

Molt in Two Populations of the House Mouse, *Mus musculus*

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Abstract

This study correlated molt in two population samples of the house mouse, *Mus musculus*, with sex, age, geographic origin and time of year. Sample A consisted of 273 house mice trapped in 1964 and 1965 on Sand Island, Johnston Atoll, central Pacific Ocean. The 272 mice of Sample B were caught over a 6-month period in Delaware County, Indiana, in 1968 and 1969.

Incidence of pigmented areas (molt) on the fleshside of the pelts of both samples was recorded and statistically analyzed to find patterns and percent molt. There was no positive correlation between incidence of molting and origin and age of sample mice, nor between incidence of molting and sex or month of collection.

Introduction

The present study correlated molt (as indicated by pigmentation of the fleshside of pelts) in two feral populations of the house mouse, *Mus musculus*, with sex, age, geographic location and time of year. The term "feral" as used here implies mice which are either living out-of-doors or in unheated buildings.

Sample A represented an insular population from the central Pacific Ocean. Sample B was taken from Delaware County, Indiana. Percentage molt and areas of molt were recorded and each specimen was assigned to an arbitrary age class.

Related Literature

Osgood (11) noted three different phases of pelage color in *Peromyscus* which corresponded to age—juvenile, adolescent, and adult. Allen (1) described molt in this same genus as generally beginning in the feet and around the nose and extending dorsally and also proceeding anteriorly from the base of the tail. Collins (3) agreed that this is the general pattern of spring molt in *Peromyscus maniculatus*, but that it is subject to much irregularity. He found that the juvenile pelage was complete at 4 to 5 weeks and transition from juvenile to post juvenile pelage occurred between the ages of 6 and 8 weeks. Molt on the ventral surface was usually completed before the dorsal surface and usually proceeded from anterior to posterior. Collins (3) checked for molt by parting the hair and checking for the presence of new hair. But as pointed out by Golley *et al.* (5), the molt is more readily determined from the underside of the skin and may be well underway before it is detected on the surface.

Gollschang (6) stated that some *Peromyscus leucopus*, both captive and wild, molt over an indefinite period of time, and that body weight had no direct relationship to onset of pelage change.

Most mammals have similar pigmented areas as illustrated by Kopenen (9) who examined the sequence of pelages of the Norwegian

lemming, *Lemmus lemmus*, by using the pigment patterns of the fleshside of the skin and Skoczen (12), who studied seasonal changes of pelage of the mole, *Talpa europaea*, as measured by the planimetric measuring of pigmented areas on the underside of the skin.

Golley *et al.* (5) studied skins of *Peromyscus polionotus* by pinning the skins out to dry on cardboard for 6 months with the furside down and then using a planimeter to measure total area exhibiting molt. He found that molt was influenced by increasing age; however, he also noted it may be influenced by sex, body size, trauma, and other environmental factors. The percentage of the pelt involved in the molt process progressively declined with age. He found 80 to 90% of total pelage involved in molt in juveniles, but it never exceeded 45% at later stages of development. There was a 35% maximum in post-juvenile molt. Golley *et al.* (5) also noted areas of gray pigmentation preceding or following the areas of most active molt.

The pigmentation of flat-skin mounts of 33 specimens of known age *Microtus californicus* used in an experiment by Ecke and Kinney (4) revealed a close age-molt correlation from 17 to 60 days of age. Animals could be aged by degree of molt to within 4 days of their actual age. The method was 88% accurate with laboratory-reared mice. Evidence from skins of old animals indicated that all adult molts are irregular after the molting of post-juvenile pelage. These occurred as mottled patterns of dark and light areas on the underside of the skin with no apparent consistency of design. No significant molt variation was found between the two sexes.

Methods

Sample A was collected on Sand Island, Johnston Atoll, central Pacific Ocean, by the junior author while working with the Pacific Ocean Biological Survey Program in 1964 and 1965. The atoll covers less than 800 acres and this insular population has developed since 1923 when the U.S.S. Tanager Expedition biologists found no mammals on the island (8).

Sample B was taken from Delaware County, Indiana. A minimum of 30 mice per month was collected during a 6-month period from September 27, 1968, through March 22, 1969. The mice came from 2 county locations: 1) Delaware County Fairgrounds, Muncie, Indiana; 2) Earl Southworth's farm—1 mile west of Tillotson Avenue on Bethel Pike, Muncie, Indiana.

