Seasonal changes in the coat of the cat

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The coats of four cats were studied for 20 months through one winter and one summer in Australia. It was found that the outer coat and undercoat length varied from 25 mm and 12 mm in summer to 30 mm and 15 mm in winter. Follicle activity was at a maximum about February (late summer) and at a minimum in August (late winter). The peak of winter inactivity was narrow, and fell short of 100 per cent. During summer never more than 70 per cent of the outer coat hairs, and 50 per cent of the undercoat were active, indicating that despite a basic seasonal cycle, hair replacement is relatively gradual.

THIS INVESTIGATION WAS carried out in Australia in 1960–62 following a study of seasonal change in the coat of the wild Mouflon sheep (Ryder 1960), which was the first of a series of papers (summarised by Ryder 1973) in which it was demonstrated that hair growth cycles can be adequately studied only by using skin biopsies.

Cats moult in the spring, and this involves the gradual loss of individual hairs, rather than the casting of large areas of the coat at the same time, as occurs in primitive sheep.

In the present investigation the coat of four cats was studied for 20 months from the end of December 1960 until the end of July 1962. At that time the only information on the coat and skin of the cat that could be located was in a paper by Hofer (1914). In this it was stated that the cat had three types of hair: leading hairs which grew in large follicles with a sweat gland that would be regarded today as central primary follicles; beard hairs which grow in two smaller follicles, one on each side of the central follicle, and which in other species would be regarded as lateral primaries, except that they lack a sweat-gland; and wool hairs, ie, the typical underwool of mammals which grows in the smallest, secondary follicles that lack the sweat gland as well as the erector muscle possessed by the primaries. Hofer also recognised the first two secondary follicles by their earlier development, and often larger size, as 'by hairs' of the laterals. This gives a '5 stage', following the primary trio group, which is often evident during the development of the follicle population in sheep (Ryder and Stephenson 1968).

More recently Strickland and Calhoun (1963) gave details of the histology of cat skin and Baker (1974) has published the results of an investigation into hair replacement in cats from skin removed in each month of the year from animals that were destroyed, as well as hair plucked from four housed cats.

Materials and methods

The observations began on two almost all black male kittens aged about three months, one of which was castrated after the first sample. A ginger female was added after four months and a fourth, a tabby male aged three weeks, was added in October 1961, but the data from it were not grouped with those from the other males until December, because of the age difference.

The observations started in mid-summer (December 1960) and continued through the next winter and summer, ending in the mid-winter following (July 1962). The observations were carried out at the University of New England, Armidale, New South Wales (latitude 30°S).

The cats were kept in a large wire netting cage outside. At the end of each month a coat sample was taken, from alternate sides of the animal, and a tiny skin biopsy removed from the mid-side position. The technique employed, as well as that used in the histology and microscopy of the skin was described in Appendix I of Ryder and Stephenson (1968). Coat length was measured against a ruler.

The number of inactive follicles was noted each month in horizontal sections of skin, using a projection microscope, the criterion for inactivity being the loss of pigment and/or medulla, or the formation of a brush end to the fibre. It was confirmed by the examination of sections cut at a lower level in the skin than that of the count, that fibres lacking a medulla and pigment did in fact end in a brush.

Results

Body weight

The animals were weighed monthly from October

(spring) 1961 to July (winter) 1962 to seek any seasonal change. The tabby male was still growing rapidly during the period, but the others had a more or less constant weight, with only the slightest tendency for an increase during summer and a decrease during winter, like that reported in male sheep by Ryder (1973).

Coat observations

At the end of March (after the autumn equinox) the black male and the castrate, which were six months old, had a well developed undercoat, and there was some shedding of individual hairs. This continued during April and May, but by the end of June (mid-winter) the shedding had stopped and the coat appeared in 'peak' condition. It was the end of August before the peak of follicle inactivity was observed in the skin (see below).

The shedding of individual hairs started again in the first half of August. This must have been the result of premature loss from the follicle, since no regrowing hairs were observed in the skin sections at that time, although day-length had begun to increase. The 10-month-old males were in advance of the six-month-old female in their hair loss, an observation which was confirmed from the follicle activity in the skin.

