MATERNAL BEHAVIOR OF THE FERRET, MUSTELA PUTORIUS

Dissertation for the Degree of Ph. D.
MICHIGAN STATE UNIVERSITY
ANN UNDERHILL SHUMP
1975

This is to certify that the

thesis entitled

Maternal Behavior of the Ferret
(Mustela putorius)

presented by

Ann Underhill Shump

has been accepted towards fulfillment
of the requirements for

Doctoral degree in Zoology

Richard H. Adler
Major professor

Date 11/11/75

O-7639

ABSTRACT

MATERNAL BEHAVIOR OF THE FERRET,
MUSTELA PUTORIUS

By

Ann Underhill Shump

Certain aspects of the ferret, Mustela putorius, were studied to determine possible effects of domestication on the behavior of this animal as well as to ascertain its value as a research animal. Various parameters of maternal behavior, including time in nest, nursing, licking and self grooming, were observed over an eight-week period for each of nine female ferrets. Growth and development of the kits were also studied over 16 weeks. Experience and fostering effects on maternal behavior were conducted with 19 females and it was shown that experience had no effect on maternal behavior except in rate of retrieval and latency to begin retrieval, and fostering had no effect on any of the parameters studied.

MATERNAL BEHAVIOR OF THE FERRET, *MUSTELA PUTORIUS*

By

Ann Underhill Shump

A DISSERTATION

Submitted to
Michigan State University
in partial fulfillment of the requirements
for the degree of

DOCTOR OF PHILOSOPHY

Department of Zoology

1975

ACKNOWLEDGEMENTS

I wish to express sincere appreciation to the members of my graduate committee, Drs. Rollin Baker, Richard Aulerich, Stanley Ratner and James Braddock, for the advice and inspiration they gave during this study. In addition, Dr. Richard Aulerich of the Department of Poultry Science generously provided the animals and research facilities and devoted much of his own time in helping with the project.

I would also like to thank Steve Olejnik of the Michigan State University School for Advanced Studies for his most valuable statistical and computer programming advice. Use of the Michigan State University computing facilities was made possible through support, in part, from the National Science Foundation. Some statistical tests were carried out on the Wang 600-14 calculator in the Michigan State University Museum.

I wish to thank Bill Johnson who fed and watered the animals and helped construct equipment, and the other graduate students in the Michigan State University Museum who gave advice and support throughout the study.

Finally, I would especially like to thank my husband, Karl, who helped with much of the research and encouraged me when things went wrong.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF FIGURES (CONTINUED)

INTRODUCTION

The purpose of this study is (I) to examine the "normal" maternal behavior, i.e., the conduct of the female toward her young from birth to weaning of the kits, of the female ferret (Mustela putorius), and (II) to investigate the possible effects of cross-fostering and experience of the females on this maternal behavior.

The European ferret is a fairly small carnivore weighing approximately 500-900 grams for females and 1200-1700 grams for males. It has been domesticated for at least 2000 years in Europe (Zeuner, 1963), primarily for destroying rabbits and rats, and it is believed to have originated from the European polecat (Pocock, 1932; Morris, 1965) which is found in Europe, Asia, and North America.

Recently the ferret was introduced into the laboratory for studies concerning such topics as photoperiodism and circadian rhythms (Bissonnette, 1932, 1935a, 1935b; Hart, 1951; Hill and Parkes, 1934; Marshall, 1940), reproduction (Allanson, 1931; Chang, 1965a, 1965b; Vincent, 1970; Hammond and Marshall, 1930; Hammond and Walton, 1934a, 1934b), growth and molting (Harvey and MacFarlane, 1958) and disease control, particularly distemper and influenza (Hahn and Wester, 1969). However, comparatively little has been published on ferret behavior. Otis et al. (1971) studied exploratory behavior; Pitt (1921) and Poole (1972) examined the similarities of certain behavioral characteristics in ferrets, polecats and their hybrids; Poole (1966) investigated

aggressive play; and others have looked at various other aspects of ferret and/or polecat behavior (Shump et al., 1974).

The ferret is docile, no doubt due to its long period of domestication, and, except for females with litters or near parturition and some individual males during the breeding season, is normally easily handled without gloves. The odor is rather pungent, since, like all mustelids, they have anal scent glands that secrete a musky odor. However, the ferret's charm far outweighs the smell, and these glands can be removed surgically. The effect on behavior of this removal is not known. The normal breeding season for the animals at East Lansing, Ingham Co., Michigan, is March to August or September, although this time can be altered with proper changes in photoperiod (Hart, 1951; Bissonnette, 1932, 1935a, 1935b; Hill and Parkes, 1934; Marshall, 1949; Vincent, 1970). Gestation is 41-42 days with little variance. If females are bred early enough in the season, two litters of up to 12 or 13 young (average 7-8) can be obtained each year under normal photoperiod, which agrees with the findings of Hammond and Marshall (1930); Walker (1968) reports that this is also true for the wild polecat. The females seem to be able to raise most of their kits successfully (by comparison, the mink often has trouble raising four, Aulerich, 1975) and will readily accept foster young of their own species; the use of ferrets as foster-mothers to mink has been reported by Bahlcke (1939).

It would seem, then, that the ferret might be a good model of a small carnivore for various maternal behavior studies. There have been extensive investigations of maternal behavior carried out on such animals as Rattus norvegicus (Beach and Jaynes, 1956a, 1956b, 1956c; Carlier and Noirot, 1965; Denenberg et al., 1963; Grota, 1973; Wiesner and Sheard,

1933; Rosenblatt and Lehrman, 1963; Rosenblatt, 1970; Smith and Berkson, 1973; Smart and Preece, 1973); mice, including Mus musculus and Peromyscus maniculatus (Priestnall, 1973; Sayler and Salmon, 1969, 1971; King, 1958); rabbits primarily Oryctolagus cuniculus and Sylvilagus aquaticus (Denenberg et al., 1958, 1959, 1973; Sawin et al., 1969; Zarrow et al., 1962, 1965; Ross et al., 1959, 1963); the dog (Rheingold, 1963); the cat (Schneirla et al., 1963); and Richardson's Ground Squirrel (Michener, 1971, 1973). Although there have been a few descriptions of mating and parturition in the ferret (Hammond and Walton, 1934b; Rempe, 1957; Nacktgeboren, 1961; Herter, 1953), the maternal behavior of the ferret is poorly known (Herter, 1953; Lazar and Beckhorn, 1971). Likewise, little research has been done on the behavior of the other mustelids, so few intrafamilial comparisons can be made. Most studies of mink have been concerned with disease and nutrition (Shump et al., 1975). Although several breeding studies have also been carried out (Pallen, 1944; Gilbert and Bailey, 1970; Bond, 1971; Curran, 1972), very little mention is made of the behavior of the female toward her kits. East and Lockie (1964), Hartman (1964) and Heidt (1970) have made some behavioral observations on Mustela nivalis, and Ewer (1968,1973) has written two books on carnivores and other mammals in general, including various mustelids. Since the ferret is becoming increasingly more common as a laboratory animal, its behavior, including its maternal behavior, should be studied in detail, for better understanding of the animal as well as for more insight into maternal behavior in general.

METHODS AND MATERIALS

The animals used in this study were provided by the Michigan State University Mink Farm which is administered by the Department of Poultry Science. The original stock was obtained from the Marshall Fur Farm of North Rose, New York, in November of 1969. This research was carried out over two breeding seasons, 1973 and 1974. Five or six males were used for mating all the females each season.

The ferrets were kept in individual wire cages (1 inch or 2.5 cm mesh) measuring 76.2 x 38.1 x 45.7 cm. A few days before parturition the females were removed to cages with similar mesh but measuring 76.2 x 76.2 x 45.7 cm with a strip of 1/2 x 1 inch (1.3 x 2.5 cm) wire mesh up to 10.2 cm from the bottom to keep young from falling out. They were left there with their litters until the kits were weaned at 6-8 weeks. Nest boxes measuring 38.1 x 29.2 x 26.7 cm were constructed of 3/4 inch (1.9 cm) wood with 1/2 inch (1.3 cm) wire mesh on the front, on the top under a flap of wood (for observation), and on the bottom 1.3 cm above a 38.1 x 29.2 cm sheet of metal (to allow feces to drop through). These boxes were attached to the fronts of the cages with a 10.2 cm hole connecting the next box with the cage. A few days before parturition a "false bottom" consisting of 1/2 inch (1.3 cm) wire mesh was placed on the floor of the cage to prevent the tiny kits from falling through, and excelsior and crushed sugar cane (Ser-val) were placed in the nest box for bedding. (Figure 1 shows the basic nest box used from the top. In Experiment I the side opposite to the entrance hole was replaced with 1/2 inch wire mesh; in Experiment II this side and the top were replaced with clear plastic. Figure 2 shows the nest boxes attached to the cages.)

Figure 1. Model of basic nest box. (See text for modifications in each experiment.)

Figure 2. Nest boxes attached to cages.

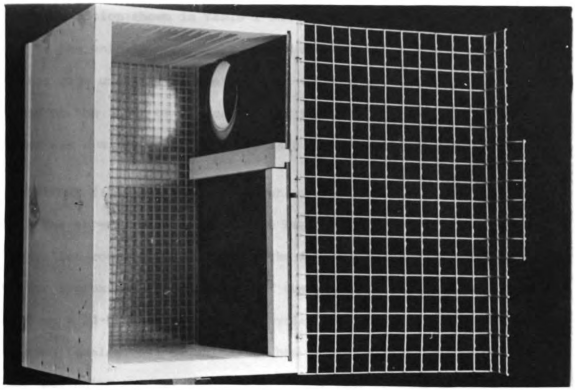
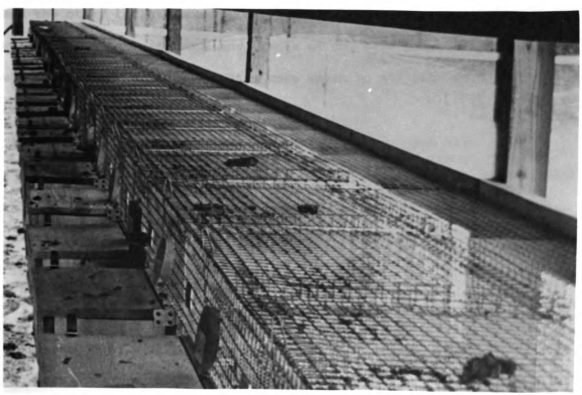


Figure 1.

Figure 2.



The ration shown in Table 1 was mixed at the MSU Mink Farm and fed to the animals once daily. Feed was placed on the wire on the top of the cage until after whelping, at which time it was placed on a feed board on the floor of the cage so it would be accessible to the kits. Water was available at all times in a cup attached to each cage.

EXPERIMENT I: General Maternal Behavior

The experimental ferrets were kept in their cages in a light-controlled room, 4.3 x 2.7 m, at the Poultry Science Research and Teaching Center approximately 3 km south of the main MSU campus. The room was kept on a 14-hr light:10-hr dark cycle. Observations were carried out on nine females, all of which had had previous litters.

Beginning the day after parturition (Day 1) each female was observed closely for two 15-minute periods every third day (Day 1, Day 4, Day 7, etc.). Whenever possible, one observation was made in the early morning and the other in late morning or early afternoon. Observations were made through the wire tops and fronts of the nest boxes while sitting at eye level with the boxes. Notes were taken on all behavioral events, but particularly observed were:

1. Amount of time actually spent within the nest box.
2. Amount of time the female spent nursing her young. This was based on the sight of one or more kits suckling plus the sound of suckling.
3. Amount of time the female spent licking the kits, including nibbling at them.
4. Amount of time the female spent grooming herself, including licking, scratching, and chewing.

Approximately 74 hours of observations were made.

Kits were weighed and measured (total length, tail length, ear length and hind foot length) each week from birth until 16 weeks of age, at which time most of the kits were over 3/4 grown. The data for males

Table 1. Ingredients in the Ferret Ration.

	Per cent of total weight
Cereal (XK-40 mink cereal)[1]	20
Tripe	15
Liver (beef, inedible)	5
Poultry ("spent" chickens)[2]	20
Fish (cod, haddock, flounder mix)	30
Lungs (beef)	10

1 X-K Sales and Development Co., Inc.
P. O. Box K
Thiensville, Wisconsin 53092

2 Birds 18 to 20 months old which are no longer profitable for egg production and are not in demand as food for human consumption (Aulerich and Schaible, 1965)

and females were compared using a Student's t-test. Observations were also made to determine time of eye and ear opening, hair development, and eruption of some of the teeth, particularly canines and incisors.

EXPERIMENT II: Effects of Cross-Fostering and Experience

For this experiment the animals were kept in an outdoor open-sided shelter that protected them from rain, snow and hot sun, but subjected them to natural temperatures and photoperiod (Figure 3). The wire on the fronts and tops of the nest boxes were replaced with clear plastic for better observations.

Four groups were used, each consisting of five females (Group I had only four females due to the loss of a litter near the end of the study). Ten animals that had previously whelped (experienced) were subdivided into Group I in which the females cared only for their own kits and Group II in which half of the kits were theirs and the other half were fostered from other females. The other ten females were primiparious (inexperienced) and were subdivided into Group III (own kits) and Group IV (cross-fostered kits).

All litters were reduced to four kits at two weeks of age by placing all the kits in a litter into a box and randomly pulling out four kits. Litters were reduced to four because some females gave birth to only four young and a greater number would have caused too great a variation between litters. At this time all kits were marked on the head or back with picric acid, a yellow dye, for separate identification, and cross-fostering was carried out. This fostering was always between two litters not more than one day apart in age.

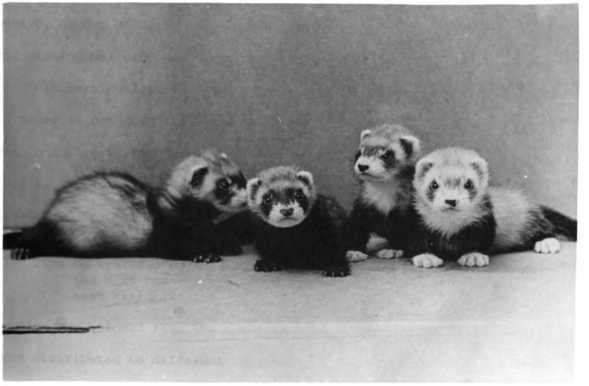
Behavioral observations were begun on Day 14 (the day young were marked and cross-fostered) and carried out for 10 minutes every third

Figure 3. Michigan State University Mink Farm showing open-sided shelters.

Figure 4. Ferret kits approximately 6 weeks of age.

Figure 3.

Figure 4.



day for each litter. When possible, these observations were made in the mornings. To insure a maximum of behavioral interactions during the test period, the females were removed from their litters for 5-10 minutes before observations were begun by blocking the entrance to the nest box and leaving the female inside the cage. The females normally left the nest boxes voluntarily in response to the opening of the cage lid. The same behavioral events as in Experiment I were noted and timed except that nursing and licking of the young were timed for each individual kit. These observations were recorded on a tape recorder and later transcribed. A two-way univariate analysis of variance was used to test differences between experienced and inexperienced females, between non-fostered litters and half-fostered litters, and also to show any differences toward those kits that were fostered and those that were not. Approximately 32 hours of observations were made.

Kits were weighed and measured each week as before beginning with Week 0, or day of birth, and ending Week 6, the day the kits were weaned and testing was concluded (Figure 4).

Kit retrieval studies were begun on Day 1 and continued until weaning. In order to cut down immediate effects of learning on retrieval, testing was conducted at intervals of 3 days, 1 day, 3 days, 3 days, 1 day, etc. (Day 1, Day 4, Day 5, Day 8, Day 11, etc.). The following events were timed:

Time to begin retrieval (latency)
Time to retrieve each kit (timed from the moment the female left the nest box for one kit until she left the box for the next kit)

Females were closed into the nest boxes while the kits (four of them) were distributed to different locations in the cage. The door to the nest was then opened, at which moment timing began. Testing was concluded

after five minutes if the female had not retrieved all the kits by then. A two-way univariate analysis of variance was again used to test differences between non-fostered litters and half-fostered litters, between fostered and non-fostered individuals, and between experienced and inexperienced females.

MISCELLANEOUS STUDIES

Several short pilot studies were carried out and, although they are rather incomplete, results may be of help to future research.

One two-day old ferret kit was put with a white mink and her litter of three kits six-days old while the remaining two mink kits were put with the ferret and her three remaining young. To accomplish this, the females were blocked from their nest boxes while the kits in each litter plus the fostered ones were all handled for a few seconds and then placed in the nests. The mothers were then allowed into their respective nest boxes, and results were observed.

