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Moult and colour change in English weasels (*Mustela nivalis*)

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(With 1 plate and 3 figures in the text)

The moult pattern of the weasel is similar to that of the stoat (*M. erminea*). English weasels rarely turn white in winter but the winter fur is a paler shade of brown than the summer fur.

Contents

Introduction

In the colder parts of their range, small mustelids regularly turn white in winter. The moulting patterns of winter-whitening species are easy to observe externally on preserved skins or on living animals, and have been described in *M. erminea* and *M. frenata* by Hamilton (1933), Hall (1951), van Soest & van Bree (1969), and Müller (1970), among others, and in a small collection of *M. nivalis* from central USA by Easterla (1970). In Britain, weasels (*M. nivalis*) very rarely turn white, and their moult patterns have not been described.

Van Soest & van Bree (1969) collected 300 dead *M. erminea* from Holland and arranged the cased skins in sequence showing, from the pattern of colour change, the progression of the two annual moults. The spring moult begins on the back and sweeps down to the ventral side, and the autumn moult follows the same route in reverse. The head is usually the first area to show moult in spring and the last to complete new hair growth in autumn.

The present study was designed to compare the patterns of moult in *nivalis* and *erminea*. During the process of examining the material, an unexpected difference in shade between the summer and the winter fur was observed, which is also described here.

Material

Altogether, 122 skins of weasels were examined. They were collected from three estates in England (53 from Sussex, 18 from Berkshire, and 51 from Northumberland). Possible differences between the subsamples, due to latitude and climate, could not be investigated as the total was too small to subdivide. However, there were no significant differences between the sample areas in mean monthly temperatures or number of frost-days per year (King, 1977, Table V(b)).

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Methods

None of the skins showed any winter whitening. The stages of moult were classified from the inside of the skin, by plotting the distribution of the dark pre-moult patches indicating the anagen phase of the moult cycle, when the follicles become active, enlarge and extend deep into the dermis (Ebling & Hale, 1970). Schwalbe (1893) showed that these patches result from the deposition of pigment in the hair follicles preparatory to the growth of new brown hairs, and Santisteban (1949) stated that in *M. frenata* the patches appear in the skin about 18 days before any change can be detected in the fur. Dating the time and duration of moult by this method is more accurate than by external observation, since the old coat is not necessarily shed at the same time as the new one is grown (Ling, 1970).

The line formed by the junction of dorsal brown and ventral white fur in *M. nivalis* is irregular, and forms a pattern which is individually distinct (Linn & Day, 1966). In order to avoid spoiling this pattern the main incision in the skin was made along the dorsal surface, and then the dorsal sides of the fore- and hind-legs were cut and the skin pinned out flat. When it was dry, the superficial fat was scraped off with a blunt scalpel and the skin stored, without preservative or further treatment, in a cellophane sleeve. The distribution of the specimens by month can be seen from Table I.

TABLE I

Percentage distribution of moult classes by month in English weasels

Month	*n*	Winter coat	Spring moult Early	Spring moult Mid	Spring moult Late	Inhibited	Summer coat	First coat still growing	Autumn moult Early	Autumn moult Mid	Autumn moult Late
January	20	95·0									5·0
February	4	100·0									
March	20	50·0	50·0								
April	16		37·5	31·2	12·5	18·8					
May	21		14·3	42·8	4·8		38·1				
June	5			20·0	40·0		40·0				
July	4						100·0				
August	2						50·0	50·0			
September	3						66·7		33·3		
October	3								66·7	33·3	
November	16	25·0							6·3	43·7	25·0
December	8	75·0								12·5	12·5
Total	122										

The patterns formed by the migrating pre-moult patches have been recorded as follows. A set of record sheets each showed three outline sketches of a weasel, two (A and C) from the dorsal aspect and one (B) from the ventral aspect (see Fig. 3). On the first two outlines, A and B, the pre-moult patches were drawn in as if the epidermis were transparent and the observer were able to look through the skin to see the position of pre-moult activity from outside. This was done from the flat skin with the aid of a mirror. The third outline, C, was used to show external pelage changes.

