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Duration and reliability of placental scars in the Norwegian lemming *Lemmus lemmus* (L.).

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The development of placental scars and the correlation between the number of scars and the number of young born, was studied in Norwegian lemmings *Lemmus lemmus* (L.) from a laboratory colony. The 55 females used were separated into series where the number of young, the number of litters and the length of the post-natal period varied. Placental scars were visible for at least 190 days after the birth of a litter. There was considerable variation in the appearance of the most recent scars, and they could not be used for age determination or to separate different litters. In females with one, two or three litters, each scar showed 0.14, 0.25, and 0.06 too many young ones. A significant correlation between the number of scars and the number of young could only be shown in females with one litter. When the number of scars was below 15, the correlation was significant, irrespective of the number of litters. The correlation decreased with increasing number of scars. Possible explanations could be total or partial abortions, common placentas or fusion of scars.

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INTRODUCTION

A placental scar is a pigmented uterine area which occurs at the site of a previous placental attachment (Corthum 1967). In a variety of species placental scars have been used for information about reproductive status of the individuals, e.g. to identity parous from nonparous animals, or to separate the last litter from the earlier ones. The scars have also been used as a measure for the number of young or the number of litters. This necessitates, among others, information about the persistence of scars, and the correlation between number of scars and number of young. Such information is available for several mammal species including small rodents, such as the laboratory mouse (Adamczewska-Andrzejewska 1969) and the laboratory rat (Davis & Emlen 1948), *Microtus* spp. (Corthum 1967, Rolan & Gier 1967), and *Lagurus lagurus* (Tupikova 1958).

Placental scars have been used to assess the number of parturitions in the Norwegian lemming (Koponen 1970). Our knowledge about the conditions in *Lemmus* spp. is however negligible. The durability of scars in the brown lemming, *L. sibiricus (trimucronatus),* is said to be at least 201 days (Mullen 1968), while in the Norwegian lemming scars are presumed to last for about three to four months (Koshkina & Khalansky 1962). The present paper presents some data about the reliability of placental scars as a source of information about the reproductive performance in the Norwegian lemming.

MATERIAL AND METHODS

All lemmings used for this study were from a laboratory colony housed at the Biological institute, University of Oslo.

They were kept under controlled conditions. The experimental animals were provided with a varied diet, ample nesting materials, controlled illumination and constant temperature about 15°C. The entire material consisted of 55 animals. This included animals born in 1969—1970 and used for the two experimental series, here referred to as the time series and the litter series respectively.

The purpose of the time series was to study the persistence of placental scars and how they changed with time. Each of the 13 animals in the time series gave birth to one litter only. The animals were sacrificed 15 to 190 days after delivery of their single litter.

The litter series consisted of animals with one, two, or three litters. The inter-litter period varied, as did the time interval between the latest delivery and the time of death. The purpose of the litter series was to determine the correlation between the number of young and the number of scars when these two parameters varied, and also to discover to what extent the different litters could be separated by placental scars. Included in the material were also two animals which died nulliparous. A more or less random cross-section consisting of 13 parous females from the stock covering the period 1964—1969 was also used. The 13 animals from the time series were also included in the litter series.

After being killed the animals were immediately frozen, and all further treatment was carried out later at one and the same time. After the uterus was dissected out, fat as well as parts of the mesentery were removed, and the uterus was cleaned, laid out on a light wax surface and examined in reflected illumination under a dissecting microsope. It was then placed on a slide and examined in reflected and transmitted illumination under a dissecting microscope, and also photographed. After being fixed in 4% formaldehyde, the uterus was placed in clove oil and examined as before. It was later preserved in clove oil. Five animals which died pregnant, and the two which died nulliparous, were handled in the same way.

The scars were classified according to distinctness and intensity of colour. The contrast was usually greater before fixation. The observed number of scars before and after fixation corresponded well. After fixation one new scar was detected, whereas the number of scars observed was reduced in six cases (one scar in five females, two scars in one female). In cases of uncertainty the scars were classified several times.