Two pairs of ferrets were bred on August 11, 1974, and allowed to remain together throughout gestation. All four ferrets were young of the year before, but the males had been used in breeding in the spring of 1974 and both females had had litters that year.

Some simple observations were made on the interactions of males with kits. A male was placed in a cage for five minutes before a kit (newborn, 1, 2, 3, 4, 5, or 6 weeks of age) was introduced. Observations were then made for five minutes.

Tests were also run on the ferrets to try to determine stimuli that could be effective in other behavioral and psychological studies.

Some brief studies were also carried out on predation by the ferrets on mice. Ferrets of different ages and sexes were placed in the

bottom of a barrel with a mouse and observations made of the killing behavior.

RESULTS

PARTURITION:

Several attempts were made to observe birth, but only one of these attempts was successful. This female was noticed late in the afternoon in her cage with one kit born but still attached to the female. She was licking the kit and chewing on the umbilical cord. Within a few minutes a contraction forced the afterbirth out and she then proceeded to eat it. Sixty seconds after the cord was severed, the female entered the nest box without the kit, but a minute later she pulled the kit in and continued to lick it. Approximately 30 minutes after the first kit was born, the second appeared. The female licked the kit often while it was still in the birth canal, with the first kit sometimes getting in the way and getting licked. Thirteen minutes after the appearance of the second kit, the third emerged. Again, the female licked the kit vigorously while it was still in the canal. Twenty-three minutes later, the female entered the cage dragging the third kit. There she licked the kit some more and turned around several times as if trying to rid herself of a burden. She went back to the nest box after two minutes, but almost immediately went back out again and then back in. After a total of 49 minutes the placenta of the third kit and the fourth kit were expelled together. The fifth was born 19 minutes later. Before the female finished cleaning the fourth one she ate an afterbirth and then concentrated on the last kit. One hour and 29 minutes after it was born the first kit began nursing. Unfortunately, although I watched this female give birth to five young, there were only three remaining the following morning. This was not surprising since on several occasions partially eaten kits were found in nests, showing that ferrets do some-

times devour their young.

At another time two females were given bedding right next to their nest boxes the day before parturition to see if and how much of it they would pull into the boxes. However, both of these ferrets had their kits on the nesting material rather than inside the nest boxes and because of this, several of the newborn kits fell through the wire to the floor.

FEMALE-KIT INTERACTIONS:

Figures 5-8 show the average times the females spent in the nest, nursing the kits, licking each kit, and grooming themselves, respectively, out of a total of 30 minutes (1800 seconds) observation over the 8 weeks of testing. Figure 9 shows the percentage of time spent doing each of these acts.

The mother ferret spends most of her time in the nest with the kits until they are about four weeks old (28-31 days) after which she spends progressively more time in the cage. The kits suckle much of this time the female is with them. Between Days 28 and 31 nursing time begins to drop rapidly until the kits are eating on their own almost completely at 46-49 days.

The mother normally lies on her side to allow the kits to nurse and curls tightly around them, although sometimes she will crouch over them. Even though they are not very mobile until they are about three weeks of age, the babies are adept at finding the mother's belly. Kits only a few days old are able to wiggle completely around the female, who often pays no attention to their cries, and by the time they are a week old they often climb over her. On occasion, the mother will reach behind her and pull a kit over her back to join the others or will

Figure 5. Average time spent in the nest by female ferrets during 30 minutes of observation over 8 weeks (N=9).

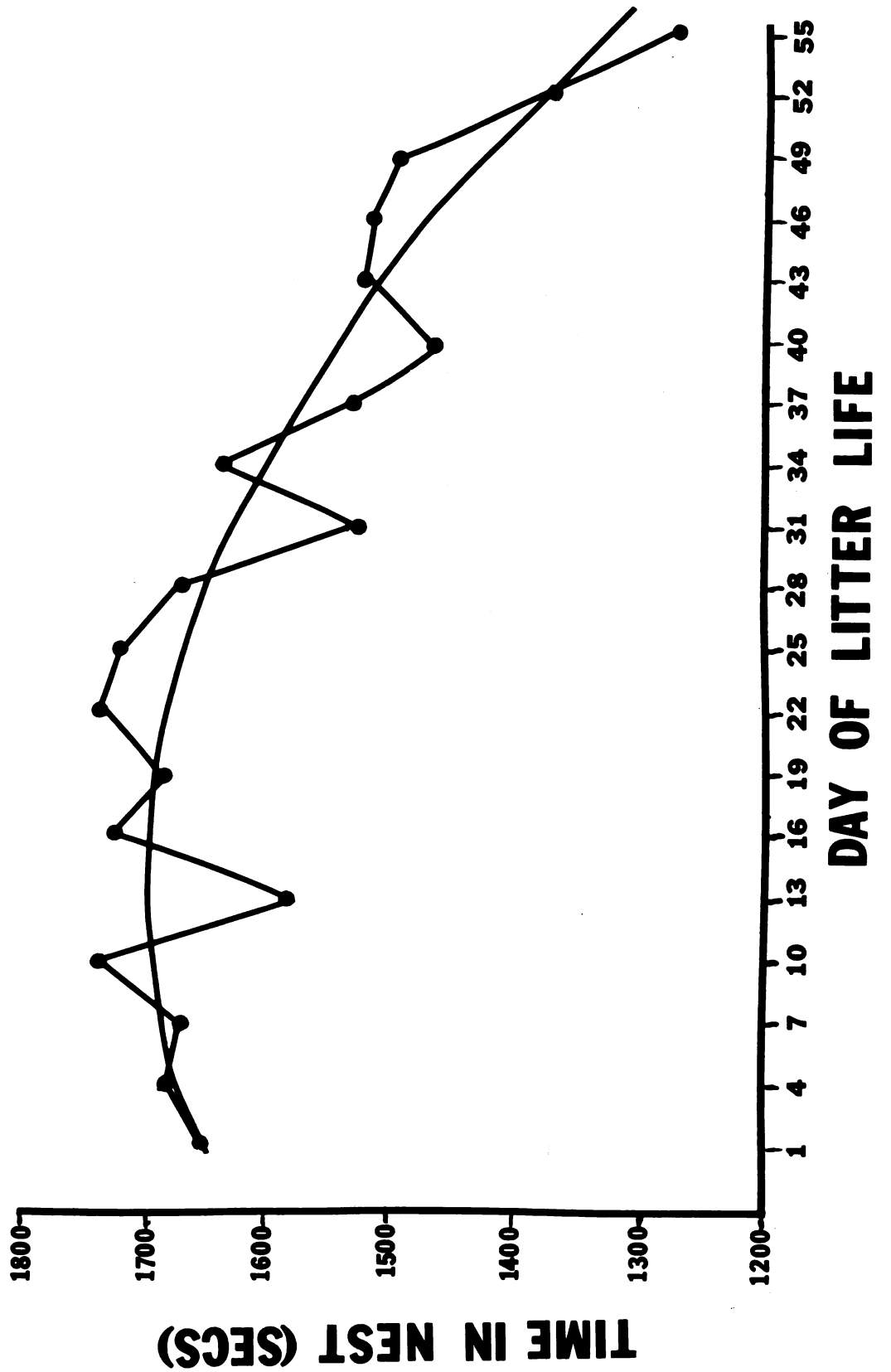

TIME IN NEST (SECS)
1800
1700
1600
1500
1400
1300
1200
1 4 7 10 13 16 19 22 25 28 31 34 37 40 43 46 49 52 55
DAY OF LITTER LIFE

Figure 5.

Figure 6. Average time spent nursing the kits during 30 minutes of observation over 8 weeks (N=9).

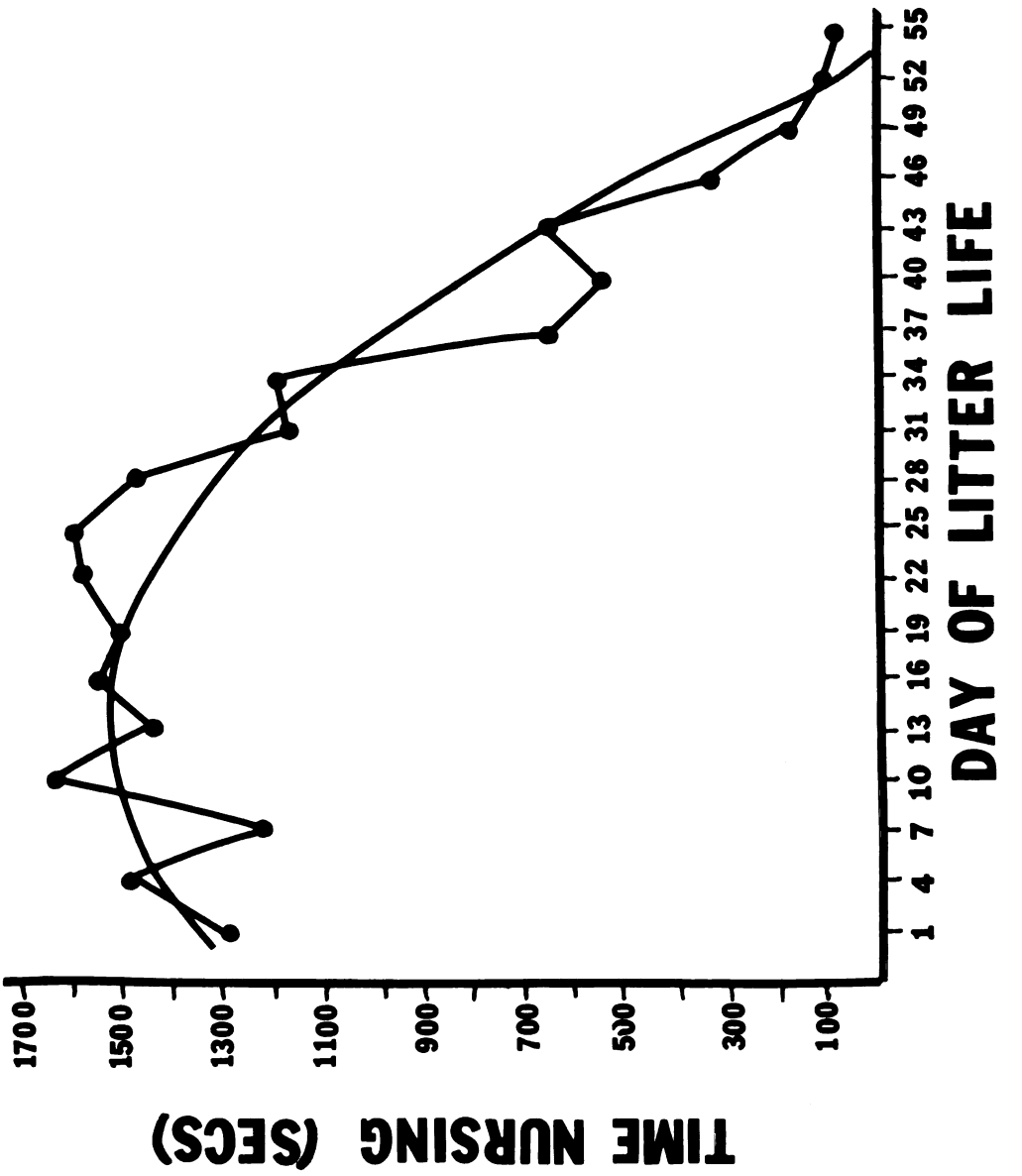

TIME NURSING (SECS)
1700
1500
1300
1100
900
700
500
300
100
1 4 7 10 13 16 19 22 25 28 31 34 37 40 43 46 49 52 55
DAY OF LITTER LIFE

Figure 6.

Figure 7. Average time spent licking each kit during 30 minutes of observation over 8 weeks (N=9).

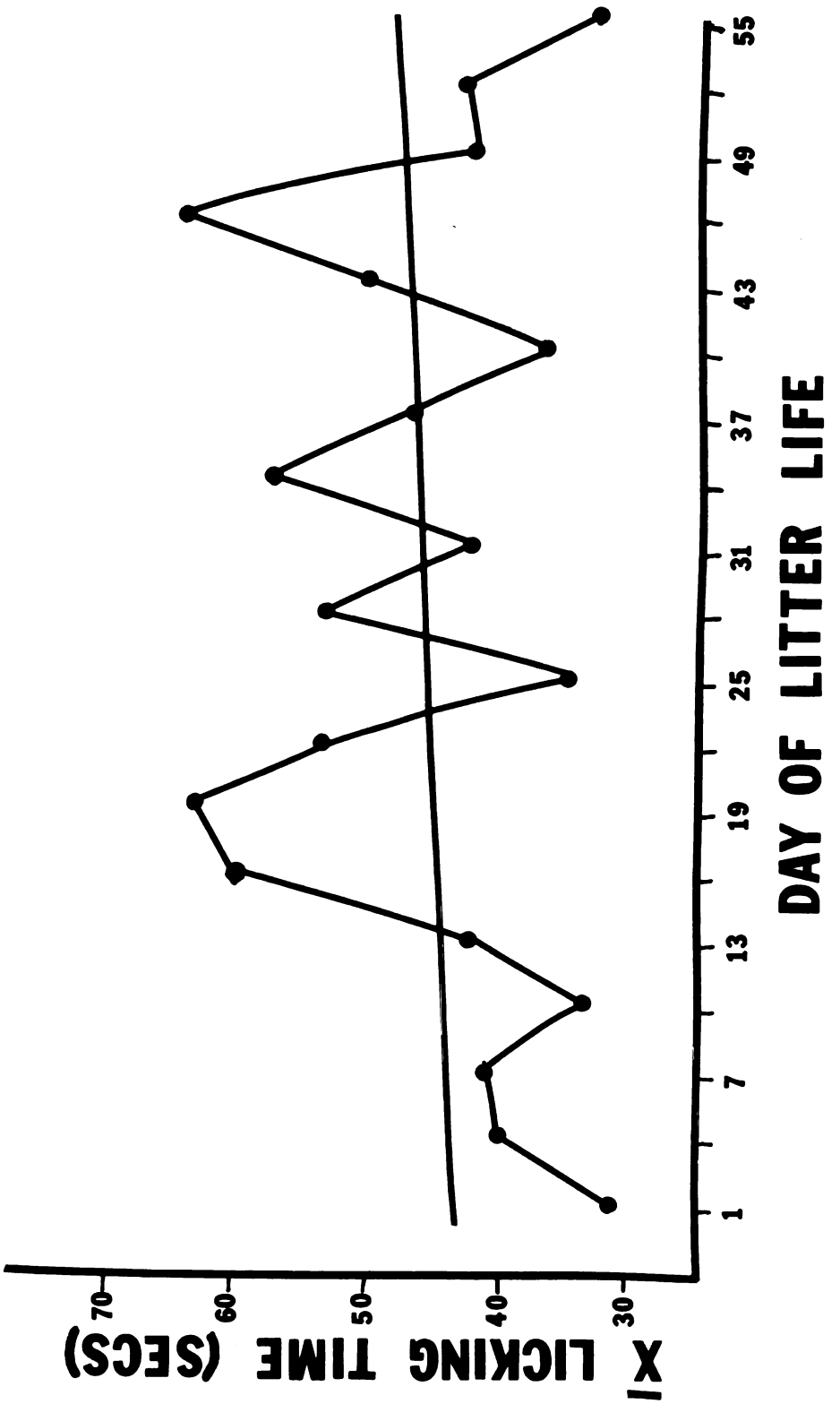

X LICKING TIME (SECS)
70
60
50
40
30
1
7
13
19
25
31
37
43
49
55
DAY OF LITTER LIFE

Figure 7.

Figure 8. Average time spent by females grooming themselves during 30 minutes of observation over 8 weeks (N=9).

