
VOLUME 62 2002

Seasonal fibre replacement and harvesting of fur in brushtail possums *(Trichosurus vulpecula)*.

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ABSTRACT

Annual patterns of fur growth are described from captive possums skin biopsied at three-weekly intervals between April 1985 and May 1987. Counts of hair follicles showed that follicle activity was poorly synchronised between individual possums, with maxima occurring mostly in spring and summer. No more than 40% of follicles sampled were active at one time in any individual. Derived follicles continued to develop in adult animals, increasing the follicle population by 23 ± 6% per annum. Follicle neogenesis therefore accounted for much of the fibre growth in possum skin and there was no marked seasonal coat change. However, shedding and regrowth cycles like those of other mammals were apparent in primary follicles. The mean duration of follicle activity induced by plucking was 82±2 days. The estimated rate of fibre replacement from all follicle types was 13 ± 7% per annum. Management of either farmed or wild possums for their fur should be conducted with consideration of the diffuse, asynchronous growth, and absence of true "moult" or "prime" condition in this species.

Keywords Fibre, fur, hair cycle, hair follicle, moult, possum, seasonality, shedding.

INTRODUCTION

Brushtail possums (*Trichosurus vulpecula*) were first introduced to New Zealand some 150 years ago as the basis of a fur industry. They are now widespread in New Zealand, and hunting for fur has become a rural tradition, and at times, a significant element of local economies. However, possums have also become a vector of tuberculosis and major forest pest, necessitating large scale, costly control measures (Batchelor and Cowan, 1989).

High prices received for possum pelts in the late 1970's and early 1980's (Pearson, 1987) stimulated an interest in possum farming, sustainable harvesting and more organised control operations. Little was known about seasonal fibre growth cycles in possums, although this aspect of their biology has implications for optimal harvesting times and methods (Brockie *et al.*, 1984).

In the present study, fur growth was described by sampling captive possums at regular intervals to determine hair follicle activity, follicle numbers, and duration of the growth phase. These three parameters were then used to estimate the rate of fibre replacement over a 12 month period.

MATERIALS AND METHODS

Animal capture and maintenance

Possums were trapped in cage traps from Keebles Bush reserve in the central Manawatu district. Grey coloured possums were selected, drenched with 10 mg/kg mebendazole (Ethnor), and adjusted to captivity over two to six week periods.

The captive animals were individually housed in wire cages fitted with wooden nest boxes. The cages of six animals (group A), comprising three males and three females, were enclosed within a three-walled, naturally-lit building, so that the animals were exposed to natural rhythms in temperature and light. A second group (group B) of four animals, two of each sex, was exposed to a 12 hour light: 12 hour dark photoperiod and ambient temperatures of 15, 25, and 5°C in three successive trials.

For the first two to three weeks after capture the diet consisted of greenfeed and possum pellets (Northern Roller Mills) based on the specifications of Dellow *et al.* (1985). Thereafter, the animals received only pelletized feed, *ad libitum*.

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Skin sampling and follicle scoring

Samples of skin and fur were taken from a mid dorso-lateral position of group A possums at three weekly intervals between April 1985 and May 1987. Animals were anaesthetized with 1.0 to 1.2 ml/kg i.m. saffan (Glaxovet). Fur was clipped with scissors, skin samples removed with 6 mm diameter disposable biopsy punch, and the wound stitched. Animals were weighed at the time of each sampling as an indicator of growth and condition. Hair growth was induced in group B animals by plucking a 2 x 8 cm area at the mid dorso-lateral position. Skin and fur were sampled from the plucked area, as described for group A animals, at three weekly intervals for 21 weeks. This procedure was repeated at the three different ambient temperatures noted above, using the same four animals. The median duration of fibre growth was determined from the time taken for half of the follicles to become inactive after induction.

Skin tissue was processed by standard techniques for sectioning in paraffin wax, and stained in Mayer's haemalum and eosin. Hair follicle activity and number of follicles per compound follicle (bundle) were determined in each sample by counting 400 to 600 follicles sectioned at the level of the sebaceous gland. Follicles in the active phase (anagen) contained fibres with a medulla, heavy pigmentation, or cuticle scales. An eosinophillic inner root sheath was also often visible. Follicles in the quiescent phase (telogen) possessed club-ends of fully grown fibres.