This procedure resulted in drawings of the moult patterns of *M. nivalis* which could be compared with those of van Soest & van Bree (1969) for *M. erminea*.

The pelage of each animal was recorded first as being in one of four classes: winter or summer coat, spring or autumn moult. Since the moult followed a definable pattern, the two moult classes could then be further broken down into early, middle or late phases. The number of animals in each of the eight classes was then expressed as a percentage of the number caught each month (Table I).

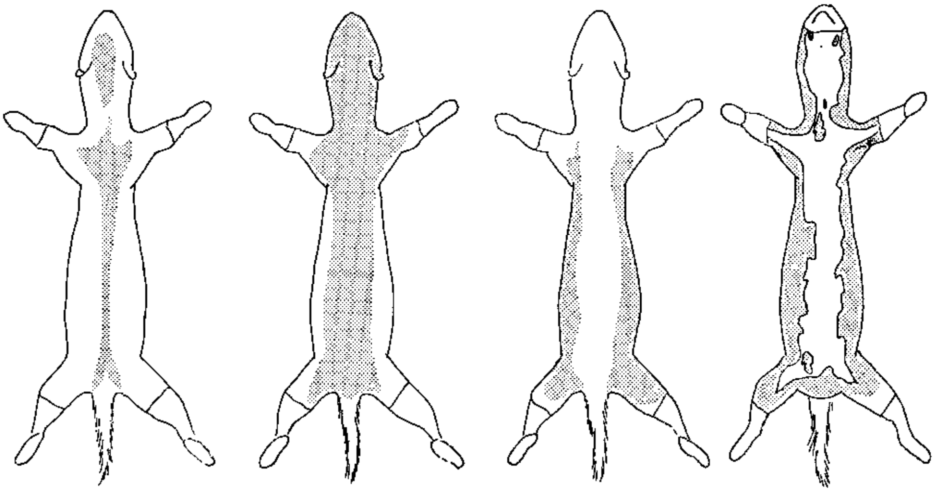

FIG. 1. Progress of the spring moult in *M. nivalis*, as shown by the distribution of pre-moult patches on the inside of the skin. From left to right, 1: early phase, 2: middle phase, 3 and 4: late phase.

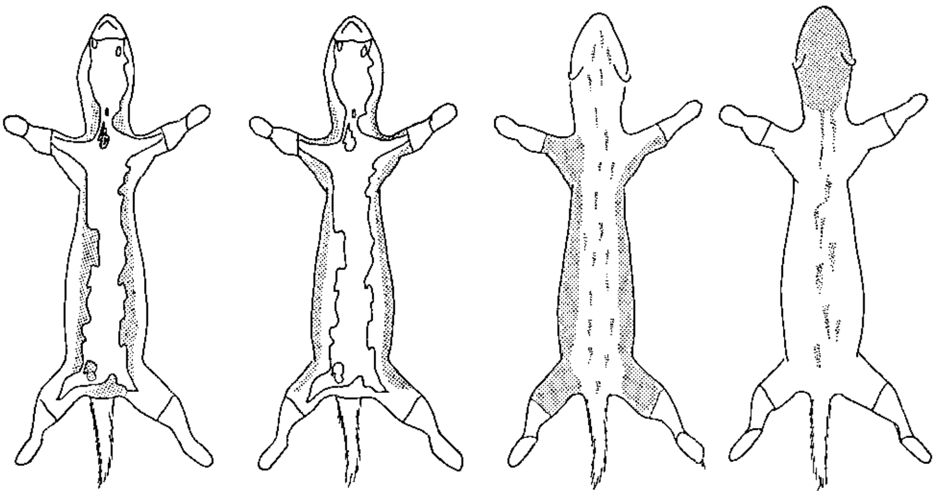

FIG. 2. Progress of the autumn moult in *M. nivalis*. From left to right, 1: early phase, 2 and 3: middle phase, 4: late phase.

Only the growth of the brown fur could be recorded. Both *M. erminea* and *M. nivalis* are white on the ventral side all the year round, and the growth of the white fur cannot be recorded either from moult patches or from the observation of colour change. It might be possible to distinguish winter from summer fur on the belly by the thickness of the pelt, though that prospect was not pursued in this study.