All but 6 of the 272 mice in Sample B were assigned to arbitrary age classes based on molar wear after Lidicker (10). The remaining 6 were not aged because the skulls were destroyed during trapping. Data collected from the 266 usable specimens were compared with data from the 273 mice in Sample A.

Mice were collected using live-traps and snap-traps. The pelt was removed from the carcass, tagged, and pinned with the furside down to dry. Facia and excess fat were removed as suggested by Clark (2), to prevent their masking of molt pattern.

Percentage of molt was estimated. A grid system composed of $\frac{1}{8}$ -inch squares was imposed on a plastic transparency. This was then placed over the skinside of each pelt, and the percentage of molt was calculated by comparing the total number of squares covered by the pelt to the number of squares covered by pigmented areas.

We decided that a modified version of the pelt pattern used by Hendricks (7) would best demonstrate the possible patterns (Fig. 1). A map with 14 areas was prepared for each pelt. To designate an area as molting, a minimum of $\frac{1}{8}$ square inch of that area must be molting as demonstrated by the presence of pigmentation. This indicator was arbitrarily chosen.

The areas of molt on each pelt were marked on the map of the pelt, along with other pertinent information available for that speci-

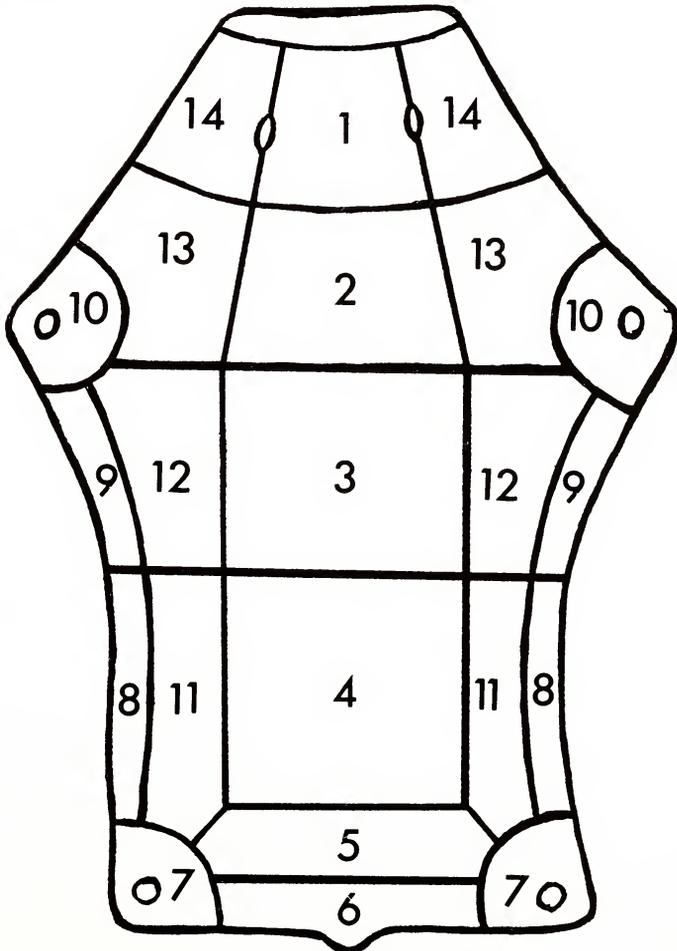


FIGURE 1. Pelt map of house mouse illustrating areas of molt.

men. A combination of Chi-square and co-factor analysis was run to find the most frequently occurring patterns.

After these patterns were determined, each pelt map was again examined and classified as representing one of the main patterns, as irregular, or as displaying no molt.

A pelt was recorded as having a certain molt pattern if it displayed molt in 50% or more of the areas comprising that pattern. It was possible for more than one pattern to be represented on the same pelt. This information was analyzed for correlation of molt pattern with age, sex, geographic origin, and time of year.

Results and Discussion

Population Samples A and B were analyzed separately for representative molt patterns. Five patterns were found in Sample A and four patterns in Sample B (Fig. 2). The molt patterns were lettered A through I; J was used to indicate an irregular unclassified molt pattern; and K represented no molt.