By the end of September the coat of the female cat had a pale base, such loss of pigment from hairs being a common feature before a resting stage. In October, the skin area of this cat that was sampled the previous month was visible, and there had been no new hair growth, but all the animals shed hairs when stroked. The female was still shedding at the end of January 1962 (summer).

During the second autumn the coats were long and dense by the end of April (equals October in the northern hemisphere) and by the end of May the base of the coat of the black male clearly lacked pigment, indicating follicle inactivity, although again it was August before peak inactivity was observed in the skin. No change was observed in the coat from May until August and September when a few hairs came out when animals were stroked, or the coat gently pulled.

By the first August, when the black castrate was nearly a year old, its coat had faded at the tip to a dark brown, as is seen in many black sheep after a year's growth. The coat of the entire male began to fade in October (at an age of 15 months). The black markings on the tabby cat were only at the tip of the coat, so that the hairs had in fact agouti banding.

Coat length

Owing to individual variation, which was aggra-vated by age differences in the present animals, it is always difficult to produce mean graphs for changes in coat length. In the young black male and castrate the outer hairs were about 20 mm and the underwool 10 mm long at the start of the observations. These rose to about 30 mm and 15 mm respectively by March, the time of maximum follicle activity in the autumn (see below).

Thereafter the coat length remained constant until spring when the outer coat decreased to 25 mm (September) and the underwool to about 12 mm (October). During the second autumn the change in coat length was more gradual, not reaching the maximum of 30 mm and 15 mm again until May.

Observations on the skin

The hair follicle groups. The description of Hofer (1914) was in general confirmed. The follicle group comprised a large central primary follicle with an erector muscle, bilobed sebaceous gland and sweat gland. On each side of this was a much smaller lateral primary around which were clustered the secondary follicles. Many of the secondary follicles shared a common opening to the skin surface, probably with the lateral hairs.

The 'lateral primary follicles' were often indistinguishable from the secondaries, owing to their apparent lack of sweat glands and erector muscle, and similar size. For this reason the secondary/primary follicle ratio (S/P) could not be determined with the same accuracy as with sheep. The S/P ratio was, however, of the order of 3/1 in the young animals, and rose to 10/1 to 15/1 as the cats matured.

As illustrated by Baker (1974) the central primary hairs had a wide latticed medulla (or sometimes a wide non-latticed medulla) in place of the more usual ladder-type medulla of fur fibres (Wildman 1954) that was found in the secondaries.

The hair growth cycle. During the sampling sequence the percentage of inactive follicles in each month was plotted on separate graphs for the primary and secondary follicles of each animal (Fig 1). The figure used was the sum of (a) the percentages of follicles with fibres lacking pigment and/or a medulla, (b) follicles having fibres with a brush end, and (c) any follicles that were empty due to shedding of the hair; such 'shed empty' follicles were, however, much more rare than in sheep for example.

The most obvious feature of these graphs is the annual cycle with maximum follicle activity in summer and minimum activity in winter. New hairs began to grow in September (after the spring equinox) and the follicles started to become inactive again in March (after the autumn equinox).
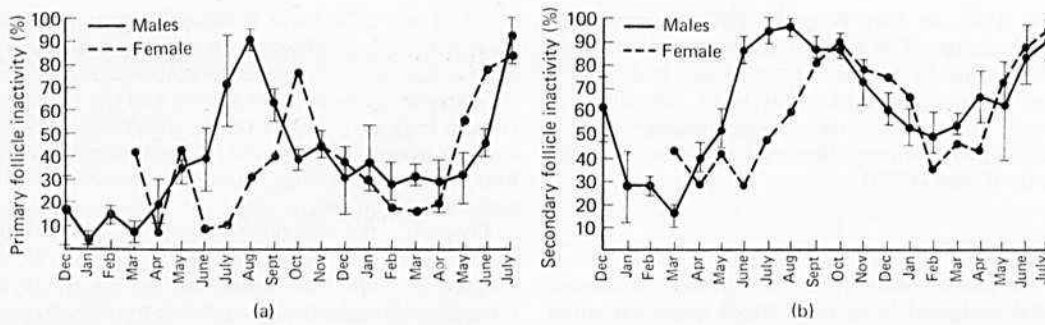
FIG 1: (a) Mean primary follicle inactivity, (b) mean secondary follicle inactivity. Vertical bars indicate the range of values

As observed by Baker (1974) there was no difference between the castrate and the entire male in either the pattern of the cycle or the extent of follicle activity at any sampling time. No seasonal influences are evident in the first part of the graph when the animals were young.