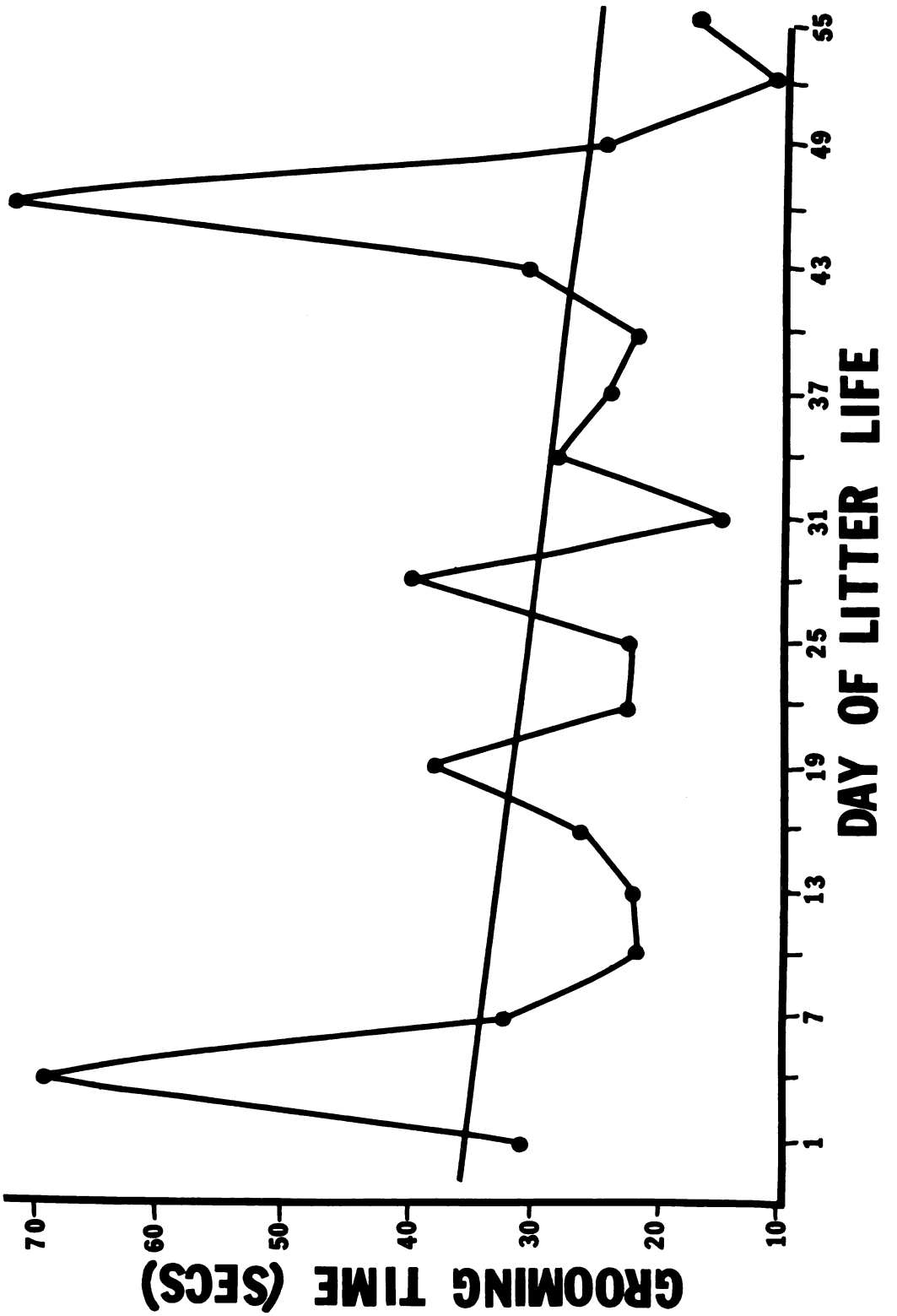

GROOMING TIME (SECS)
70
60
50
40
30
20
10
1
7
13
19
25
31
37
43
49
55
DAY OF LITTER LIFE

Figure 8.

Figure 9. Per cent of total time females spend in the nest (▲—▲), nursing the kits (△--△), licking each kit (○—○), and grooming themselves (●--●). Curves are plotted by least squares analysis, lines are linear regression analysis.

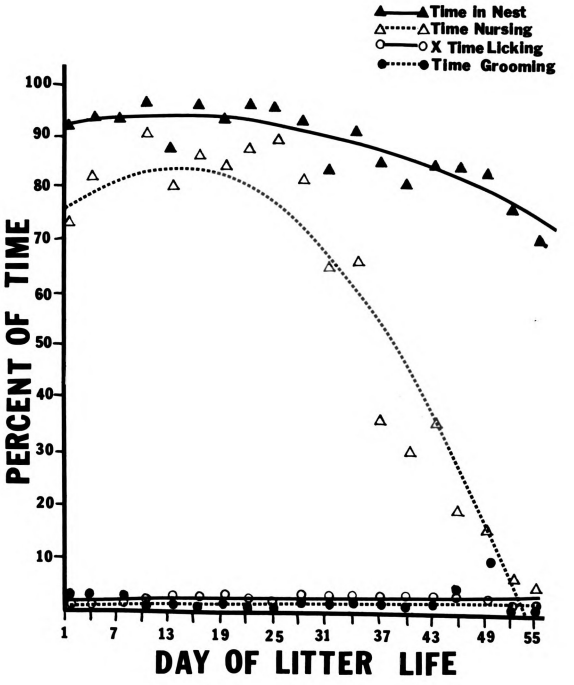

Time in Nest
Time Nursing
X Time Licking
Time Grooming
PERCENT OF TIME
100
90
80
70
60
50
40
30
20
10
1
7
13
19
25
31
37
43
49
55
DAY OF LITTER LIFE

Figure 9.

get up and turn around to the kit (which sometimes means the rest of the kits are stranded behind her back), but more often she will wait until the kit begins crawling between her legs and will then lift her leg or actually kick the kit in closer to the other babies with her leg. The female often changes positions while nursing which wakes sleeping kits which then begin searching for a nipple. Ferrets are not nipple specific, but instead grab on to the nearest nipple. Two kits often try to grab the same nipple, and if one is pushed away it will either find another nipple or go to sleep.

Nearly all nursing occurs in the nest box, although some older kits try to grab a nipple as the female walks by while they are in the cage. No really forcible weaning was ever seen to be imposed by any of the mothers. They did sometimes seem to ignore a kit that might be following trying to nurse, but no punishing was ever observed.

About 17 - 20 per cent of the female's total time is spent licking the kits, but only a fraction of this is spent on each kit. This does not change significantly over time and the female spends an average of 2.6 per cent of her time grooming each of her kits. Of course, kits are often licked and nursed at the same time.

The mothers are often seen holding a kit down or turning a kit with their front feet while washing them. Sometimes they will pull a kit closer, lick it, and then stick it between their hind legs or under their tails as if to encourage it to nurse. Occasionally a mother (normally the same two or three animals) would lick a kit and then hold it by the throat for several seconds while the kit struggled or cried or gasped for breath before being let loose. The cause of this action was never understood. Of course, a good deal of time during the first

three or four weeks is spent licking the anal region to stimulate urination and defecation, as in dogs (Scott, 1963) and many other mammals (Ewer, 1968), and to clean the area, but as the kits begin to eat solid food, the mothers lick other parts of the body more and they can often be seen washing the kits' faces. Two or three times on a very hot day a female was observed to lap some water and then to immediately lick a kit. A similar action was observed by Goethe (1940) in polecats when a female wet her belly in water and then curled up around the young. It was supposed that this action had a cooling effect.

Four-, and especially 5- and 6-week old kits often solicited licking by forcing their way between the mother and another kit that was being licked. Some kits were also seen licking their mother. One in particular licked its mother's mouth and even held her muzzle in its front paws while licking her. It may actually have been drinking her saliva as has been reported by Hamilton (1933) in Mustela frenata. The significance of this action is not understood.

Ferrets are playful animals at any age, but kits seem able to play for hours. They begin tumbling and biting each other in the nest before they are four weeks of age. The mother often joins in, unlike Mustela nivalis (East and Lockie, 1964), but she is decidedly more gentle with her kits than they are with her. They will leap at her and bite her as hard as they can while she only mouths at them in play. Much of the time, however, the female will simply sleep (or try) while her kits tumble around on top of her. A mother ferret seems very tolerant of her exuberant kits.

The amount of time the female grooms herslef appears to be unrelated to the age of the kits. Although Figure 8 shows that there was a slight

decrease through time, this was not significant ($P > 0.1$). If a female got wet or rolled in the wet food while trying to get to her kits when she was blocked from the nest box, she would lick herself much more and in two or three cases results were biased somewhat because of this.

Just before parturition the females normally become rather aggressive and remain this way to varying degrees until the kits are weaned. This aggression was not measured quantitatively, but it did vary noticeably from the females that allowed themselves or their kits to be picked up to those that would savagely attack anything that lifted the lids of their cages. This aggression did dwindle as the kits became older, but the more aggressive ones were still biting when the kits were six weeks old.

RETRIEVAL. Female ferrets are quick to retrieve their kits and seem to pay no attention whatsoever to which kit they pick up. Normally a female will enter the cage from the nest as soon as she is allowed, pick up the first kit she comes to (by the nape of the neck usually, but tiny kits are often almost completed enclosed in the mouth and are held by the back or belly), take it into the nest and deposit it, and then return almost immediately to get the next kit. After all of the kits are retrieved, she usually at least looks back into the cage as if looking for more as does Richardson's Ground Squirrel (Michener, 1971). Some females will reach as far as possible out of the nest without completely leaving it and grab as many young as they can. Only then will they go all the way into the cage to get any remaining kits. Some will deposit several kits at the door before entering the nest and pulling the kits in after them. Occasionally a female will spend a few seconds nuzzling or licking a newly retrieved kit, and very occasionally (usually during the first

few retrieval trials) will retrieve and curl up around two or three kits and forget the rest. As the kits get older, they will often return to the nest box on their own. Quite often after about four weeks of age the mother would go after the kits and herd them back rather than carry them. Females have been seen, however, actually carrying 6 1/2 - 7-week old kits, and it was common to see females with kits old enough to eat solid food trying desperately to keep them from leaving the nest. On the other hand, they often left kits that were in the process of defecating or eating in the cage either until they were done (and usually returned on their own), or at least for several seconds or even minutes before they would pull them away.

Ferret kits do often vocalize (a squeaking noise), which sometimes does attract the female, at least initially. Often, however, the mother ignores the cries, but whether this is due to a disturbance by the observer, a "laziness" due to domestication, or something completely different is not known.

GROWTH:

Figure 10 and Table 2 show the increase in weight of ferrets from birth to 16 weeks and Figures 11-13 and Tables 3-6 show growth of body length, tail length, foot length and ear length, respectively. An F-test showed that males and females did not begin to differ in size until Week 7 for body weight, foot length and ear length and until Week 9 for body length and tail length ($P < .05$). At this point the males grew faster and leveled off somewhat later than the females (two or three weeks later for ear, foot and tail length--body length and weight were still increasing slightly at 16 weeks). Body weight increased steadily until 4-5 weeks of age (which coincides with the time the kits begin to eat solid food)

Figure 10. Body weight of male and female ferrets from birth to 16 weeks. $P < .05$ at Week 7.

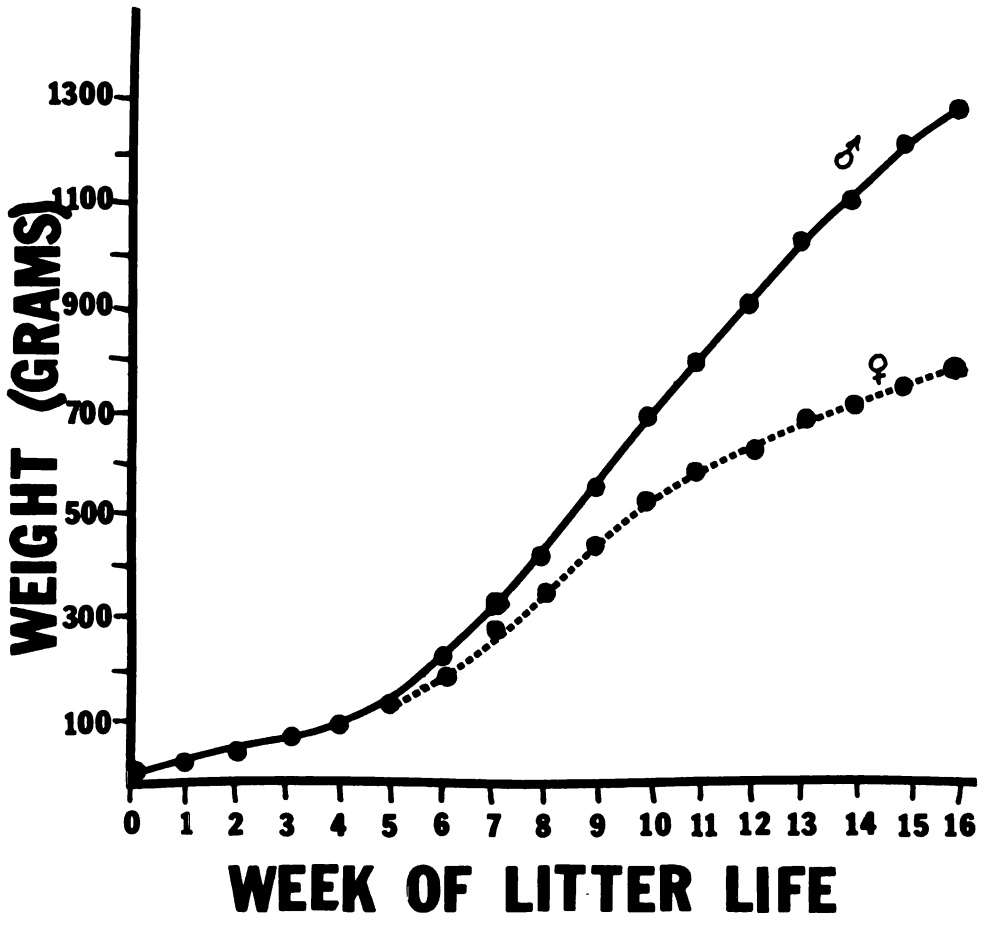

1300
1100
900
700
500
300
100
WEIGHT (GRAMS)
♂
♀
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
WEEK OF LITTER LIFE

Figure 10.

Table 2. Body weight (grams) ± standard error with range and sample size for male and female ferrets to 16 weeks of age.

	♂				♀			
WEEK	$\bar{x}$	S.E.	RANGE	N	$\bar{x}$	S.E.	RANGE	N
0	9.58	0.49	5.8- 14.8	24	9.51	0.47	5.1- 13.9	27
1	31.00	1.23	15.8- 43.5	35	28.63	0.94	18.8- 36.4	30
2	63.80	1.74	24.3- 79.4	45	56.89	1.46	31.5- 72.4	42
3	87.60	2.69	47.5- 120.4	52	80.43	2.20	43.2-106.6	55
4	110.85	5.08	53.4- 157.8	36	109.62	4.34	53.5-165.0	44
5	156.20	8.29	70.0- 240.7	31	145.08	5.68	77.2-216.6	34
6	223.54	10.91	89.9- 325.3	36	205.65	7.72	101.5-307.1	33
7	340.57	11.60	194.4- 457.4	44	309.65	7.78	150.0-393.8	41
8	433.36	12.23	218.4- 595.6	53	356.33	7.61	152.4-465.1	51
9	551.48	13.17	386.1- 686.0	52	445.53	9.08	173.3-540.0	49
10	694.82	15.76	469.6- 832.3	50	542.03	7.47	385.1-654.4	48
11	809.62	16.10	550.0- 975.8	52	587.24	9.35	420.0-743.1	48
12	903.02	14.66	667.1-1032.9	52	626.65	9.62	497.8-844.1	48
13	1024.24	15.77	770.0-1186.0	52	699.44	8.14	544.5-855.5	48
14	1112.19	15.56	857.7-1287.1	52	719.46	8.50	546.5-855.3	48
15	1215.39	16.42	942.9-1382.5	52	760.61	9.25	592.4-844.5	48
16	1284.02	18.95	982.5-1654.4	52	789.25	10.84	625.8-942.4	48

Figure 11. Body length of male and female ferrets from birth to 16 weeks. $P < .05$ at Week 9.