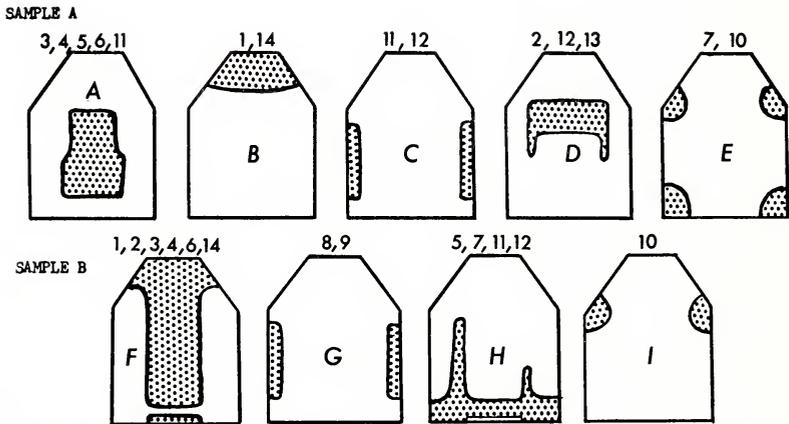


FIGURE 2. Predominant molt pattern in samples from two house mouse populations.

Each pelt was again checked to determine which pattern or patterns it represented. It was possible for several patterns to be represented on one pelt. When this occurred, the composite of patterns was considered as one pattern. For example, many of the pelts represented one clear-cut pattern, such as I or H; but, some of the pelts had patterns F, G, H, I represented on the same pelt. Such pelts were considered as representing one pattern, the pattern of FGHI.

Males and females within the same sample were considered jointly, since they were characterized by the same distribution and frequency of molt patterns. The molt patterns were randomly distributed throughout the age classes and the months of collection, and did not show

positive correlation with either of these. The samples were represented by different patterns, with the exception of C and G, which were identical in both samples.

Ecke and Kinney (4) were able to age *Microtus californicus* up to 60 days of age by using a combination of weight and molt pattern. They found that all older mice had irregular molt. Our findings indicated that in the house mouse, regular patterns indicative of the populations are present. These are randomly distributed throughout the age classes and months in both sexes.

There was no significant difference between the percentage molt of the sexes ($P = 0.05$). In Age Classes 3 and 7, the females nearly doubled the percentage of molt displayed by the males. However, most

TABLE 1. Mean percent molt by sex and age class in samples from two house mouse populations.

Age Class	3	4	5	6	7	Mean %
Sand Island, Johnston Atoll						
Male	15.6	20.0	16.0	13.2	10.0	14.9
Female	33.6	24.8	20.0	21.5	19.1	23.8
Combined	24.6	22.4	18.0	17.3	14.5	19.3
Delaware County, Indiana						
Male	10.1	11.1	4.2	5.2	1.7	6.4
Female	20.5	10.0	3.6	5.9	8.1	9.6
Combined	15.3	10.5	3.9	5.5	4.9	8.0

TABLE 2. Percent molt by month for male and female house mice collected from two populations.

	Sand Island, Johnston Atoll			Delaware County, Indiana		
	Male	Female	Sum	Male	Female	Sum
Sept.	19	30	49	3	2	5
Oct.	30	37	67	15	11	26
Nov.	14	31	45	9	9	18
Dec.	21	15	36	5	3	8
Jan.	14	19	33	7	15	22
Feb.	14	9	23	6	5	11
Mar.	—	—	—	5	20	25
Apr.	10	12	22	—	—	—
May	25	10	35	—	—	—
June	16	25	41	—	—	—
July	18	29	47	—	—	—
Aug.	10	19	29	—	—	—

of the sample representatives are in Age Classes 4, 5, and 6, with only a small number in Age Classes 3 and 7 (Table 1).

The amount of molt was inversely proportional to age. The greatest percentage molt occurred in Age Class 3 (the youngest mice), and the least percentage of molt in Age Class 7 (the oldest mice).

Sample A showed the greatest percentage of molt during June, July, September, October and November. The least molt was evidenced in February and April (Table 2). There were no March specimens used in this study.

Month of collection did not correlate significantly with percentage of molt in Sample B. September and December had the smallest percent molt; whereas, October and March had the greatest percent (Table 2). However, this sampling period was but 6 months in length.

Geographic origin of sample mice was related to mean percent molt and was significant at the 0.05 level. Table 1 reveals that in each age class, percentage of molt in Sample A was at least 1½ times that of Sample B.

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