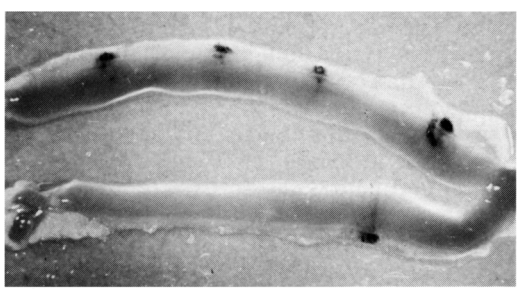

Fig. 1. Fresh uteri from a female with 1 litter of 5 young, 15 days post partum. 5 scars were identified: 2 distinct and dark, 3 small, but distinct, of medium lightness.

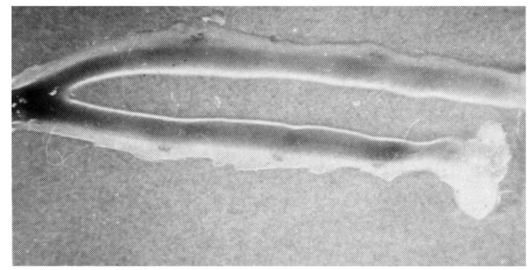

Fig. 2. Fresh uteri from a female with 1 litter of 5 young, 190 days post partum. 5 scars were identified: all indistinct, light or extremely light.

RESULTS

Persistence and change with time

The time series showed that scars from females 15—70 days post partum had wide variation in colour and distinctness, both within one single litter and between different females (Fig. 1). Old scars, i.e. older than about three months, were small and light in colour. Scars persisted for 190 days post partum. They were by that time small and faint (Fig. 2), and some would probably soon have disappeared. These observations all refer to non-pregnant females. Scars were not more difficult to identify in pregnant, multiparous females. In pregnant uteri scars were often very dark and large. We found no indication that the scars disappeared during the first 150 days, even it the female had another pregnancy.

Placental scars are gradually broken down by macrophages which wander towards the mesentery from the original endomethrial site (Deno 1937). The site of pigmentation in the uterine wall did however not prove to be a reliable criterion for the age or scars in the present study.

The results indicate that very distinct or dark scars are younger than about 100 days, while a small or light-coloured scar may be old or recent, and may even represent an abortion. The scars become more similar with age. The conclusion therefore is that, by observing scars, it is impossible to tell whether a scar is recent or old, or to separate different litters.

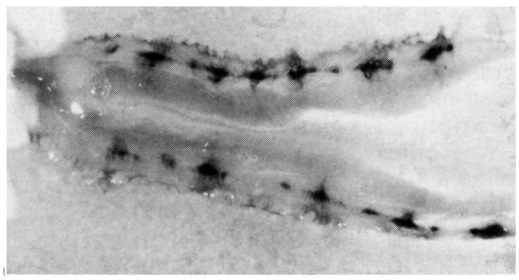

Fig. 3. Fresh uteri from a female with 3 litters, totalling 20 young. 18 scars were identified.

Correlation between number of scars and litters, and between number of scars and young ones.

Because of the great variation in size and colour of the scars referred to in the previous chapter, it proved impossible to separate the different litters (Fig. 3).

The correlation between number of scars and number of young is shown in Fig. 4. Of the females with one litter only, 14 out of 19 corresponded exactly. For the others the number of scars was higher, average number of scars: 4.53, average number of young: 3.89. In other words, each scar gave 0.14 young too many. The correlation is, however, quite good (r = 0.707) and significant (0.05% level).

In the two litter series half of the 16 females had a scar number corresponding to the number of young. The other half showed more scars than young. Each scar gave 0.26 young too many. The range of variation was considerable, and correlation not significant. In females with three litters, only two had a corresponding number of scars and young, eight had an excess of scars, and eight an excess of young. Therefore the average number of scars was quite close to the average number of young, each scar giving only 0.06 young too many. The correlation was, however, not significant.

Two females where copulation probably had failed, or where abortion had taken place early, were nulliparous when autopsied. No scars were found.

Fig. 4 shows that the correlation decreased as the number of scars increased. When the number of scars was lower than 15, the correlation was significant (r = 0.899; 0.5%), irrespective of the number of litters. With higher number of scars, the method gave unreliable results with regard to young born.

