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Commentary

Reproductive parameters of wolverines (*Gulo g. gulo*) in captivity

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Although wolverines have been bred in captivity for the first time as early as in 1915 in Copenhagen Zoo, it is still considered a difficult species to breed and only 42 birth events have occurred worldwide 1915–1994. The species is endangered throughout its European range where it exists in Norway, Sweden, Finland and Russia (Schreiber et al. 1989). The Swedish free-ranging population showed a slow increase after its total protection in 1968 and was reported stable around 150 wolverines (Bjärvall 1989; Franzen 1992). Recent surveys, however, indicate that despite the protection, the decline in numbers has been continous and the present population of wolverines in Sweden does not exceed 100 animals (Andersson 1995). In Norway the wolverine estimates are 150 ± 30 (Kvam et al. 1988) while in Finland they are estimated as only about 90 (Nyholm 1993). Less information is available from the European parts of Russia, although Novikov (1994) reports figures of 400 for the Arkhangel region, 160 for the Murmansk area, almost 900 from the Komi area and 80 for the Russian parts of Karelia.

Because of its decreasing number, mainly due to human activities, the interests in preserving the wolverine and possibly restoring free-ranging populations have rosen. These efforts are hampered by the scant information available about the basic biology of this species. Due to the elusive nature of the wolverine, studies of its reproduction in the wild are both difficult and expensive. Captive breeding can, however, provide useful information. To improve successful ex situ breeding, it is essential to gain a better understanding of the reproductive behaviour and physiology of the wolverine. Some reproductive parameters such as age the at first oestrus, length of oestrus and gestation as well as age of maximum fecundity in captive wolverines assist demographic predictions also in free-living populations.

Results

The information presented here is mainly based on the first volume of the Regional Studbook for Wolverines kept in captivity (Blomqvist 1994). The data concern individuals of known age, kept in captivity between 1963–1994. The length of oestrus has been calculated from the first to the last day when copulations have been observed. Length of gestation has been determined as the period from the first day of observed matings until parturition. Due to the scanty data additional information has been collected from reports on captive breeding individuals published elsewhere, which, to a large extent, include wolverines of unknown origin (Blomqvist & Larsson 1990).

Like several other mustelids, the wolverine has a delayed implantation with heat occurring

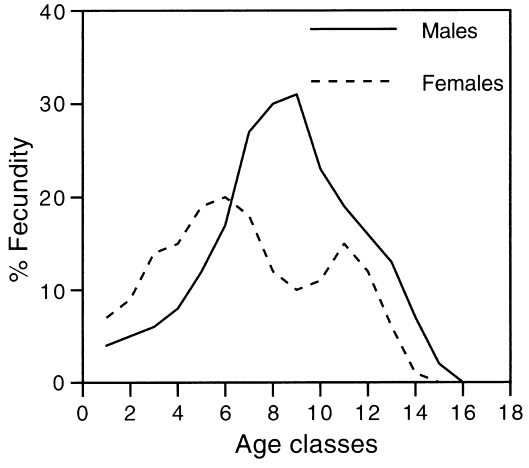

Fig.1. Percent of fecundity in captive wolverines. Period analyzed: 1 Jan. 1970–1 Jan. 1995 (51 birth events of known age tabulated.)

in summer and the fertilized eggs remaining in the female until the following winter. Once implantation takes place, the foetuses develop quickly and the cubs are born in mid-winter (Rausch & Pearson 1972; Pulliainen 1983).

My data contains mating observations of altogether 14 different pairs. However, several pairs have been observed mating on several subsequent years. This makes a total of 25 heats recorded. Matings have been observed on a total of 84 days. Literature data increases the oestrus data to 132 days in 34 different heats of 20 wolverine pairs (Mehrer 1976; Blomqvist & Larsson 1990).

Table 1. Reproductive cycle in captive wolverines.

Time Period	Oestrus*	Parturition**
1–18 Feb.	–	17
19 Feb.–5 Mar.	–	18
6–20 Mar.	–	4
21 Mar.–3 Apr.	2	1
4–17 Apr.	–	–
18 Apr.–1 May	1	–
2–15 May	1	–
16–29 May	5	–
30 May–12 Jun.	10	–
13–26 Jun.	7	–
27 Jun.–10 Jul.	4	–
11–22 Jul.	4	–
Total	34	40

* Oestrus informed as number of heats when matings have been observed
** Parturtion informed as number of litters bred

All matings were observed from 23. March to 22. July, 44% occurring from mid-May until mid-June peaking in the two first weeks of June when 29% of all observed matings have taken place (Table 1). The duration of oestrus varies from 1 to 11 days with an average duration of 4 days.

A total of 42 litters have been bred in captivity since 1915. Of these, the exact date of birth is lacking from three litters whereas 30 births are registered to have taken place in Europe in 1970–1994. All parturitions occurred between February 1 and March 22, most of which (60%) have been recorded in the last two weeks of February (Table 1). The length of gestation in captivity is defined as the period from the first day of observed copulations until parturition or to the day when the dam enters her den. The mean gestation period for 13 successful copulations in which both matings and parturitions are observed, is 255 days (range 183–330).