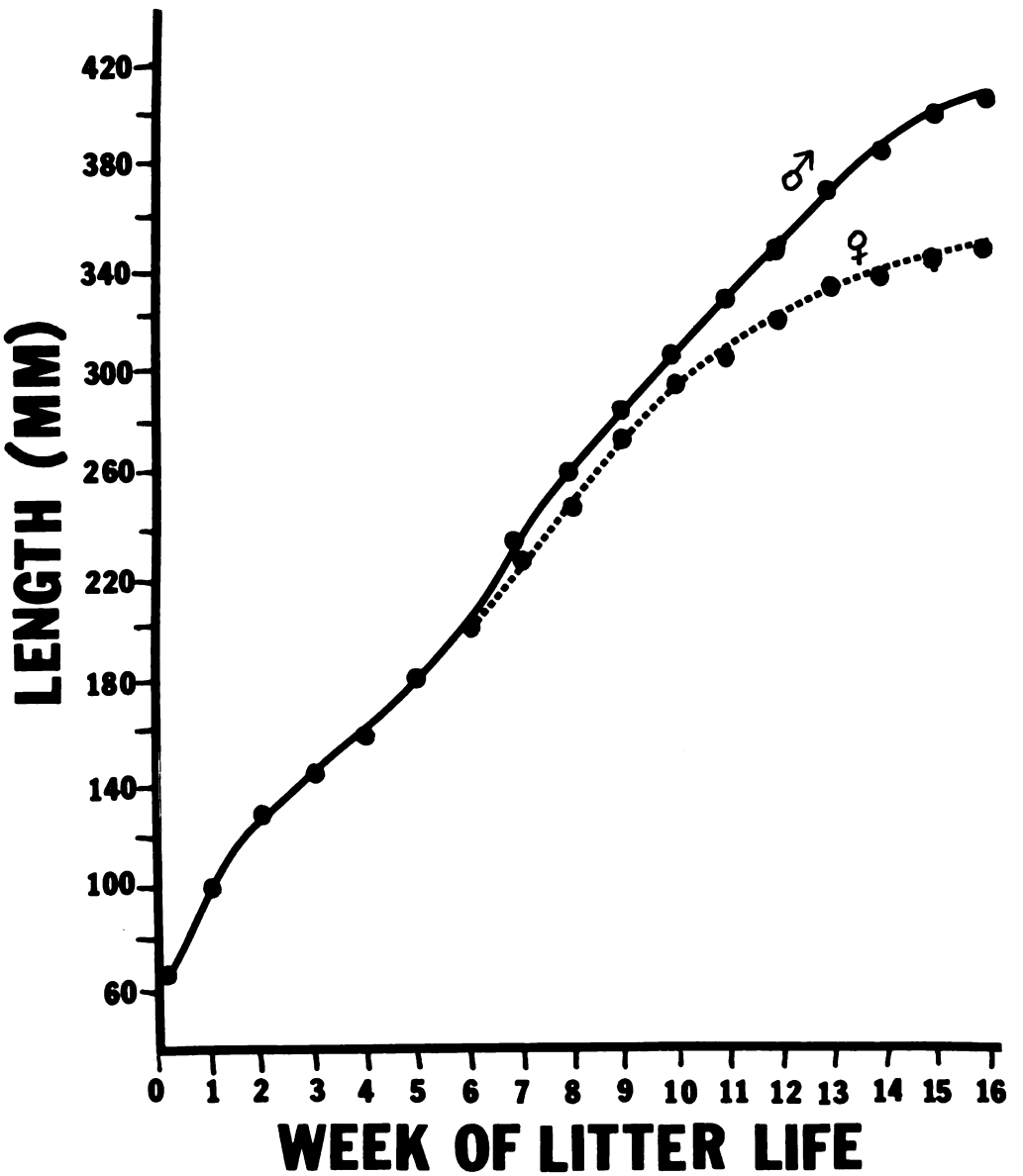

LENGTH (MM)
420
380
340
300
260
220
180
140
100
60
♂
♀
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
WEEK OF LITTER LIFE

Figure 11.

Table 3. Body length (mm) ± standard error, with range and sample size for male and female ferrets to 16 weeks of age.

	♂				♀			
WEEK	$\bar{x}$	S.E.	RANGE	N	$\bar{x}$	S.E.	RANGE	N
0	66.67	0.90	60- 88	24	66.67	0.89	57- 79	27
1	100.60	1.68	82-113	35	99.43	1.45	82-113	30
2	129.60	1.63	90-143	45	127.05	1.40	105-143	42
3	145.27	1.78	112-172	52	142.67	1.40	117-158	55
4	156.08	2.48	117-185	36	157.66	2.34	123-187	44
5	178.06	3.30	131-203	31	177.47	2.72	143-202	34
6	198.06	4.01	134-230	36	200.06	3.71	146-228	33
7	231.80	3.64	171-265	44	233.54	2.69	187-261	41
8	247.17	3.66	202-285	54	245.55	3.23	199-280	51
9	286.31	3.78	223-370	52	275.35	2.86	245-305	49
10	307.96	3.65	262-370	50	296.38	3.41	260-325	48
11	328.98	3.04	290-370	52	306.23	3.09	260-325	48
12	347.69	3.23	305-400	52	320.81	2.31	285-370	48
13	369.65	2.85	335-410	52	333.92	1.92	300-370	48
14	384.04	2.16	360-415	52	336.62	1.58	315-370	48
15	396.06	2.40	365-425	52	346.15	1.51	305-370	48
16	404.04	2.91	375-440	52	348.12	1.68	315-375	48

Figure 12. Tail length of male and female ferrets from birth to 16 weeks. $P < .05$ at Week 9.

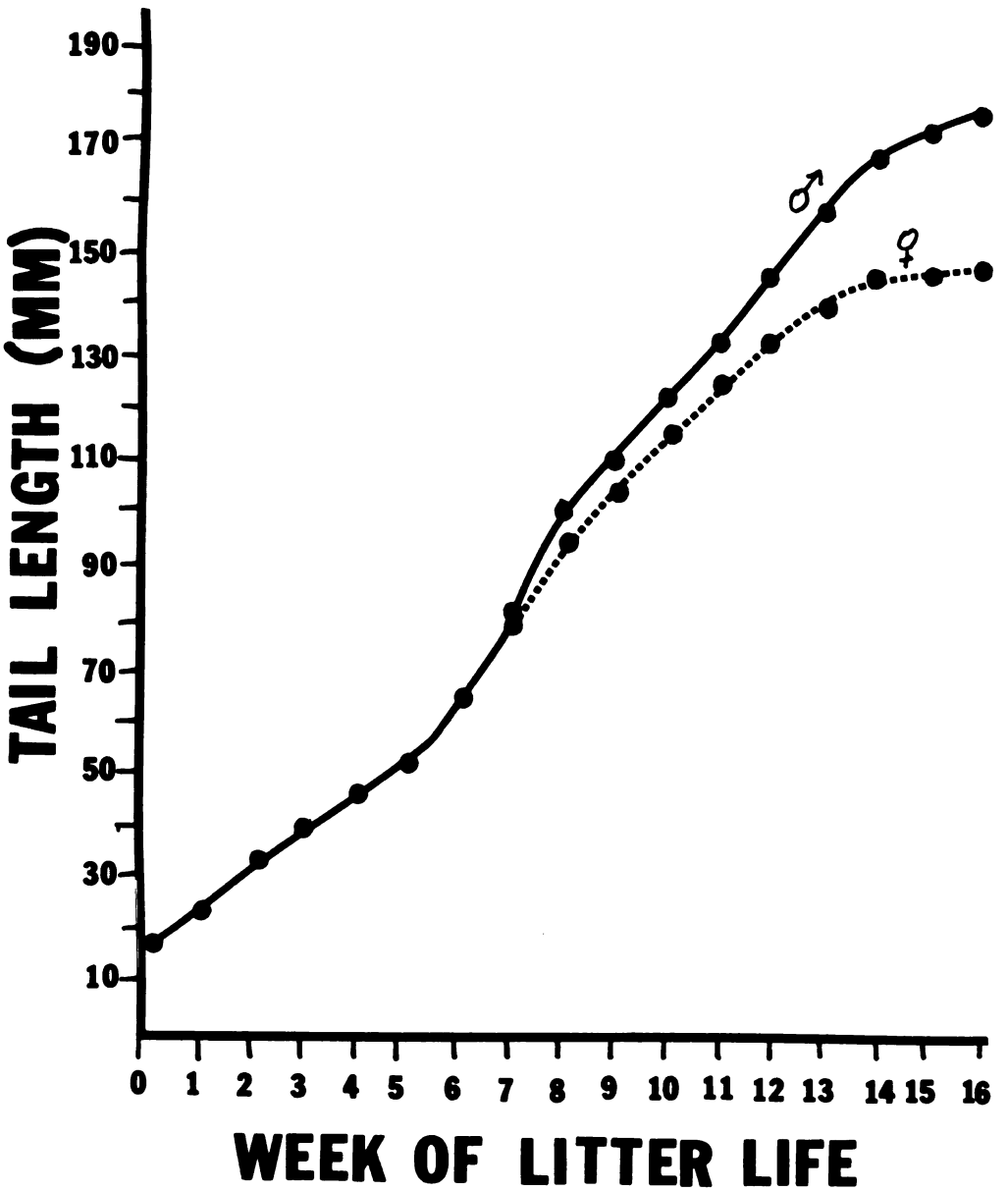

TAIL LENGTH (MM)
190
170
150
130
110
90
70
50
30
10
♂
♀
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
WEEK OF LITTER LIFE

Figure 12.

Table 4. Tail length (mm) ± standard error, with range and sample size for male and female ferrets to 16 weeks of age.

	♂				♀			
WEEK	$\bar{x}$	S.E.	RANGE	N	$\bar{x}$	S.E.	RANGE	N
0	16.71	0.36	14- 21	24	16.85	0.35	14- 20	27
1	23.53	0.43	17- 29	34	22.97	0.37	20- 27	30
2	32.26	0.46	24- 38	43	31.48	0.44	25- 38	42
3	38.41	0.75	22- 48	51	38.20	0.55	27- 46	54
4	44.60	1.27	28- 58	35	44.57	0.86	30- 53	44
5	48.13	2.38	30- 70	30	49.59	1.13	35- 65	34
6	63.80	2.10	35- 85	35	63.09	1.61	41- 80	33
7	78.95	2.03	45-100	44	78.95	1.54	55- 98	41
8	97.10	1.82	65-115	52	94.25	1.34	68-110	51
9	107.80	1.93	84-145	50	102.37	1.38	71-120	49
10	121.19	2.17	95-150	48	114.58	1.45	90-140	48
11	134.88	2.22	107-160	50	124.10	1.47	100-140	48
12	148.08	2.10	114-180	50	132.58	1.33	110-150	48
13	157.41	1.90	120-180	51	139.00	1.18	120-155	48
14	165.59	2.13	125-195	51	144.38	1.44	130-180	48
15	171.86	2.18	125-200	51	144.48	1.25	130-180	48
16	175.98	2.00	130-200	51	146.15	1.30	130-180	48

Figure 13. Hind foot length and ear length of male and female ferrets from birth to 16 weeks. $P < .05$ at Week 7.

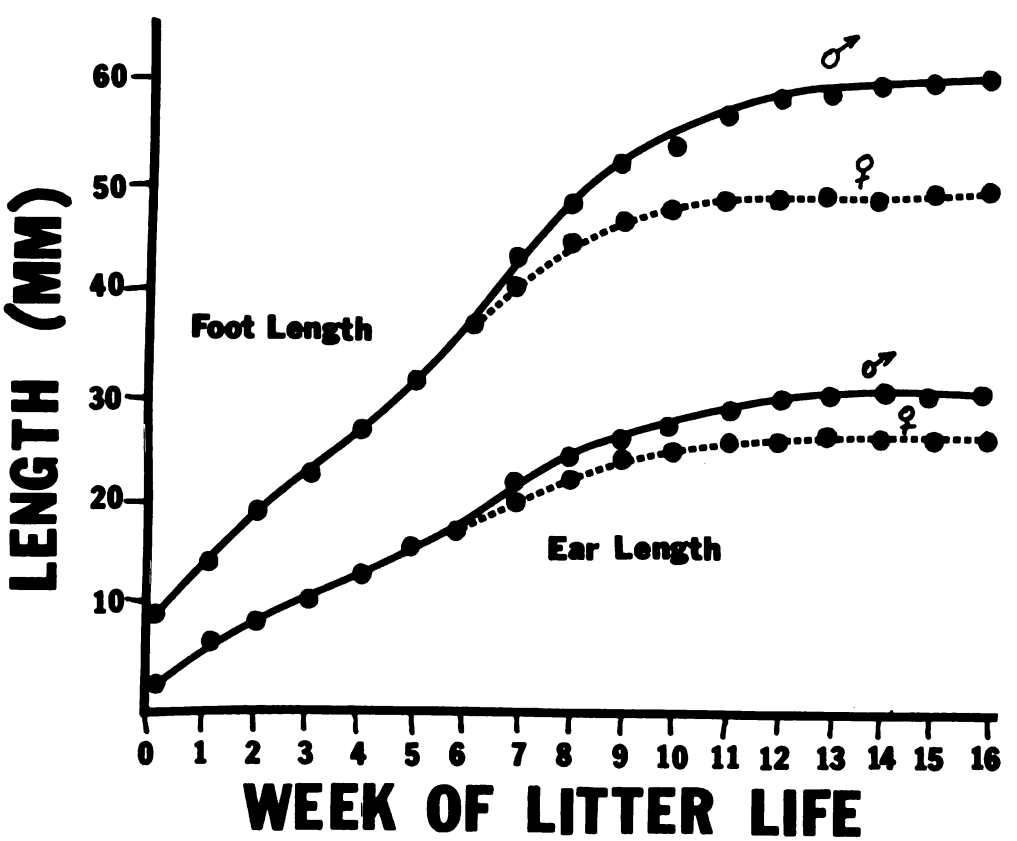

LENGTH (MM)
60
50
40
30
20
10
♂
♀
Foot Length
♂
♀
Ear Length
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
WEEK OF LITTER LIFE

Figure 13.

Table 5. Hind foot length (mm) ± standard error, with range and sample size for male and female ferrets to 16 weeks of age.

	♂				♀			
WEEK	$\bar{x}$	S.E.	RANGE	N	$\bar{x}$	S.E.	RANGE	N
0	8.92	0.15	8-10	24	8.65	0.14	7-10	27
1	13.51	0.24	11-17	35	13.20	0.21	10-15	30
2	18.49	0.23	14-21	45	17.60	0.20	15-20	42
3	22.44	0.29	17-26	52	21.85	0.26	15-25	55
4	26.50	0.59	18-33	36	26.25	0.43	18-31	44
5	31.19	0.78	22-37	31	30.32	0.53	22-34	34
6	36.97	0.86	24-45	36	36.15	0.58	26-40	33
7	43.34	0.70	32-50	44	40.95	0.46	31-45	41
8	48.20	0.50	37-54	54	45.06	0.39	38-50	51
9	51.77	0.49	44-59	52	46.82	0.40	38-50	49
10	53.58	0.45	47-59	50	47.81	0.24	44-50	48
11	56.92	0.40	52-61	52	49.00	0.21	46-52	48
12	57.63	0.41	53-62	52	49.04	0.30	46-52	48
13	58.81	0.34	54-63	52	49.54	0.36	45-57	48
14	59.85	0.31	55-63	52	49.85	0.24	47-57	48
15	59.87	0.28	55-64	52	50.08	0.29	45-57	48
16	60.15	0.31	55-64	52	49.98	0.24	45-57	48

Table 6. Ear length (mm) ± standard error, with range and sample size for male and female ferrets to 16 weeks of age.

	♂				♀			
WEEK	$\bar{x}$	S.E.	RANGE	N	$\bar{x}$	S.E.	RANGE	N
0	2.23	0.06	2- 3	24	2.15	0.06	2- 3	27
1	5.86	0.11	5- 7	35	5.98	0.14	5- 7	30
2	8.76	0.14	7-10	45	8.55	0.12	7-10	42
3	10.58	0.17	8-12	52	10.45	0.12	8-12	55
4	13.28	0.29	9-16	36	12.84	0.17	10-15	44
5	15.35	0.26	11-18	31	14.97	0.22	11-16	34
6	17.89	0.43	13-23	36	17.45	0.30	14-22	33
7	21.30	0.30	17-25	44	20.51	0.23	17-23	41
8	23.74	0.24	20-28	54	22.24	0.22	18-26	51
9	25.42	0.27	20-28	52	23.96	0.24	20-27	49
10	27.06	0.22	24-30	50	24.85	0.19	20-27	48
11	28.52	0.19	25-31	52	25.60	0.17	23-28	48
12	29.08	0.21	25-32	52	25.79	0.16	23-28	48
13	29.83	0.17	28-33	52	26.29	0.17	24-29	48
14	30.00	0.16	28-33	52	25.83	0.16	24-29	48
15	30.14	0.17	28-33	51	26.33	0.16	25-29	48
16	30.41	0.18	29-34	51	26.19	0.13	24-29	48

when this increase became slightly sharper (Figures 14 and 15).

Newborn kits weigh one per cent or less of the adult weight and have fine white hair all over their bodies. The pink skin is thin enough to see some of the dark outlines of the internal organs. The necks are quite long with a fat pad on the back of the neck and the kits stay slightly curled up most of the time. The young seem better able to use their front legs than their hind legs and, unlike rat pups, which are incapable of initiating suckling (Rosenblatt, 1970), they are able to pull themselves to the female remarkably well.