Results

The pattern of the moult process

Figures 1 and 2 show that in *M. nivalis*, the moult follows the same pattern as in *M. erminea*. No exceptions were found. In the terminology proposed by Ling (1970), the autumn moult wave may be classed as dorso-cephalad and the spring moult wave as ventro-caudad. He suggests that the reason for the reversal of direction may be so that the belly fur is the last to lose its insulation in spring and the first to obtain it in autumn, an advantage in unpredictable temperate climates.

Age at first moult

The first coat of a young weasel appears to be complete by about 2 months old. Four young weasels of this age were skinned, of which only one (collected in Northumberland, 24 August) was still growing its first coat: the whole of the inside of the brown part of the skin was dark with active follicles. On the average, the young weasels moulted into their first winter coat at about the same time in autumn as did adults (Table (IIb)); the few young ones still moulting in December and January were probably born late in the season. (The term "young" refers to the young of the year, which may or may not be reproductively mature (King, unpublished)). The season of births in British weasels may be up to 5 months

TABLE II

(a) *Seasonal distribution of pelage categories*

State	Sex	*n*	Range of dates	Duration of category in days
Winter coat	♂	26	19 November–19 April	151
	♀	19	5 November–22 March	137
Spring moult	♂	28	12 March–9 June	89
	♀	11	12 March–10 May	59
Summer coat	♂	10	3 May–1 September	121
	♀	8	16 April–27 July	102
Autumn moult	♂	16	10 September–11 January	123
	♀	3	21 October–10 December	50
		121*		

*Excluding one still growing first coat.

TABLE II

(b) *Range of moulting dates by age and sex*

Moult	Sex and breeding condition	*n*	Range of dates	Duration of moult (days)	Modal date
Spring	Males	28	12 March–6 June	89	23 April
	Inactive females	4	12 March–26 April	45	1 April
	Breeding females	5*	16 April–12 May	26	1 May
Autumn	Adult males	4	30 Oct–18 Nov	19	9 Nov
	Adult females	0			
	Young, both sexes	15	10 Sept–11 January	124	18 Nov

*Excluding 3 with possible oestrogen interference (Northumberland, 9 and 25 May, and Sussex 16 April); if these are included the modal date becomes 5 May.

long: hence, the period between completion of the first coat at about 2 months, and the first autumn moult in November, will obviously depend on when in the season a given young weasel was born. One of the three young under two months old with clear skins, mentioned above, was collected in Sussex on 19 November, so must have been born very late in the season; it had not yet begun its autumn moult.

Timing and control of the moult

The range of dates over which the two moults were recorded in the total sample is shown in Tables I and II(a). In general, the winter coat is worn from November to March, and the summer coat from May to September. For August, September and October there was very little material, but since by November half the 16 weasels collected in that month had nearly or completely finished the autumn moult, it probably begins in September or October. The spring moult begins in March and ends in June.

In some species, oestrogen inhibits or retards the growth of hair follicles (Ebling & Hale, 1970; Ling, 1970). To check this possibility in *M. nivalis*, Table II(b) lists the moulting weasels caught in spring (March–May inclusive) separately by sex and breeding condition. All males had enlarged testes and were presumed to be fertile. Females considered to be in breeding condition were those visibly pregnant or in oestrus, the latter arbitrarily defined by a uterus weight exceeding 100 mg (Deanesly, 1944). If oestrogen inhibits moult in *M. nivalis*, one would expect to find that moult in breeding females will be delayed, and that some may be caught which show no moult patches in spring, the time when such signs would be expected. Table II(b) shows that, of eight females in oestrus or pregnant, five were moulting a month after the inactive females, and three showed no moult patches but clear external signs of half-completed new hair growth (a dorsal stripe of new fur of a darker shade). The samples are very small and show only that temporary inhibition of moult during oestrus in *nivalis* is a possibility. However, since the skins of four of the five pregnant females showed anagen follicles, moult activity is clearly not incompatible with pregnancy. In contrast to *erminea*, the period of moult in breeding females was not greatly different from that of males (Table II)b)).