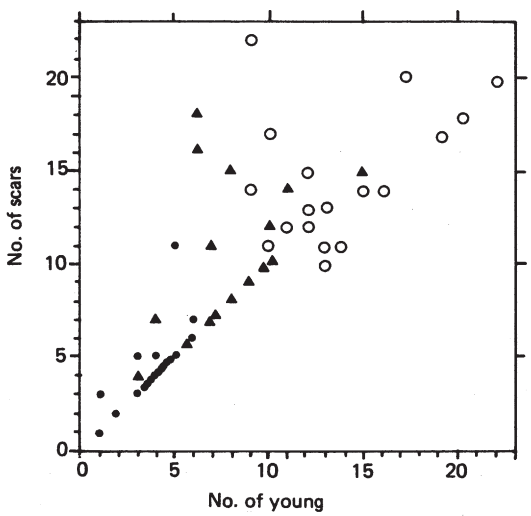

Fig. 4. Correlation between number of placental scars and number of young born by females with 1 (●), 2(▲) or 3 (○) litters. For females with less than 15 scars correlation was significant (r = 0.707).

DISCUSSION

One main result from our study is the great variation in size and colour of scars of the same age. This is in agreement with findings from other rodents, e.g. in *Microtus* where there is much colour variation in adjacent scars even in the same uterine horn (Corthum 1967). That the scars grow lighter with age is also observed in the Norwegian lemming (Koshkina & Khalansky 1962) and in other rodents such as *Microtus* (Corthum 1967) and *Lagurus* (Tupikova 1958). There is more uncertainty about the duration of the scars. In the brown lemming placental scars are said to persist for at least 201 days, that is through most of the life of the lemming (Mullen 1968). They are reported to be visible for a year in *Mus musculus* (Deno 1941) and in *Rattus norvegicus* (Davis & Emlen 1948). In the water rat, *Hydromys chrysogaster,* they disappear 4—6 months after birth (Olsen 1982), in *Peromyscus maniculatus* and *Microtus ochrogaster* the scars are probably not grossly visible over three months (Rolan & Gier 1967). Our data suggest that in the

Norwegian lemming the placental scars fade away after 190 days.

Our results are very similar to those from the laboratory mouse described by Adamczewska-Andrzejewska (1969): in females with one or two litters, the number of scars exceeds the number of young born, whereas in females breeding three times the cumulative number of young exceeds scar counts.

Scar counts outnumbering number of young born is also reported from other mammals, e.g. the red fox (Lindström 1981). The common explanation is partial or total abortions. It is proved that scars are formed from late abortions in laboratory rats and mice, and also in *Microtus pennsylvanicus, Clethrionomys gapperi* and *Peromyscus maniculatus* (Beer, Macleod & Frenzel 1957). Furthermore, it has been shown in the laboratory rat that size and appearance of scars of resorption are similar to term scars (Conaway 1955).

The difference in numbers between scars and neonates should therefore give a minimum figure for intra-uterine mortality. In our study the total post-implantation loss for the period after the formation of the scars is about 17 per cent. The figure includes seven cases with presumed total abortions (about 12 per cent). This figure is higher than what is reported as probable post-implantation loss in most other species: from 1.3 to 2.9% in the brown lemming (Mullen 1968), up to 8.9% in *Myopus schisticolor* (Skaren 1963) and 11.3% in *Microtus californicus* (Hoffman 1958). In a study of different strains of the laboratory mouse intra-uterine mortality was in general below 20 per cent (Hollander & Strong 1950). Post-implantation loss is probably strongly influenced by breeding conditions. The intra-uterine mortality rate found in the Norwegian lemming in the present paper can therefore not be applied to field animals.

In the three-litter series there were eight cases where the number of scars was lower than the number of young. There is nothing to indicate that this was due to the length of the postnatal period. Similar situations have also been reported from other small rodents, and the explanation given is usually common placentas (e.g. Carr 1945, Hollander & Strong 1950), or the fusion of scars (e.g. Adamczewska-Andrzejewska 1969).

The present study emphasises the importance of caution when using placental scars for evaluating the reproductive performance of the Norwegian lemming. Scars may be used as a method of separating parous and non-parous females, but even here embryo resorption may interfere with the results. The same holds for the correlation which was shown for females with less than 15 scars. The fading of the scars and probable disappearance of the scars after a 190 days period, indicate that distinct scars in spring animals are signs of winter reproduction.

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