By about the third day the hair is thicker and visibly gray (or white if albino), but the color is uniform. The hair is somewhat longer on the neck and head than elsewhere by about the end of the first week. This is also found in the ermine (Mustela erminea) which carries its young by the nape of the neck (Ewer, 1973) as does the ferret. Mustela nivalis and M. frenata, which have been seen picking up their young by the middle of the back, do not have this neck mane. The fat pad on the back of the neck undoubtedly protects the kits when carried in this fashion. Characteristic dark markings begin to appear between the third and fourth weeks but are not really prominent until the kits are nearly five weeks old.

Eyes and ears begin opening at approximately the same time--usually around 28 days. Occasionally the eyes begin opening a little earlier. Both eyes are normally open by Day 36 or 37. Females often "chuck" to their kits, but chucking was very seldom heard more than about a week before normal ear opening.

The deciduous canines begin to appear about Day 14 and are normally completely through the gums by Day 18 or 19. The premolars begin to

Figure 14. Adult male (at top) and female ferrets showing difference in size.

Figure 15. Ferret kits of different ages. (Top row, l. to r.: 42 days, 36 days, 26 days of age. Bottom row, l. to r.: 15 days, 11 days, 6 days, 4 days of age.)

Figure 14.

Figure 15.

emerge by this time. No deciduous incisors were seen, but these were not watched as closely as they might have been and their presence may have been temporary. However, permanent canines appear before the deciduous canines fall out and are visible by 47-52 days; the deciduous ones fall out between 56-70 days.

The kits begin to eat solid food fairly regularly by 4 1/2-5 weeks of age, although one litter was observed in the cage eating from the food plate as early as 18 days on a very warm sunny day. Some kits were seen lying in their cage (which is much more open and airy than the nest box) on very hot days when they were only 14 days old, but no eating was observed. The mothers were first observed taking food into the nest boxes when the kits were about 23 days old, but food was seen in the nests five or six days before this a couple of times.

The kits begin to defecate without stimulation from the females about the time they begin eating solid food. They definitely are able to do this by the time they are four weeks old and two kits were observed defecating in the nests at 23 days. Up until this time, the mother licks the anal region to stimulate defecation and urination.

EXPERIENCE EFFECTS:

Using a two-way univariate analysis of variance (with experience of the female and fostering as the two variables), it was found there were no significant differences ($P > .05$) between primiparous and multiparous ferrets in time spent in the nest, nursing, licking or grooming (see Figures 16-19). There was a difference, however, in latency of retrieval and time to retrieve kits ($.01 < P. < 05$) on the first test day. As can be seen in Figures 20 and 21 this difference decreased rapidly so that there was no difference for either measure on the second test day. After this,

both retrieval time and retrieval latency remained rather constant until the kits were close to four weeks of age at which time they began returning to the nest box on their own and the mother often did not even go after them. This accounts for the strange data points after Day 25 in Figures 20 and 26.

The amount of time spent in the nest decreased significantly ($.05 < P < 0.1$) and at approximately the same rate for the two groups. The time spent by each group nursing increased slightly between Day 14 and Day 23 and then began to decrease significantly ($P < .01$) until there was essentially no nursing at 41 days when the kits were weaned. The amount of time licking also decreased ($P < .01$) steadily over the four weeks. Grooming time, however, did not change significantly ($P > .05$) for either group. The statistical tests showed no interactions in any of the measures.

FOSTERING EFFECTS:

Fostering had no effect ($P > .05$) on how the ferrets treated their entire litters for any of the six variables studied according to a two-way univariate analysis of variance (see Figures 22-27). Differences in amount of time spent licking and nursing and rate of retrieval of the kits that belonged to the females with mixed litters and those that were fostered were also tested. No significant differences ($P > .05$) in these parameters were found. A split-plot factorial analysis of variance also showed that there were no differences in growth rates of fostered or nonfostered kits.

Retrieval times for two females with young kits were also tested with other kits of different ages. Retrieval was nearly immediate except in one case where the alien kit was six weeks old and one female's own young were one week old. In this case, the female reached out and bit the unrelated kit. One female that was pregnant for the first time was

Figure 16. Average time spent by multiparous (N=9) and primiparous (N=10) females in the nest.

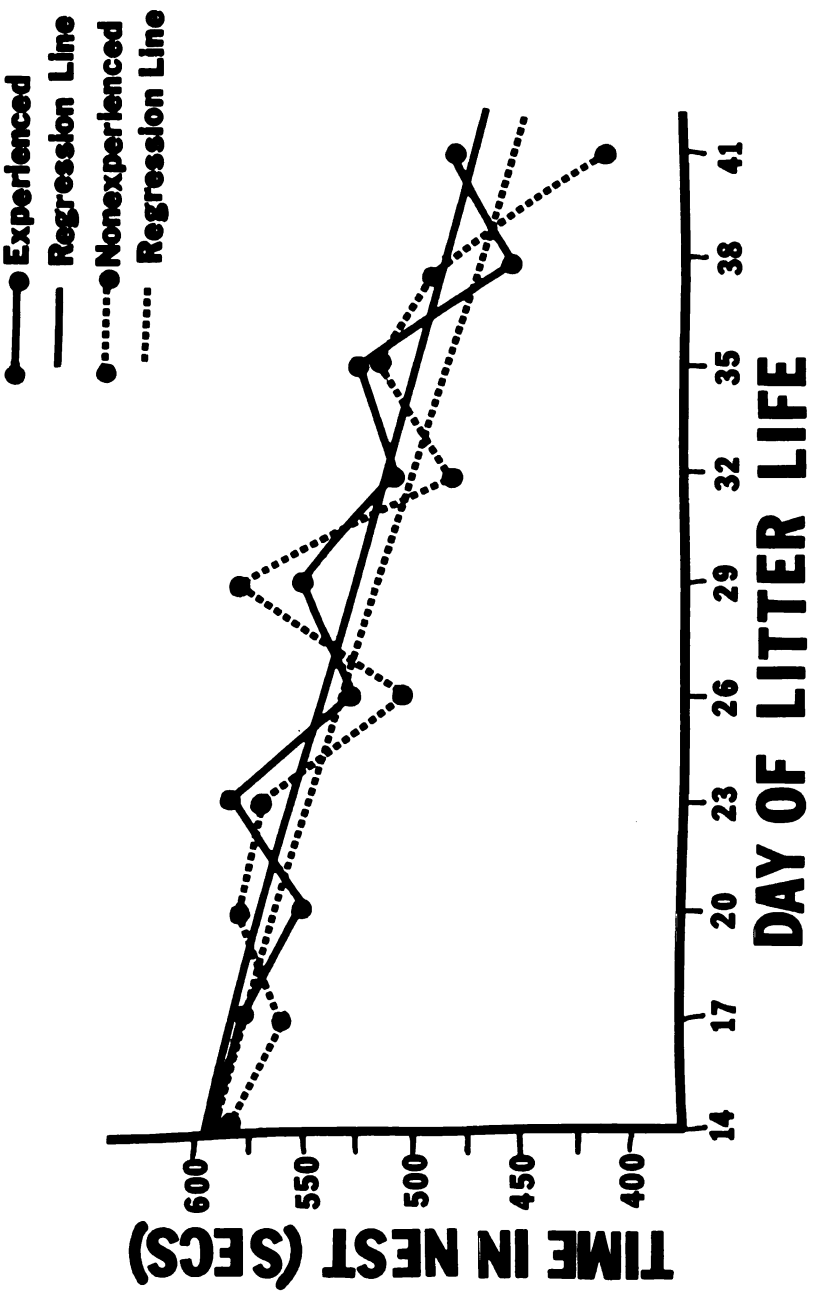

Experienced
Regression Line
Nonexperienced
Regression Line
TIME IN NEST (SECS)
600
550
500
450
400
14
17
20
23
26
29
32
35
38
41
DAY OF LITTER LIFE

Figure 16.

Figure 17. Average time spent by multiparous (N=9) and primiparous (N=10) females nursing each kit.

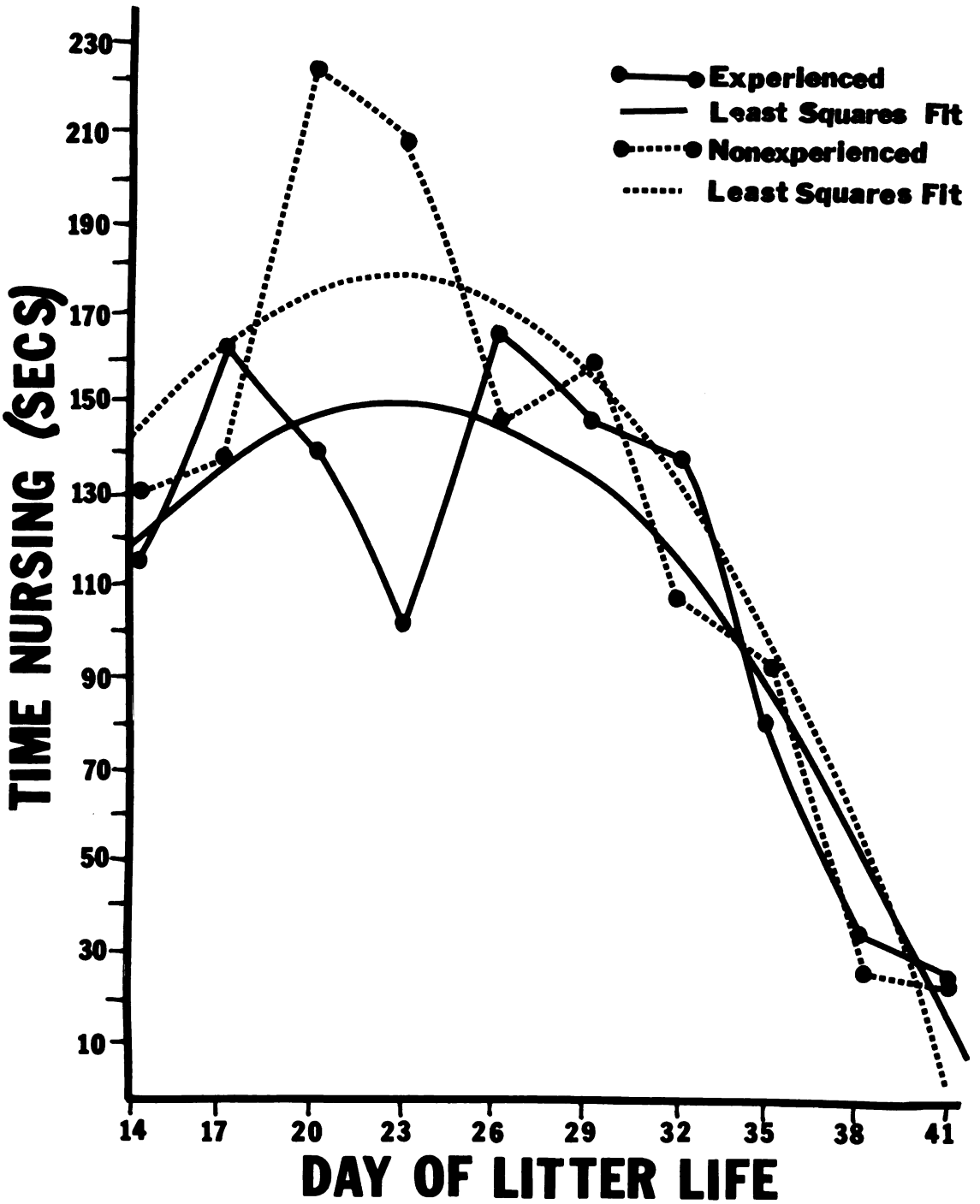

Experienced
Least Squares Fit
Nonexperienced
Least Squares Fit
TIME NURSING (SECS)
230
210
190
170
150
130
110
90
70
50
30
10
14
17
20
23
26
29
32
35
38
41
DAY OF LITTER LIFE

Figure 17.

Figure 18. Average time spent by multiparous (N=9) and primiparous (N=10) females licking each kit.

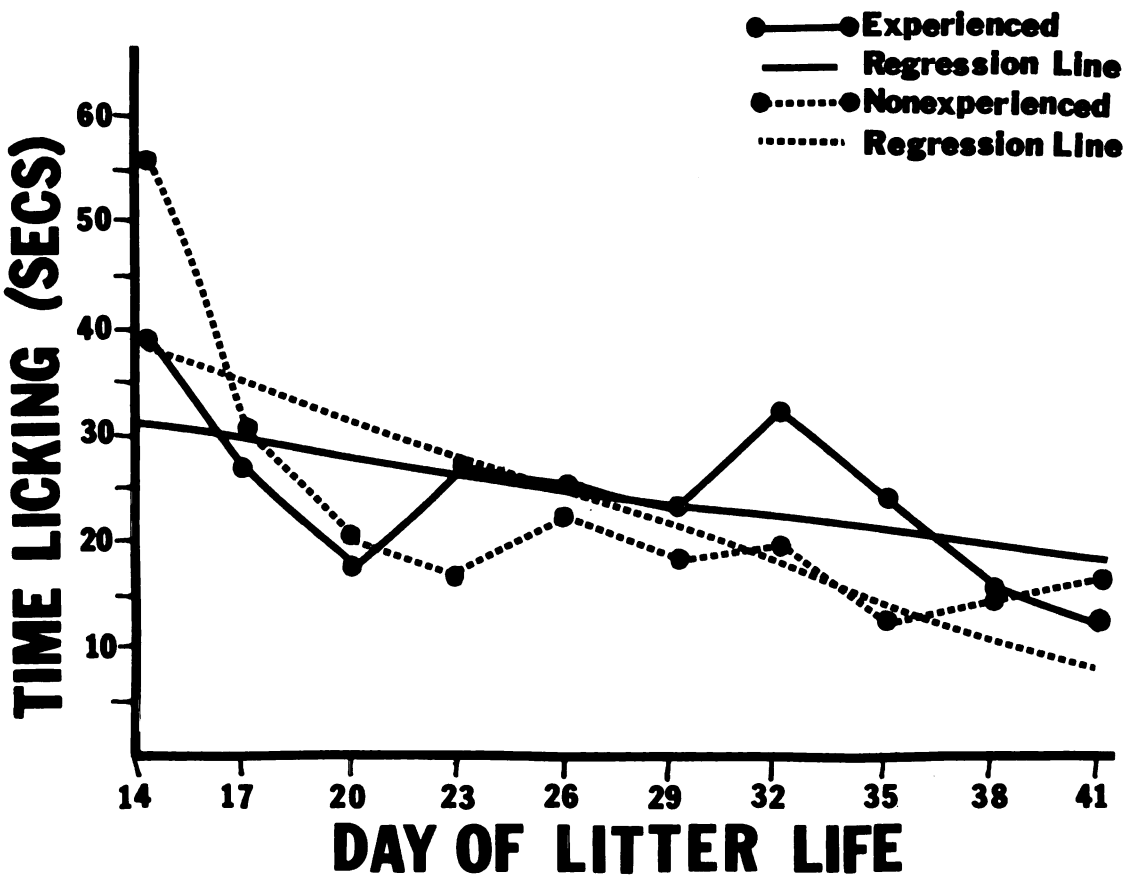

Experienced
Regression Line
Nonexperienced
Regression Line
TIME LICKING (SECS)
60
50
40
30
20
10
14
17
20
23
26
29
32
35
38
41
DAY OF LITTER LIFE

Figure 18.

Figure 19. Average time spent by multiparous (N=9) and primiparous (N=10) females grooming themselves.