Colour of the pelage

Hamilton (1933) and Rothschild (1944) stated that the winter fur in individuals of *M. frenata* and *M. erminea* which do not turn white is nevertheless a paler shade of brown than is the summer fur. Clear evidence of a similar colour change in *M. nivalis* emerged from this study.

In the spring moult, the incoming new growth can be distinguished easily in the early stages, because the summer fur is slightly darker than the winter fur and it appears as a dark dorsal stripe (Plate I). Later the difference in colour is easily missed, as the new growth spreads laterally and the dark stripe soon widens and passes across the curve of the flanks.

In the autumn moult, although the incoming fur is paler than the old, the advancing front of growth is more diffuse and the two shades merge imperceptibly (in *M. erminea* and *M. frenata* turning white, this condition is referred to by fur-trappers as "grayback"—an interspersed mixture of brown and white fur (Hamilton, 1933)). But in some specimens the incoming winter fur can be distinguished on a flat pelt by an increase in thickness. The paler appearance of the winter fur might be due mainly to an increase in the proportion of grey underwool. and this possibility could be checked on more extensive material.

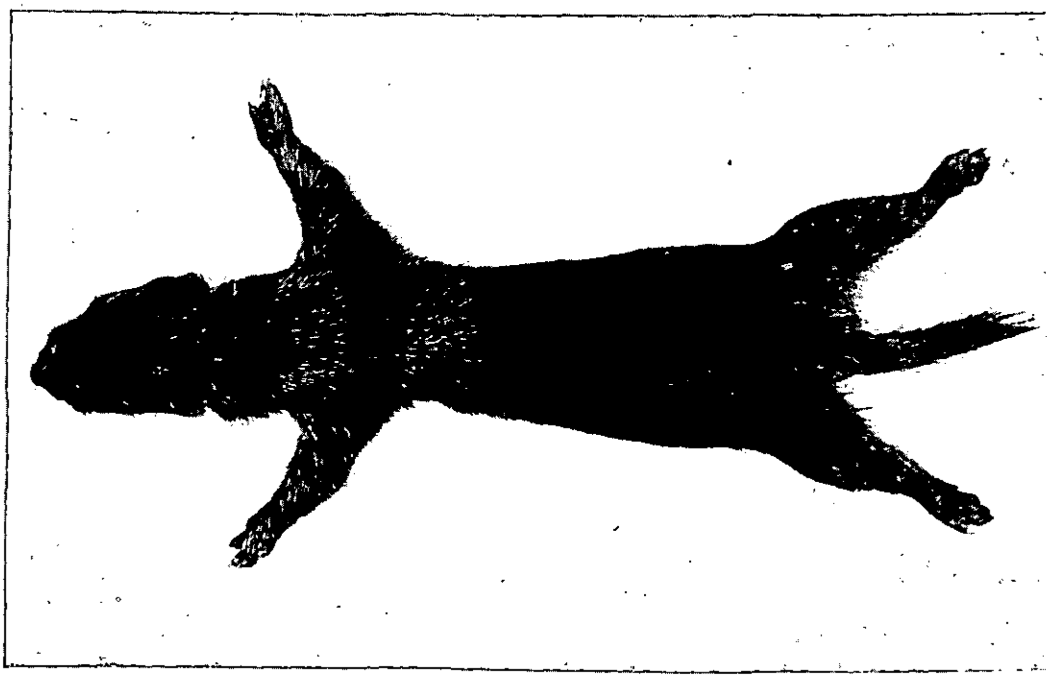

PLATE I. Spring colour change in *M. nivalis*. Hair growth is spreading laterally: darker fur is the new summer coat. (Photograph by D. A. Kempson).