In the first autumn the follicles of the two males became inactive, reaching a peak of about 90 per cent in August–September before those of the female, which reached a peak of 75 per cent inactivity in October. This suggested a sex difference like that observed in sheep (eg, Ryder 1973). But the present finding was confounded by a slight age difference, and from the following spring onwards both sexes had a cycle with a similar pattern (Fig 1). The graphs of the three males were, however, combined into a single graph using mean values, but that of the female was kept separate.

There were occasional marked differences between one sampling time and the next, which could be due to the alternation of the sides of the animal in the sampling sequence, and some still persist in the mean graphs. Where these occur as subsidiary peaks of inactivity during a mainly active period, ie, in November 1961 and January 1962 of the primary follicle graph, they are comparable with the subsidiary autumn peak or peaks of inactivity seen in some breeds of sheep, and notably red deer (Ryder and Kay 1973). In these animals they are thought to correspond to an autumn moult in which not all the hairs are replaced.

A notable feature of these graphs is the relatively narrow peak of winter inactivity, which falls short of 100 per cent and is particularly marked in the primary follicles. Also, in the summer active period, inactivity does not fall below 30 per cent in the primary follicles, and 50 per cent in the secondaries. Both these features indicate that, despite the seasonal nature of the hair growth cycle, hair replacement is much more gradual and this in turn explains the lack of a marked and obvious moult.

Discussion

The 'leading hairs' of Hofer (1914) would now be regarded as 'bristles' growing in central primary follicles, and the 'beard hairs' would be regarded as 'awns' growing in what in other species would be regarded as lateral primaries, except that in the cat they lack a sweat gland and erector muscle. Both leading hairs and beard hairs would be regarded as guard hairs forming an outer coat in contrast to the wool of the undercoat, the (secondary) follicles of which possess only a sebaceous gland and lack the sweat gland and erector muscle of the primaries.

The marked increase in S/P follicle ratio during the first few months of life accords with Baker's (1974) observation that the development of secondary follicles continues for some weeks after birth by budding from the original secondaries. This contrasts with sheep in which most follicles are thought to have been initiated by birth.

The difference between the minimum adult coat length of 25 mm and the maximum of 30 mm, is very small compared with the range from 10 mm after the spring moult to 50 mm in the autumn seen in the wild sheep (Ryder 1973). This indicates much more gradual loss of hair in the cat, and the attainment of appreciable length by some hairs before others are shed. The shedding of hairs in the autumn, was comparable with the autumn moult observed in other mammals, in which not all the hairs are replaced (eg, deer, Ryder and Kay 1973).

The sequential samples taken from the same animals in the present investigation provide interesting confirmation of the results of Baker (1974) from different animals killed at different times of the year. The peak of follicle inactivity in the skin in August corresponds exactly to the minimal activity found in February by Baker (1974) in the northern hemisphere.

Of the three kinds of hair replacement found in mammals: wave, mosaic and seasonal, the graphs given in the present paper indicate a seasonal type of

coat change, as observed in many mammals including ruminants (eg, Ryder 1973). With the well known seasonal moult in cats it would be surprising if they had a mosaic replacement pattern as claimed by Baker (1974) although he does in fact implicate increasing day-length in spring as the stimulus for hair loss. A mosaic pattern is found in guinea pigs which lack seasonal coat changes, ie, hairs are continually shed and replaced, as in the human scalp. The apparent mosaic pattern in cats is caused by not all follicles in the group being at the same stage of the cycle at the same time.

This more gradual change, despite the basic seasonal pattern is further brought out by the relatively narrow peak of maximum inactivity, which falls short of 100 per cent. This is in contrast to the situation in many ruminants in which the entire follicle population can be inactive for the whole of the six-month winter period, after which there is a marked spring moult (Ryder 1973).

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