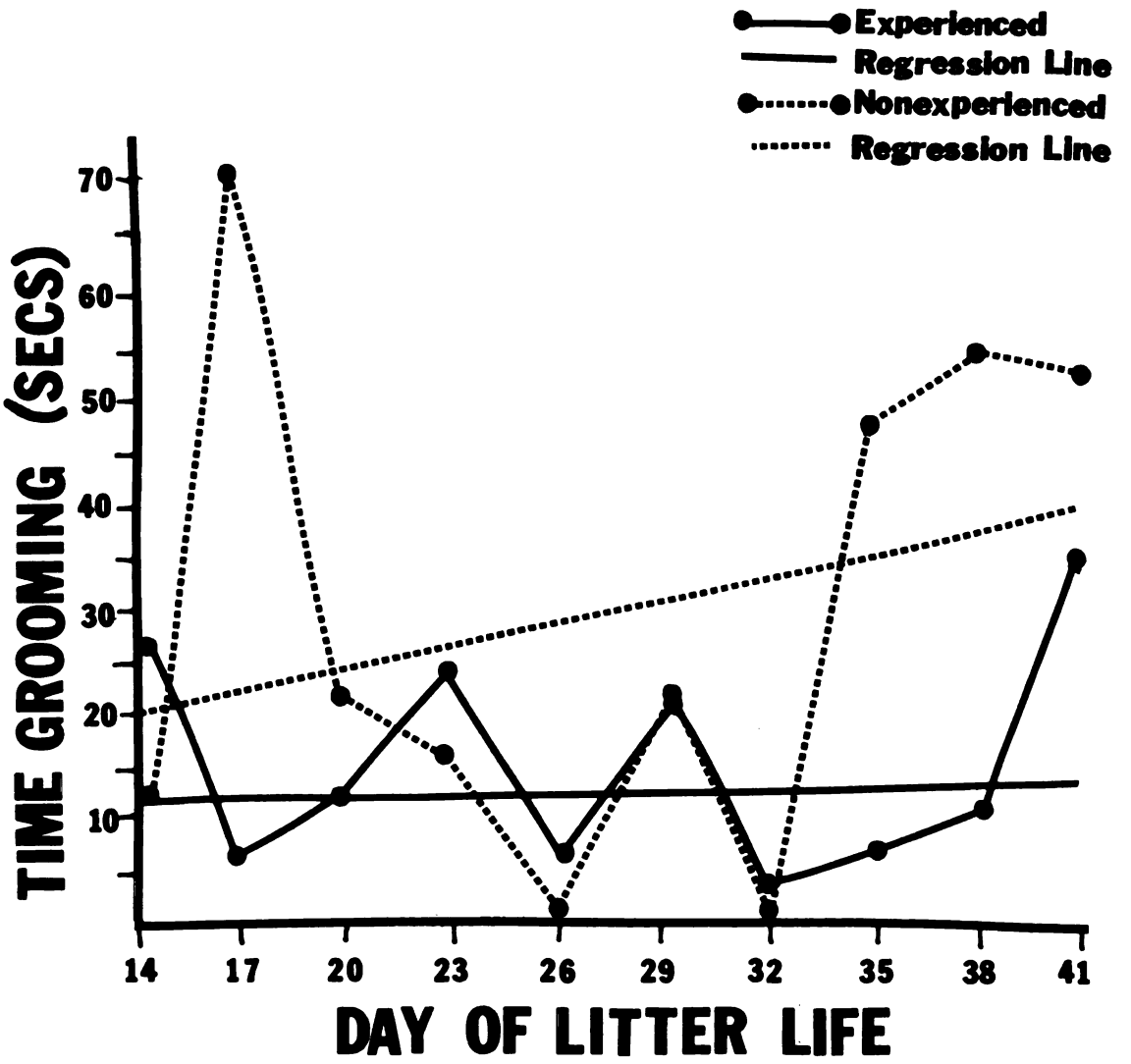

Experienced
Regression Line
Nonexperienced
Regression Line
TIME GROOMING (SECS)
70
60
50
40
30
20
10
14
17
20
23
26
29
32
35
38
41
DAY OF LITTER LIFE

Figure 19.

Figure 20. Average latency to retrieve the first kit of multiparous (N=9) and primiparous (N=10) females.

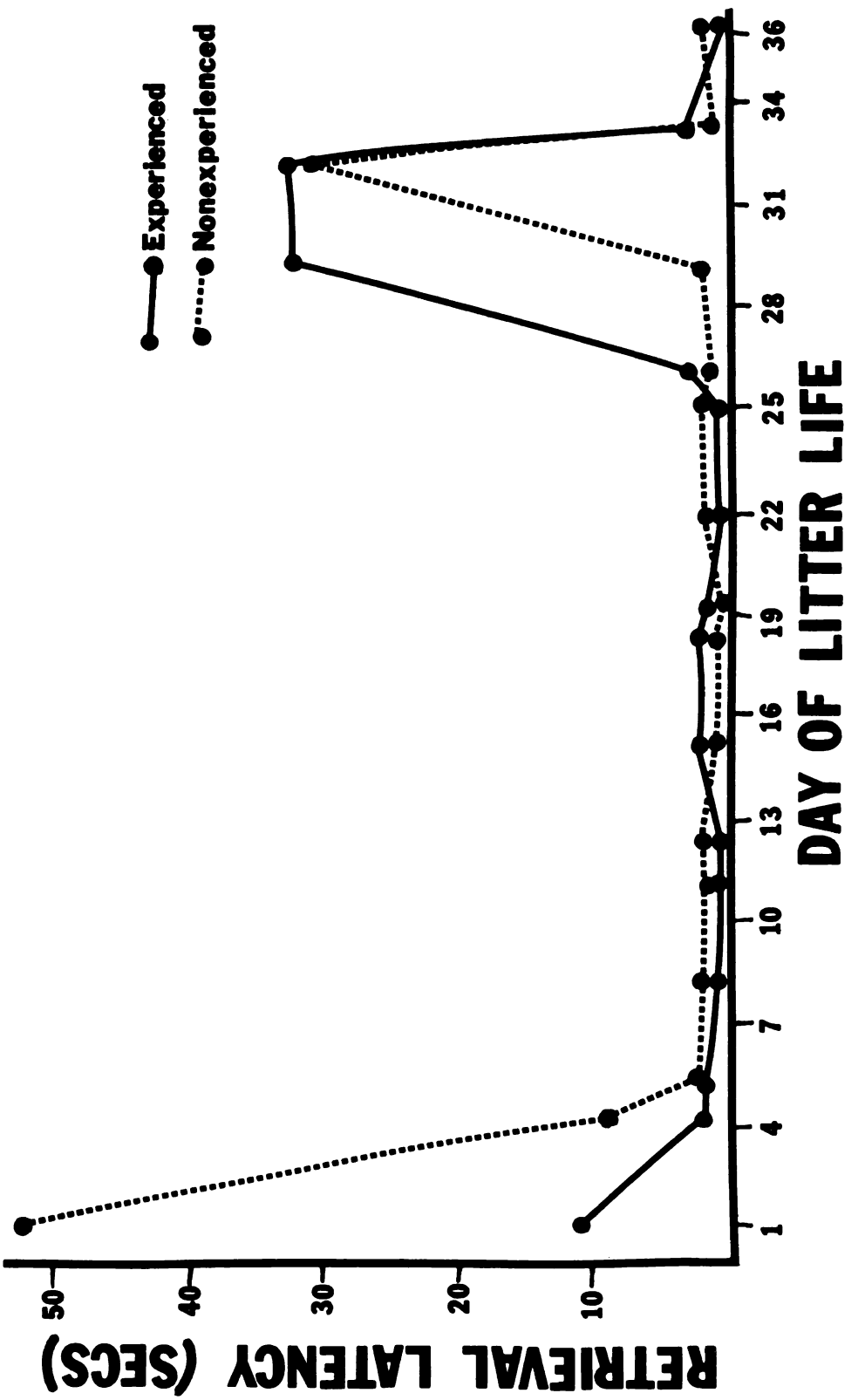

Experienced
Nonexperienced
RETRIEVAL LATENCY (SECS)
10
20
30
40
50
DAY OF LITTER LIFE
1
4
7
10
13
16
19
22
25
28
31
34
36

Figure 20.

Figure 21. Average time to retrieve each kit by multiparous (N=9) and primiparous (N=10) females.

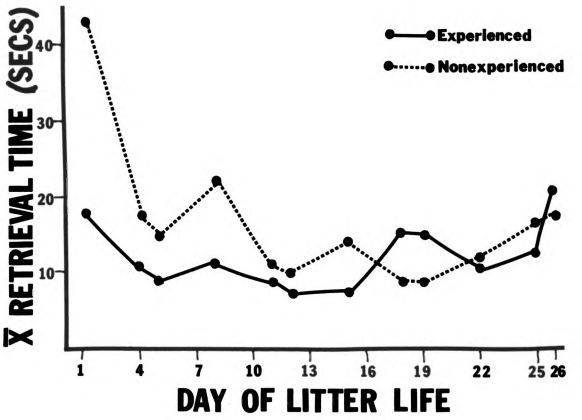

X RETRIEVAL TIME (SECS)
40
30
20
10
Experienced
Nonexperienced
1
4
7
10
13
16
19
22
25
26
DAY OF LITTER LIFE

Figure 21.

Figure 22. Average time spent in the nest by females with their own litters (N=9) and females with mixed litters (N=10).

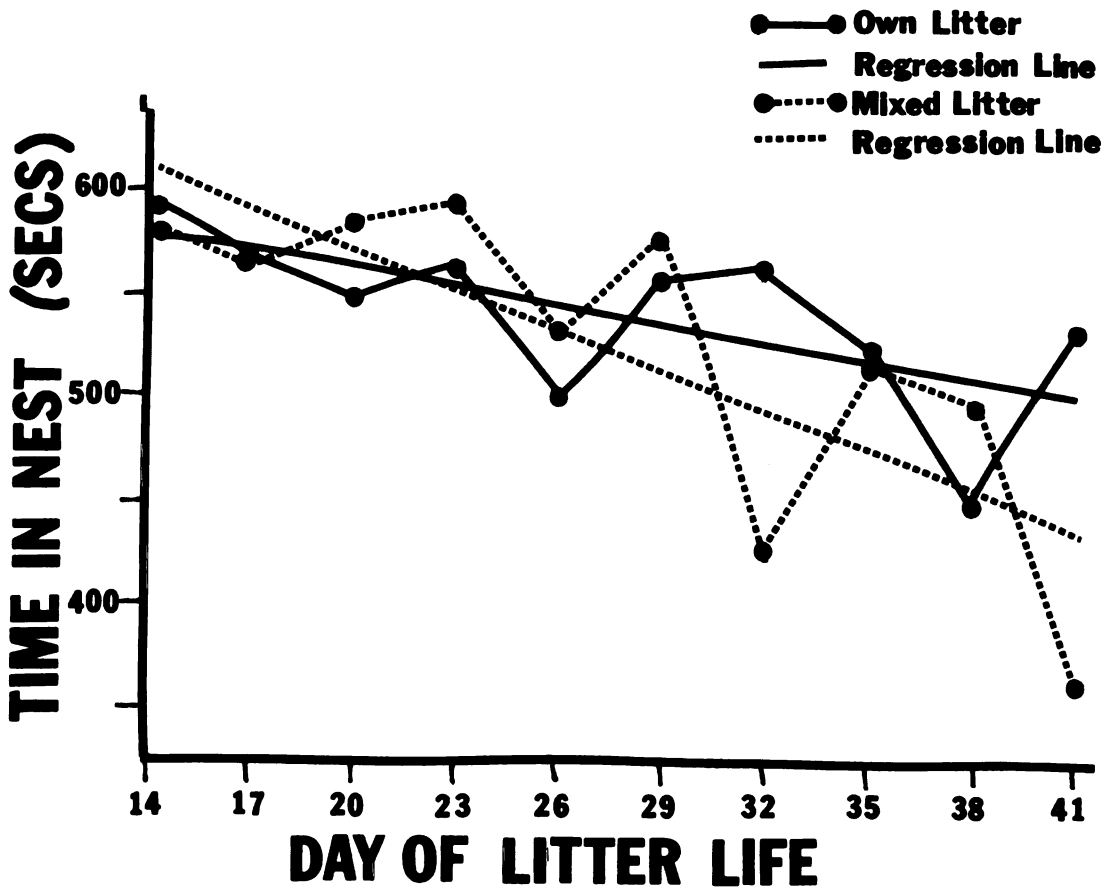

Own Litter
Regression Line
Mixed Litter
Regression Line
TIME IN NEST (SECS)
600
500
400
14
17
20
23
26
29
32
35
38
41
DAY OF LITTER LIFE

Figure 22.

Figure 23. Average time spent nursing each kit by females with their own litters (N=9) and females with mixed litters (N=10).

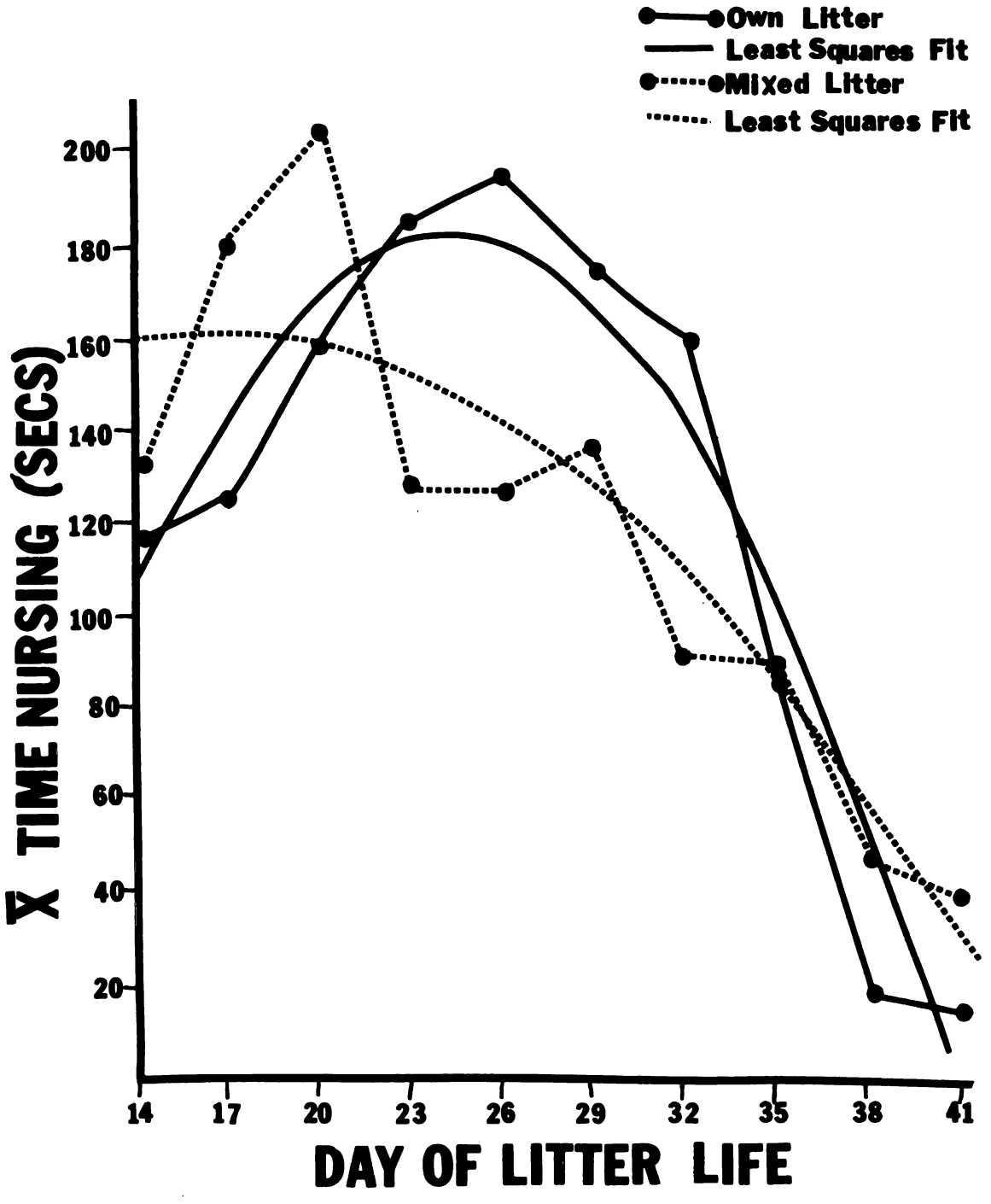

Own Litter
Least Squares Fit
Mixed Litter
Least Squares Fit
X TIME NURSING (SECS)
200
180
160
140
120
100
80
60
40
20
14
17
20
23
26
29
32
35
38
41
DAY OF LITTER LIFE

Figure 23.

Figure 24. Average time spent licking each kit by females with their own litters (N=9) and females with mixed litters (N=10).