Altogether 51 birth from parents of know age were used to estimate fecundity of the wolverines (Fig. 1). Only one pedigree-female bred when two years old, while most of the females do not reach sexual maturity until at 3.5 years age. Males reach sexual maturity one year later than females. The youngest male to breed aged 2 yr 11 mo. Males tend to breed less successfully than females in all age classes younger than six years. Some 45% of all litters reported were born to females between 4 and 7 years of age, with a peak at six years when females have a 20% probability of conceiving (Fig. 1). Fecundity was highest in males when they were 7–9 years old and started to decrease after the age of 10 years.

A total of 84 cubs (26 males/41 females/17 unknown have been bred in 42 litters in captivity. One additional litter was bred in Stockholm in 1917, but the number of cubs is unknown (Blomqvist & Larsson 1990). In these litters 32.5% consisted of one cub, 30% were twins, 32.5% were triplets and in only two litters (5%) with four cubs were born. The mean litter size in captive-bred wolverines is 2.1 cubs. The weight of the cubs is appr. 90 g at birth ($N = 6$), but the weight increases rapidly. At the age of six weeks

the average male weight was 23 times heavier and the average weight of females was 15 times heavier than at birth (Blomqvist 1994). In April–May when captive-bred cubs start to play outside the den, their average weight is 4–5 kg. In August-September, at the age of 6–7 months, captive-bred cubs are almost independent of the dam.

Discussion

Wolverine parturition has long been known from the wild, but because matings rarely have been observed, several different assumptions have been made on the timing of the mating season. Pulliainen (1968) referred to studies by Ognev from the Soviet Union where heats are reported from January to February. Ognev's report was later supported by Makridin (1964) mentioning that it might be possible that matings take place immediately after parturition in winter. Data in North America also suggest copulations in March with cubs delivered in June after a gestation period of three months (Seton 1927). However, Wright and Rausch (1955) studied the reproductive tracts in both sexes, concluding that the species has a long gestation period with matings "probably occurring in mid-summer". A more recent report from Alaska also observed matings in June and August in free-ranging wolverines (Magoun and Valkenburg 1983). Earlier published data on captive wolverines (Blomqvist and Larsson 1990), showed that all observed heaths occurred between March and July. These results have later been verified from wild-caught animals in North America (Mead et al. 1991) where testicular size peaked in June, thereafter the levels of plasma testosterone declined rapidly with regression in August. Also in females the levels of oestradiol started to increase in May with maximal vulval enlargement occurring in June–July. In the current data, all 34 heats took place beetween 23. March–22. July with 29% of all matings occurring during the two first weeks of June.

Captive wolverines reach sexual maturity at age 3–4 years for females, while males reach maturity one year later. The fecundity in captivity is, however, reached at an earlier age than in the wild. It is well established that maturity in mustelids varies with food ability (Mead & Wright 1983) and captive animals have a rich abudance of food. In free-ranging populations competition with older animals might also delay reproduction in younger animals and it is most unlikely that males in the wild reproduce at the age of three. Males have a longer potential reproductive life than females as some individuals have bred at the age of +14 years, while females usually stopped breeding 1–2 years earlier. The mean litter size in the captive-bred litters was 2.1 cubs. Corresponding data from 248 dens in the wild show a mean litter size of 2.4 cubs (Blomqvist & Larsson 1990). Most (60%) of the captive-bred cubs have been delivered during the last two weeks of February after a mean gestation period of 255 days. This prolonged gestation, known as delayed seasonal implantation (Sandell 1985), is known to occur in seven of the 12 families of living carnivores (Mead 1989), being most common in *Mustelidae*. The seasonal delay in wolverines can be an adaptation which allows mating in May–June, when wolverines are in prime condition. In the current data more than 70% of the copulations were observed during these two months.

The energetic costs are high for females during late pregnancy and lactation. In the stoat, *Mustela erminea,* food consumption was 2–3 times higher in lactating than in non-lactating females (Muller 1970). February, when the majority of parturitions occur, might be an inhospitable time of delivery for many of the northern mammals but not so for wolverines (Banci & Harestad 1988). As wolverines are mostly scavengers depending on reindeer carcasses in winter-time (Myhre & Myrberget 1975), mid-winter is the time of the year with the greatest resource availability. Parturition in winter also permits the young to develop longer before facing the hazards of the forthcoming winter in the taiga and the tundra. An early independence of the young also gives the female more time to gain the energy reserves necessary for her winter survival.

The wolverine is the most endangered land-living big carnivore in Europe and population densities in all European countries are either on a very low lewel or dangerously decreasing. Despite its legal protection in all the countries on the Fennoscandian peninsula, it is well known that illegal hunting still exists in Norway, Sweden and Finland (Bevanger 1992; Franzen 1992; Hario 1994; Karttimo 1992; Suominen 1992)

within the main distribution area which coincides with the reindeer husbandry area. A long-term captive breeding programme is therfore important for the wolverine until protection becomes efficient. This has also been affirmed in the World Conservation Strategy of the IUCN (1980), where captive propagation is an integal part of the global strategies to preserve the biodiversity of the planet.

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