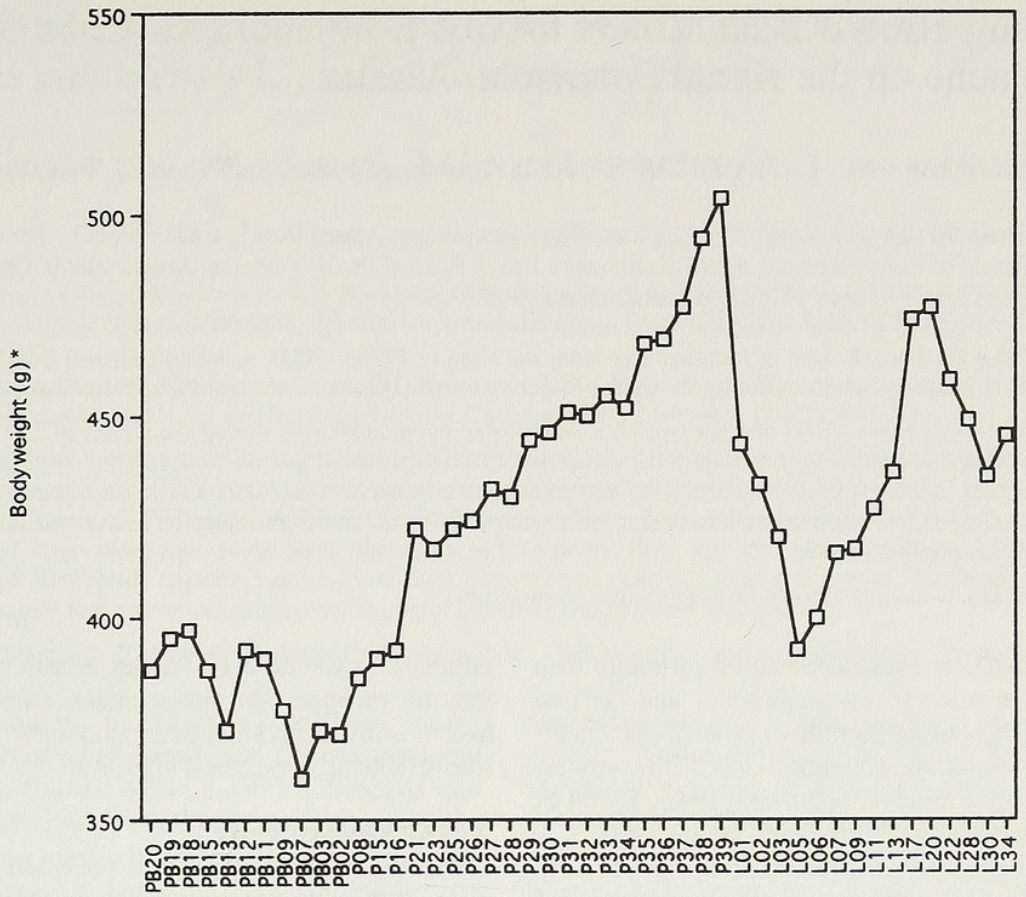

FIGURE 2. Body weight changes in one squirrel in pregnancy and lactation: PB *n*: the n days before pregnancy; P *n*: the n days of pregnancy; L *n*: the n days of lactation; *: female mean body weight on that day.

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