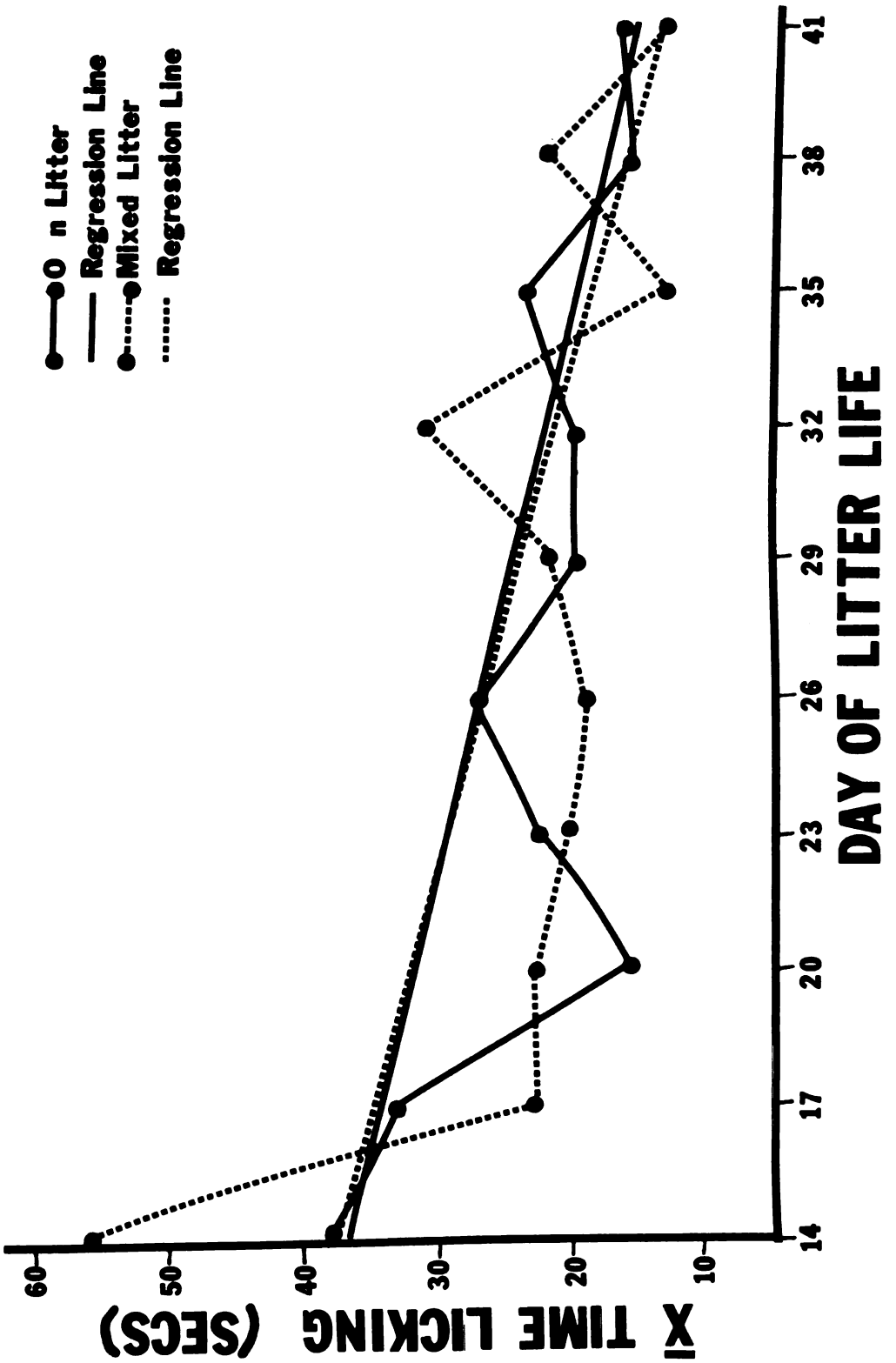

O n Litter
Regression Line
Mixed Litter
Regression Line
X TIME LICKING (SECS)
60
50
40
30
20
10
14
17
20
23
26
29
32
35
38
41
DAY OF LITTER LIFE

Figure 24.

Figure 25. Average time spent grooming themselves by females with their own litters (N=9) and females with mixed litters (N=10).

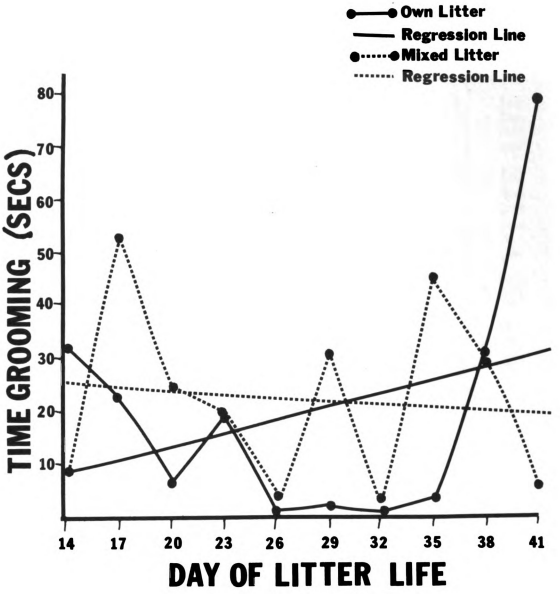

Own Litter
Regression Line
Mixed Litter
Regression Line
TIME GROOMING (SECS)
80
70
60
50
40
30
20
10
14
17
20
23
26
29
32
35
38
41
DAY OF LITTER LIFE

Figure 25.

Figure 26. Average latency to retrieve the first kit of females with their own litters (N=9) and females with mixed litters (N=10). Before Day 14 all females have their own kits.

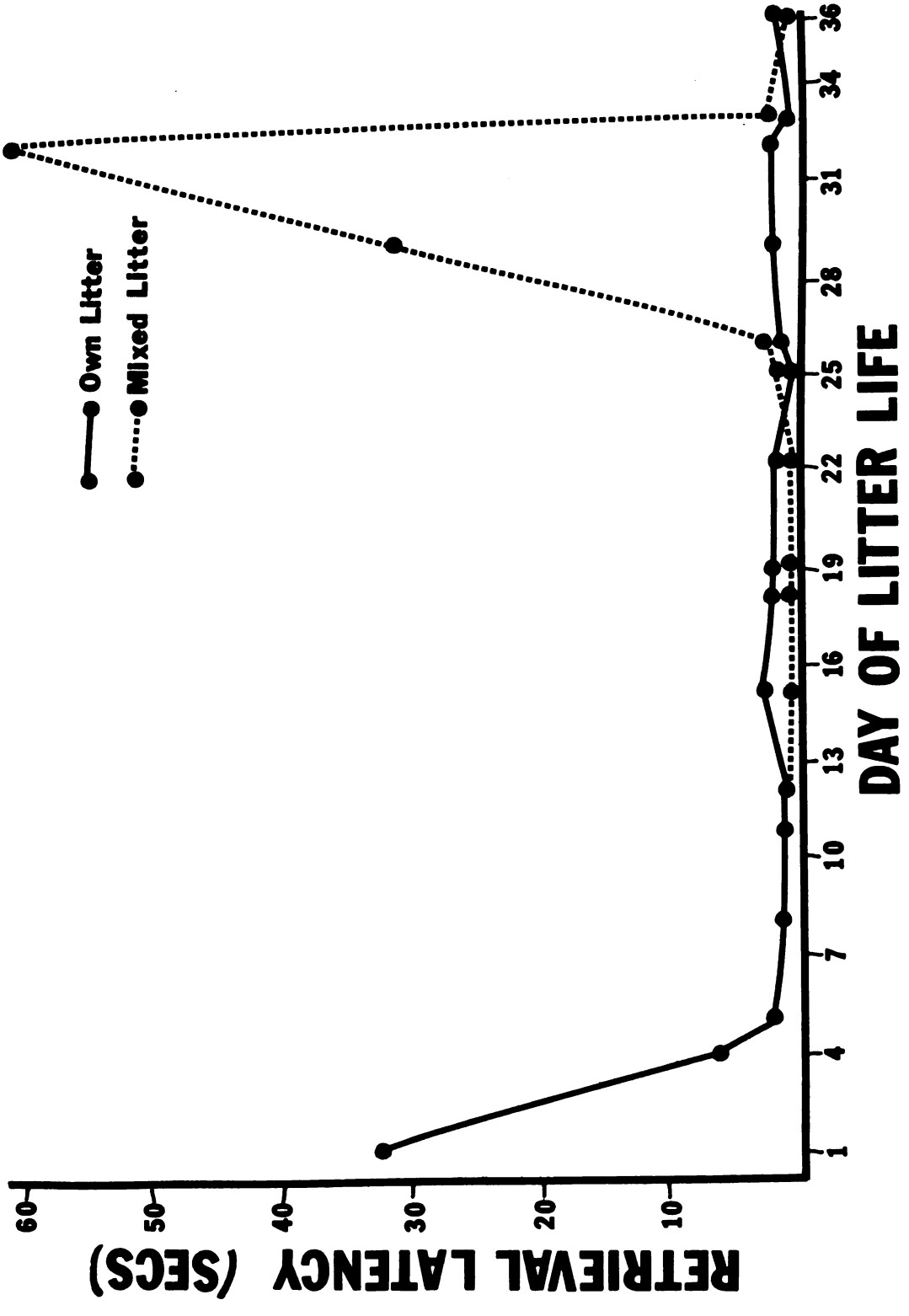

RETRIEVAL LATENCY (SECS)
60
50
40
30
20
10
1
4
7
10
13
16
19
22
25
28
31
34
36
DAY OF LITTER LIFE
Own Litter
Mixed Litter

Figure 26.

Figure 27. Average time to retrieve each kit by females with their own litters (N=9) and females with mixed litters (N=10). Before Day 14 all females have their own kits.

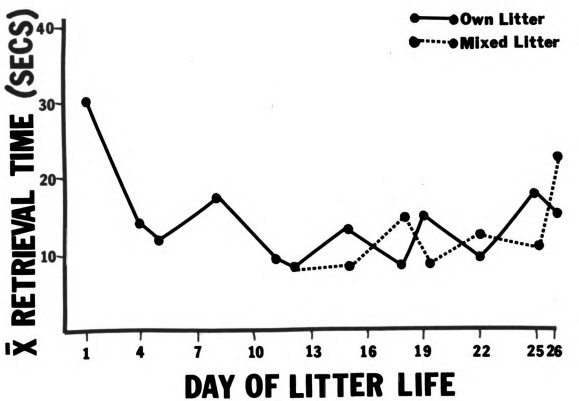

Own Litter
Mixed Litter
$\bar{X}$ RETRIEVAL TIME (SECS)
40
30
20
10
1
4
7
10
13
16
19
22
25
26
DAY OF LITTER LIFE

Figure 27.

tested for retrieval of different-aged kits. In the first test, with a three-week old kit she smelled and licked the kit and after about 30 seconds picked it up and began carrying it around the cage before taking it into the nest. All this happened within about 75 seconds after she first noticed the kit. When tested again a few days later with a 6-week old kit she immediately retrieved it. Several females either pregnant or with young were observed to respond to the cries of the kits that were put in neighboring cages for retrieval.

One female was given four 2-week old kits the same day her own kits were to be weaned. She retrieved them immediately, but her older kits attacked the younger ones. When the older kits were removed, the female licked the new kits, especially one that had been injured and 45 minutes later they were all nursing. She appeared to treat them as well as she did her first litter, but the kits never grew much and about 10 days later began to die. This could pose a very interesting problem for future research.

MALE-KIT INTERACTIONS:

The data obtained (Table 7) indicated that, on the average, the males spent much more time with kits that were over four weeks old than with younger, less mobile kits.

Most males spent some time smelling the anal region of the younger (0-3 weeks) kits and would often turn the kit over on its back, but would then usually walk away and ignore it unless it cried or happened to catch his eye again, or he stepped on it. Two of the males did a little licking, and one actually carried a kit to the food plate, licked it, and then carried it into the nest box. However, it was being rather rough, and it could not be determined if he was being somewhat aggressive or

Table 7. Amount of time (seconds) males spent with kits (possible 300 seconds).

	Age of Kits						
♂	2 days	1 week	2 weeks	3 weeks	4 weeks	5 weeks	6 weeks
EF-3	47	130	120	14	143	182	225
EF-1	76	100	16	89	193	220	160
CF-15	98	73	78	75	208	245	275
EF-61	19	48	26	45	168	185	228
CF-41	32	42	17	37	99	163	170
DF-61	31	34	31	42	74	95	95
$\bar{x}$	50.5	71.2	48.0	50.3	147.5	181.7	192.2

just overexuberant. One male (the only albino) was consistently aggressive and would immediately approach a kit and bite it. After he had killed a few kits, I was careful to remove the kit from him as soon as he started getting rough, and for this reason he was not included in the averages.

At four weeks the kits were able to maneuver somewhat by themselves, although they still cannot see. The males seemed more interested in these young that were more mobile. Several males carried their kits around the cage or into the nest box, and more licking was observed at this age. The males commonly "danced" around the kits as if trying to get them to play. Again, the albino male was extremely aggressive (my interpretation--someone else might call it over-protective) and it was difficult to take his kit away from him.

By the fifth week the kits were able to see, and a couple of times actually tried to follow a male. Some males acted frustrated at this and retreated. Several males carried their kits around or pulled them in and out of the nest boxes. This time the albino male was much less aggressive. His kit was a female and he actually appeared to be trying to mate with her. He spent over three of the allotted five minutes with her, and she never showed any signs of being hurt or even frightened.

Six-week old kits are quite playful as well as mobile and able to see well. The males "danced" around and the kits often ran after them as if to play. Several kits followed the adults into and out of nests, but there was less actual carrying than with five-week old kits.

MALE-FEMALE-KIT INTERACTIONS:

On September 20, 1974, six young were born to one pair of ferrets that was left together after mating, but four were dead. On that day the male and female were found sleeping closely together and the two remaining kits were beside the male. The next day only one kit remained and it was dead, crushed under the two adults who were curled up together.

The other pair had seven young on September 21. Both the male and female were in the nest, but the female was curled up around six of the kits and the other was by the male which was curled up an inch or so away from the female. This family was left together for six weeks, until the young were weaned, with no mishaps.

MINK X FERRET KITS:

When the ferret kit and the two mink kits were cross-fostered to respective mothers, the female ferret immediately savagely bit the 6-day old mink kits so that I was forced to remove them quickly. However, these kits died soon after. The mink female, on the other hand, never harmed the two-day old ferret kit, but after about seven days she removed it from the nest. At that time I returned the kit to its original mother, who readily accepted it, and found that it was appreciably smaller than any of the other kits in the ferret litter. This probably indicated that the kit had suckled very little from the mink.

PREDATION:

In the predation study, the ferrets seldom noticed the prey unless the mouse moved or they touched it in some way. Even though the barrel was quite small, the ferret would normally chase the mouse around it for some time. The mouse was often caught by the tail or rear a few times, at which point the mouse would usually turn around and bite the

ferret, before the ferret eventually delivered a well-placed bite to the back of the neck or the skull. Sometimes the ferret would hold the mouse under its front paws for a few seconds and then the mouse would often get away for another chase. If the ferret was unable to catch the mouse within five minutes, it generally lost interest.

All adult ferrets, both male and female, were able to kill mice within five minutes (normally less than three minutes) except for one lactating female who showed litte interest. The most adept killer was a lactating female that had sustained an injury to her abdomen not long before. She was always able to kill her mouse within 1 1/2 minutes, and was the only adult that showed any desire to eat her prey.

The youngest kit that was able to make a kill was a nine-week old female that caught her prey about two minutes after she took interest in it. A male of the same age lost interest in his mouse after about five minutes, however, and there were some 10-week old kits that were not yet able to make a kill.

Six 5-week old kits were put in the barrel together and given one mouse, but they showed little interest in it except as a play object when it moved. However, when their mother was added, and she killed the mouse, the kits were immediately interested and fought over the dead animal. The mouse was ripped apart and eaten by the kits (the female took no part) and they were very possessive of their pieces.

STIMULI:

Table 8 indicates the different stimuli tested and the responses obtained. Note the rather high frequency sounds are better than others in eliciting responses. The dropping of the can which made a loud clanging noise got much more consistent responses than the dull thud

Table 8. Stimuli used on the ferrets.

STIMULUS	RESPONSE
Odor:	
Ben Gay	shakes head
Vicks Vapo-Rub	shakes head
Food	becomes active, climbs cage; 5-9 wk. kits go to feed pan
Sound:	
Hand clap	jumps or activity stops
Drop weight	sometimes looks around
Drop can	activity stops, looks around
Dog whistle	sometimes stops activity as if listening
Other:	
Puff air	shakes head if directly in face
Running wheel	plays on it
Another ferret	see text

of a dropped weight or even a hand clap. The ferrets would often jump or look around at the first clap, but would pay no attention the second time.

A running wheel might be utilized quite well, especially by young ones (adults sleep a lot). In this study, however, a wheel was made available to a whole litter and they all tended to play on it at the same time, which meant two could be trying to turn it in different directions.