Estimation of annual fur replacement

Change in the fibre population can be represented by the following equation:

$$N_{t1} = N_{t0} + b - d$$

where: N_{t0} = initial fibre population size
N_{t1} = fibre population size at time t1
b = new fibres recruited (growth)
d = fibres lost (shedding)

This can be arranged to give an estimate the proportion of that fibres shed and regrow:

$$\frac{d}{N_{t0}} = 1 - \frac{N_{t1}}{N_{t0}} + \frac{b}{N_{t0}}$$

Where:

$$\frac{b}{N_{t0}} = \frac{a(t1-t0)}{100\,L} = \text{recruitment relative to initial fibre population}$$

and:
a = average follicle activity over time interval t0 - t1
L = duration of fibre growth

RESULTS AND DISCUSSION

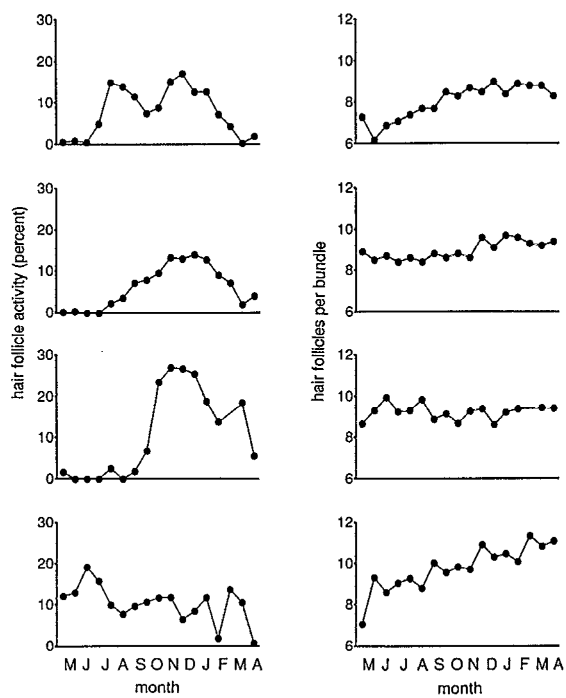

FIG 1 Hair follicle activity and bundle size over one year in three individual female possums. The first animal is shown for two consecutive years, so that the top graph is continued by the graph below. The graphs from top to bottom correspond to animal numbers F5, F6, and F7 respectively, as listed in Table 2.

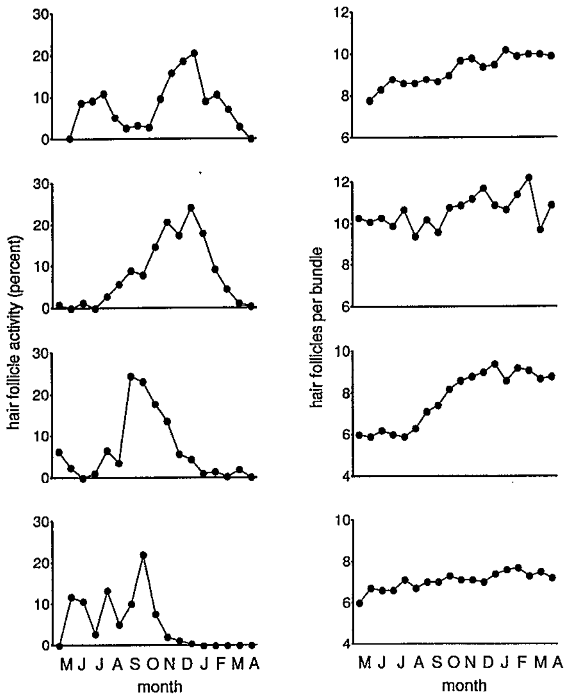

FIG 2 Hair follicle activity and bundle size over one year in three individual male possums. The first animal is shown for two consecutive years, so that the top graph is continued by the graph below. The graphs from top to bottom correspond to animal numbers M8, M9, and M10 respectively, as listed in Table 2.

Repeated sampling of group A possums maintained under conditions of natural light and temperature provided a description of seasonal fibre growth patterns in this species. Hair follicle activity and changes in follicle bundle size observed over one year are shown in Figure 1 for three females, and in Figure 2 for three males. One of each sex is shown for two consecutive years in the top two sets of graphs of each figure. Some highly unusual features of possum fur growth are illustrated.

First, the timing of fibre growth was comparatively variable. Peaks in follicle activity occurred mostly over the spring-summer period, but were poorly synchronised between individual possums. Figures 1 and 2 also show evidence that activity patterns differed between years, in the same individual. This variability suggests that fibre growth is not cued primarily by photoperiod as in many other mammals (Rougeot *et al.*, 1984). Second, peak levels of follicle activity were much lower than has previously been reported in other species. The maximum observed from captive animals was 40 %. And third, the increases in bundle size shown in the left hand graphs of Figures 1 and 2 are evidence of continued development of hair follicles in adult possums, or neogenesis. New follicles are added to compound follicles by branching, in a manner similar to that described by Lyne (1966). Neogenesis has generally been considered rare in adult mammals (Billingham, 1958), but addition of derived follicles has been reported in another marsupial, the bandicoot, *Perameles nasuta* (Lyne, 1957).