Of 122 skins examined, 26 (21 %) showed colour change: 17 in the spring moult, five in the autumn moult, and three which were females in which oestrogen interference had temporarily halted the moult process. The remaining case was a male in which the wave of follicular activity had passed on to the white fur of the belly and become invisible, while the

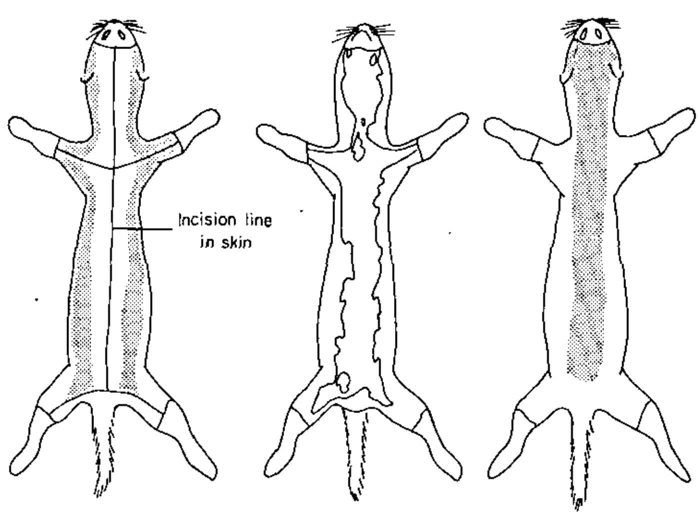

FIG. 3. Relationship between the growth of new fur (C) and the migration of pre-moult patches (A). Outlines A and B represent the dermis seen as if the epidermis were transparent, and C, the fur.

one of growth of new darker brown hair had not quite reached the last of the old paler brown hair. In skins which happened to be collected at the right time, the dark dorsal stripe on the fur side could be seen clearly coinciding with the absence of black spots on the skin side, and the areas of dark moult patches could be seen spreading along in front of the areas of new dark fur (Fig. 3).

Discussion

In neither *M. nivalis* nor *M. putorius* is there delayed implantation, so the females come into oestrus in spring. In both species oestrogen appears to interfere with the moult process, so that breeding females may be found moulting later into the spring than inactive females. By contrast, *M. erminea* females are in oestrus in summer, and in spring they tend to pass through their moult earlier than the males. Van Soest & van Bree (1969) quite reasonably concluded that the apparent early moult of *M. erminea* females was a device to avoid the energetic stress of simultaneous moult and pregnancy or lactation. But these few data for *M. nivalis* suggest the surprising and quite opposite conclusion, that the small female *M. nivalis* (averaging in Britain about 2 g: *M. erminea* females 213 g (Corbet & Southern, 1977)) are able to supply the energy needed for moult and pregnancy at the same time. Female *M. nivalis* are certainly capable of eating great quantities of food: one in captivity increased her daily consumption from about 33% of her body weight in winter to about 70% when lactating (East & Lockie, 1964).

The progress of the moult in *M. nivalis* and *M. erminea* clearly follows the same pattern, but the timing is difficult to compare. In *M. erminea* the actual production of new hair was observed, whereas in *M. nivalis*, only the preparation phase, which precedes the new growth by some unknown period of time. A second problem is that the growth of the permanently white ventral fur cannot be observed either from colour change or from moult patches. Hence, the duration of the spring moult in both species is probably longer than the data suggest: no doubt there were several skins of both species designated "summer coat" in which the growth of the brown fur was complete, but the last stage of the moult, replacement of the ventral fur, was still proceeding undetected. Nevertheless, these data suggest a difference in the timing and duration of the spring moult in females of the two species which is most reasonably explained by the difference in their reproductive cycles.

Summary

The moult pattern of the weasel (*Mustela nivalis*) in England was examined from the distribution of pre-moult patches on 122 flat air-dried skins. The winter coat is worn from November to March, the summer coat from May to September. The spring moult starts on the head and ends on the ventral side: the autumn moult starts underneath and ends on the head. Young weasels moult into their first winter coat at about the same time as do adults, except perhaps some late-born individuals. The summer fur is often slightly darker than the winter fur, and weasels in the first stage of the spring moult may show a dark dorsal stripe. Female weasels appear to be able to supply energy for moult and pregnancy simultaneously. The difference in reproductive cycles between *M. nivalis* and *M. erminea* females may account for the difference in the timing of their spring moults.

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