That at least some of the comparatively low level of fibre growth contributes to follicle neogenesis in possums, suggests that only a small proportion of hair follicles shed and regrow their fibres. An estimate of annual replacement was made using follicle bundle size at the start and end of the year as a measure of increase in follicle number (N_{t1}/N_{t0}), average activity over the year (a) calculated from three weekly samples, and duration of fibre growth (L).

Table 1 shows times taken for half of the follicles induced into activity to complete their fibre growth, in each of the group B animals, for each of the three trials at different temperatures. There was no difference in duration of anagen between trials ($P>0.1$). The overall mean ± standard error was 82 ± 2 days. Duration of anagen differed between the four animals ($P<0.05$), ranging from 87.5 to 71.8 days. The number of follicles per bundle also showed a gradual recovery. Since follicle bundle size had returned to initial value by 84 days ($P<0.05$) no correction for unobserved follicles was applied to duration of anagen.

TABLE 1 Duration of fibre growth (days)

Temperature	Animal number				Mean
(°C)	F1	F2	M3	M4	
25	87.5	82.5	84.0	73.5	81.9
15	91.0	80.5	89.5	70.0	82.8
5	84.0	80.5	75.5	-	80.0
Mean	87.5	81.6	83.0	71.8	81.7

Recruitment, relative change in the fibre population, and shedding were calculated for each of the eight possum-years shown in Figures 1 and 2. Mean values are given in Table 2. A small proportion (0.35 ± 0.03) of new fibres were grown in one year relative to the initial fibre population size, and a variable proportion of these appear to be the product of newly developed follicles. A value for change in fibre population of 1 would signify all growth was replacement, whereas values greater than 1 indicate some growth attributable to neogenesis.

TABLE 2 Annual hair replacement

Animal number/ year	Fibre growth as a proportion of initial number	Relative change in fibre number	Shedding as a proportion of initial number
	$\frac{a.T}{100.L}$	$\frac{t+T}{t}$	$\frac{d}{t}$
F5 (1985-86)	0.36	1.27	0.08
F5 (1986-87)	0.28	1.09	0.19
F6 (1985-86)	0.48	1.00	0.48
F7 (1986-87)	0.46	1.35	0.11
M8 (1985-86)	0.36	1.33	0.03
M8 (1986-87)	0.36	1.08	0.28
M9 (1986-87)	0.30	1.50	-0.20
M10 (1986-87)	0.23	1.18	0.05
Mean	0.35	1.23	0.13
S.E.M.	0.03	0.06	0.07

In the estimation of annual replacement in possums, no account was taken of differences in behaviour of different follicle types present in the skin. Unbranched central primary follicles make up about 3 % of the total adult follicle population and produce guard hairs. Activity in these unbranched follicles suggests that they undergo normal hair cycles and have a higher replacement rate than the remainder of the follicle population.

The proportion of pelage shed and replaced annually (0.13 ± 0.07), while only a crude estimate, serves to contrast fibre replacement in possums with that of other species. In most described mammals pelage is replaced annually or biannually (Ling, 1970; Maurel *et al.*, 1986). With such slow and gradual pelage replacement in possums, marked seasonal changes in coat structure like those of northern hemisphere fur-bearers would seem unlikely. Measurements of fur length and subjective assessment of the pelage of captive possums were also consistent with an absence of seasonal variation. These findings call into question a popular belief that some change in pelage, or "moult", results in "winter" and "summer" furs in possums. Some seasonal change in appearance due largely to guard hair renewal may be possible, however the concept of "primeness" in the strict sense of newly grown fibres comprising most of the coat (Stevenson, 1962) can not be applied to this species. Indeed, diffuse fibre growth generally occurs after, not before, the winter harvesting season.

It is possible that the conditions of captivity have acted to diminish seasonal effects, but evidence from a study of wild caught possums (Nixon, 1989) suggests that hair growth and replacement described here for captive possums are representative of events in wild animals.

These findings have implications for both the present industry and for potential developments. For example, grading of pelts in New Zealand commonly penalises diffuse fibre growth, which is visually apparent from skin pigmentation. As this growth involves only a small proportion of hair follicles and fibres, there is a need for an investigation of the relationship between grading and fur quality attributes of significance to manufacturers. If cage finishing were to be feasible, much of the advantage would lie in repair of patches of damaged fur, rather than pelting at a time of "prime" condition, although Pearson *et al.* (1990) report detectable improvements in fur quality in addition to repair of patches of lost fur. The description of low rate of pelage replacement would have greatest consequences for farming of possums. Pelting time should be relatively flexible under a variety of management programmes dictated by breeding or meat production considerations.

ACKNOWLEDGEMENTS

This study was conducted at Massey University with funding from Ecology Division, D.S.I.R. W.B. Parlane and S. Ridgeway assisted with animal maintenance. Comments of A.J. Pearson and N. Barlow are gratefully acknowledged.

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