These animals are inquisitive and therefore usually tend to approach other ferrets. But the stimulus elicits a much more consistent response if it is a kit attracting a female (especially if it is vocal) or a female in estrous attracting a male (or possibly just the odor of the female in estrous).

DISCUSSION

As with most mammals, the female ferret must spend much time with her young for the first few weeks of life to insure their survival. The kits are quite helpless and rather immobile until they are almost four weeks old at which time they are able to eat solid food to some extent and to wobble around the cage. Within a few days after this, the eyes and ears begin to open and development occurs rather quickly from that point on. Within less than two weeks after this, the young can depend entirely on solid food and are very active. The mother's behavior toward her young through the suckling and weaning periods is closely geared to the behavioral capacities of the young at different stages of their physical development. Therefore, the gradual changes that occur in the relationship between mother and young must always be kept in mind.

The female ferret normally spends at least 90 per cent of her time in the nest with the kits during the first four weeks. After this, she spends progressively more time out of the nest, but so do the kits, so they are still together much of the time. Adults, however, normally spend a good deal of their time in their nest boxes, sleeping, and the time the mother spends in the cage after the first four weeks could actually be more than when she is alone.

The female spends most of the time in her nest during these first four weeks nursing her kits. Individual kits do not necessarily suckle constantly, but a combination of at least one or two kits is usually nursing most of the time.

It is not too surprising that licking of the kits does not change much over time, but there was some indication that the direction of the

licking changed. Ferret kits need the stimulus of the mother's licking to defecate and urinate, as is true of many other mammals, particularly altricial species (Ewer, 1968), so it is reasonable that most of the licking should be directed to the ano-genital region until the young are able to defecate on their own. After this point, licking becomes more general with more face and ear washing especially.

Contact seems to be very important for young ferrets. As soon as the female leaves the nest, the kits immediately crawl into a pile and sleep that way until the mother returns. Ewer (1973) reports that most young carnivores have this tendency to come to rest only when in contact with a littermate's body. Undoubtedly, this contact is for warmth since their thermoregulatory mechanisms probably are not refined for some time after birth. But even six- or eight-week old kits were usually seen sleeping piled on top of each other (and their mother when she was in the nest) even if there were 10 or 12 in the litter. The ambient temperature had to be 85-90^{o}F to make them distribute themselves more widely or for them to sleep in the cage.

Adult male ferrets are significantly larger than adult females, but the kits grow at the same rate until they are 7-9 weeks old. At this point the growth of the females slows down some and tapers off two or three weeks sooner than that of the males. As should be expected, the body weight is much more variable than the length measurements, which increase from week to week regardless of the nutrition they are receiving. Some kits actually lose weight during certain weeks. This is probably due to nutritional inadequacies of the milk, since generally if one member of a litter is underweight, they all are. Normally if small kits are able to survive until they can consume solid food, they will survive to maturity

and will probably even attain the normal weight before they are fully grown.

The physical development of these kits agrees fairly well with the information supplied by Herter (1953) and Pitt (1921). They each had only one litter, but their data for eye opening and other factors fit within the ranges noted in this study. Although observations on tooth development were quite sketchy, there have been several detailed analyses of the growth and replacement of teeth in ferrets by others (Berkovitz, 1968, 1969, 1973; Berkovitz and Thompson, 1973a, 1973b; Berkovitz and Silverstone, 1969; Ruprecht, 1965). Although deciduous incisors were not observed in this study, Berkovitz (1968) explains that ferrets have four of these on each side (only three permanent incisors), but all that is ever visible is the outermost tip of the fourth one (a supernumerary incisor). The time and order of eruption of deciduous and permanent canines and permanent incisors appear to be very similar to that of mink (Aulerich and Swindler, 1968), although the ferret's teeth seem to begin erupting two or three days earlier than those of the mink. The time of eruption of the first teeth (14-19 days of age) also coincides with the first consumption of solid food which occurs, as with most carnivores (Ewer, 1973), before the eyes open.

Although in the laboratory kit ferrets can be removed from the mother at six or seven weeks of age, this does not mean the same would pertain to either them or their relatives, the polecats, in a natural situation. King (1963) and King et al. (1963) used the earliest age at which the young could be kept from their mothers for 24 hours without a weight loss as the criterion for weaning Peromyscus. It was found that ferrets can gain weight away from their mothers several says before their

eyes are open. But they obviously would not be able to survive in the wild at such an age. There was little indication that the mothers made any effort to disperse their kits even at eight or nine weeks of age. Like most carnivores that are highly skilled predators (Ewer, 1968, 1973), kit ferrets probably stay with their mother for some time after being able to eat solid food in order to gain experience in finding and killing prey, etc. Novikov (1956) reported that wild polecat kits become independent at about two months of age, but remain together until the fall of their first year.

The sparse data collected here on prey-killing behavior indicate that a ferret is capable of killing a mouse by the time it is 9-10 weeks old. However, in a natural situation where the mouse has a chance to escape, a ferret of this age may not be agile enough to capture a fleeing mouse. Mustela nivalis are able to kill mice by the time they are 42-45 days of age (Heidt, 1970), but their development is faster than that of the ferret. These data also agree with Eibl-Eibesfeldt's (1957, 1970) observations on the killing techniques of polecats. He stated that inexperienced animals chase and kill fleeing rats, but only after grabbing the rats several times by different parts of the body so the rat often turns and defends itself. Experience is important for the specific killing technique of immediately grabbing the rat at the back of the neck. Heidt et al. (1968) observed M. nivalis mothers training 40-day old kits in killing, which does appear to quicken the process, and Goethe (1940) has reported that captive mother polecats will carry a piece of meat into the nest, pull it out again and leave it so that their one-month old kits will follow the scent trail and find the food. This could be a form of predator training in an artificial environment.

This was never observed in the ferrets, but kits less than a month old orient toward meat quite readily. The method used by the ferret to kill seems to be similar to other weasels which grab prey by the nape of the neck and then bite through the base of the skull and/or throat area (Heidt, 1970; Allen, 1938; Glover, 1943; Hamilton, 1933).

It is interesting to note that neither experience nor fostering appear to have much, if any, effect on the maternal behavior of ferrets. Primiparous ferrets nurse and lick their kits in the same way multiparous females do. Inexperienced females do, however, retrieve their kits significantly more slowly on the first test day then do the experienced females, but this difference disappears by the second trial period three days later for both latency of retrieval and mean retrieval time for each kit. Even the multiparous females retrieve their kits more slowly for the first couple of trials, but for both groups, this retrieval rate and the latency decrease during the first three trial periods. These results agree with those of Carlier and Noirot (1965) for rats. Evidently a minimum of practice induces long-term changes. These changes carry over to the next litter a year later, but even then some practice is needed to gain "ideal" speed.

Fostering appears to have even less effect on the behavior of the female toward her young than does experience. The tests showed there were no behavioral differences between females with their own kits and those with mixed litters. Also, the females did not treat individuals that were fostered any differently from those that were not fostered, although immediately after fostering some females appeared to manipulate and lick the new kits more. It should be pointed out, however, that since the average number of young in a litter of ferrets is seven or eight,

there is a possibility that reducing the number of kits to four could have induced the females to react more maternally toward anything, including alien young. This seems unlikely, though, since young have been fostered into litters already containing seven or eight young with no obvious change in the maternal behavior.

Rabbits also adopt strange young readily (Sorenson et al., 1972), as do mice, rats (Beach and Jaynes, 1956a) and cats (Schneirla et al., 1963). But cats show somewhat different responses than do ferrets. Nursing cats will readily accept one strange kitten and encircle it immediately, but the addition of three strange kittens distrubs them and they will sometimes even attack. Kittens are also able to distinguish their own mother soon after birth (Schneirla et al., 1963), so an initial hesitancy to suckle a strange female is not too surprising.

Rats will retrieve alien young as do ferrets, but they do so more slowly then they retrieve their own, which indicates they recognize their own young at retrieval (Beach and Jaynes, 1956a). A ferret, on the other hand, seems to take no notice of which kit is being retrieved, and picks up the first one she comes to. Also, the mortality rate of fostered young increases and the body weight of survivors decreases in rats as the number of days the foster mother has been lactating increases (Denenberg et al., 1963). But the age of the young seems to have no effect on the ferret mothers since in these tests the kits were not fostered until two weeks of age. At another time a kit as old as five or six weeks was fostered to a female, and the new female's kits showed more interest in the alien than did the female herself. Ewer (1968) suggests that altricial species with their own nests, such as the ferret or the polecat, are generally more ready to adopt strange young than are precocial species

since there has been little need for selection for recognition of young.

The fact that these ferrets did not show any differences in the maternal behavior parameters studied, regardless of experience or fostering, could be very important to future researchers. It is difficult to get a large sample size with an animal like the ferret which takes up quite a bit of room and eats a rather expensive diet. When the age of the animal has to be considered also, even more problems are created. For future maternal behavior studies, any adult female, whether she has had young or not, can be used. Since fostering is so easily done, ferrets would be good models for studies on the effects of different-sized litters, which can be created when necessary by fostering. When survival of as many kits as possible is important, kits can also be fostered when a female dies or is incapable of nourishing her young adequately.

MINK X FERRET KITS: These results were surprising since ferret females do so readily accept alien kits of the same species, and mink very seldom do (Aulerich, 1975). Bahlcke (1939) has even reported using ferrets as foster mothers to mink when the mink litters are too large. Of course, since only one mother ferret and one mother mink were used, this could simply have been a quirk. But there must be some pre-planning to carry out an experiment such as this since the reproductive season of the ferrets in this area begins just about the time that of the mink is ending and it is sometimes difficult to find litters of each species coming at approximately the same time. Better success might have been obtained if all kits had been dusted with baby powder or some such thing to mask the new odors for a time. The odor of the mink kits is much stronger than that of the ferret kits, so these mothers must surely be able to detect a difference. Perhaps the odor of the mink kits was

strong enough to mask that of the ferret pup from the mink mother for a time, but was so overwhelming and strange to the ferret mother that she attacked them as aliens. Perhaps the females' responses would have been different if they had been allowed to retrieve the alien young along with their own. Ewer (1968) discovered that if foreign young were placed outside the nest of Cricetomys, the young were retrieved, whereas if they were placed inside the nest, these young were immediately killed. Lorenz (1956) described how dogs and other animals sometimes appear interested in foreign young but lick them as if trying to remove the fetal membranes, and since these membranes do not exist, the skin gets cut and the young eventually eaten. However, these mink pups were bitten so quickly by the female ferret that this does not appear to have been the probable cause.

If this fostering could be effected successfully, many new lines of research would be opened. Not only could we foster mink to ferrets when the mother dies or is unable to raise her kits, but such things as the effect of maternal behavior on aggression would be better studied since the mink is by nature a very unfriendly and unsocial animal. Studies of aggressive strains of mice raised with rats have shown conflicting results (Denenberg et al., 1964; Hudgens et al., 1967; Rosenberg et al., 1970), but there is some indication that the aggressiveness of the mice is reduced. It would be a great boon to the mink industry if mink could be made more passive by fostering them to ferrets when very young.

MALE-FEMALE-KIT INTERACTIONS: Although some mustelid males do take a part in caring for the young (Mustela frenata, M. vison, M. erminea, Taxidea taxus), according to Palmer (1957) polecats do not. The results

of this study, however, do seem to indicate that they would be compatible. In situations where cage room is a problem, males could be left with females after the last breeding with little fear of losing the kits as a result. The interactions of males and kits could be better discerned in this situation also. It appears that most males show very little antagonism toward kits at any age, and actually play with older kits, and occasionally retrieve and lick younger kits. Perhaps this is a result of domestication since male polecats are not known to stay with their families. Since so many other mustelid males stay with their families, it is more likely that this desertion is due to some factor other than his aggression toward the young causing the female to drive him away to protect the kits.

Although relaxation of care of the young is often inadvertently selected for during domestication by bottle-raising young that the mother either cannot or will not take care of, this does not seem to have happened with the ferret. Perhaps this is because ferrets were usually not considered as real pets, so cute and cuddly that one could not bear to see a baby die. They were a work animal, used to catch vermin, and probably were not always cared for as well as dogs or cats. The young are also too small to be able to bottle-feed easily, so most kits born of mothers either behaviorally or nutritionally deficient would not live to reproduce. Furthermore, since litters can be quite large, the breeders presumably were not overconcerned.

It is, however, quite conceivable that aggression and protection of the kits have been selected against since these animals have been protected from the elements of nature for so long. Some of these mothers were somewhat aggressive, but not to the extent found in mink mothers.

Pitt (1921) and Poole (1972) stated that polecats are quite nervous and untamable, but ferrets are indeed very tractable animals. Poole (1972) continued to develop the hypothesis that since the ferret has been kept as a pest-destroyer, selection has been toward an easily handled animal that is not too quick or nervous so they are not too difficult to recapture.

In his first chapter on the adaptations of domestic animals, Hafez (1968) states that domestic animals must be adapted to their environment and that "well-adapted animals are characterized by....high reproductive rate..." This is certainly true of the ferret which can have 10-12 young or even more at a time, although they may not all survive. Perhaps the fact that mink usually have three or four and that they sometimes have trouble raising them indicates that this animal is not yet fully adapted to its caged environment.

Actually, it is somewhat surprising that the ferret has ever been domesticated at all. Most authors (Zeuner, 1955; Ucko and Dimbleby, 1969; Scott, 1954) agree that animals which have social relations with members of their own species to begin with are more ready to form the same kind of relationship with another species--namely man. This is one reason why so many bovids have been domesticated so successfully. In addition, most people are familiar with the highly social life of wolves and most other canids to which our domestic dog is so closely related. But polecats are supposed to be rather secretive animals. The only social tie they appear to have besides at mating is between mother and offspring. So why would this animal ever be chosen? Nobody seems to have an answer. However, our present-day ferrets are at least sociable animals, if not actually social, so perhaps the polecat ancestor did have some

propensities toward a certain amount of socialization. Perhaps polecats would be more social if there were large enough numbers of them to allow them to come into contact with each other more often. Of course, it is not impossible for domestication of a solitary animal to have occurred, even 2000 years ago. The domestic cat is certainly not from a social group and there is great individual variation in animals, so some---the ones "chosen" for domestication---could have been quite social even though others may be more secretive. Acceptance of young other than their own facilitates successful domestication by allowing transfer of young and adoption of wild young by tamed mothers (Kretchmer and Fox, 1975). Since ferrets do so readily accept foster young, this could have had a large bearing on the domestication of this animal. Perhaps the fact that mink do not so readily accept foster young could account in part for the difficulty breeders have in taming this species.

Since so little has been done to investigate the maternal behavior of the other wild mustelids, few comparisons can be made and any conclusions as to changes in this behavior that could be due to domestication are almost impossible to make. Much more research needs to be done in this area on the mustelids and the other carnivores to find answers to a few of our questions.

SUMMARY AND CONCLUSIONS

Maternal behavior was observed over an eight-week period for a total of 30 minutes every third day for each of nine female ferrets. It was found that they gradually spent less time in the nests as the kits got older. Time spent nursing remained fairly constant until about Day 19 and then decreased rapidly until there was essentially no nursing by 7 1/2 weeks. Licking of the kits and grooming remained at a constant low level throughout the eight weeks.

Growth and development of kits were also studied over 16 weeks. Males and females grew at similar rates until they were 7-9 weeks of age at which time males began to diverge rapidly from the females.

Experience and fostering effects on maternal behavior were studied with 19 females divided into the following groups when the kits were 14 days of age: (I) Multiparous with own kits; (II) Primiparous with own kits; (III) Multiparous with two fostered kits and two own kits; (IV) Primiparous with two fostered and two own kits. The experience had no effect on maternal behavior as measured by time spent in the nest, nursing the kits, licking the kits, grooming themselves, rate of retrieval and latency to begin retrieval. Fostering had no effect on any of the measures except rate of retrieval and latency to begin retrieval on the first test day. There was no difference in the behavior of the females toward their own kits and the fostered kits, nor were any subtle differences shown in growth rates.

Various parameters of this maternal behavior are discussed in terms of the evolution of the ferret as a domesticated animal and maintenance of this animal for research purposes.

The following conclusions could be made as a result of this study:

1. The experience of previously having raised kits has little effect on the maternal behavior of the ferret. Those differences that are due to experience are very short-lived.

2. Fostering has no effect on the maternal behavior of the ferret. However, if the female's own kits are three to four weeks older than the fostered kits, the older kits could injure the younger ones.

3. Ferrets would be good models for the study of maternal behavior for the following reasons:

   (a) Ferrets are quite docile and are usually quite calm while being observed.

   (b) They are smaller than dogs, so eat less and take up less room.

   (c) Ferrets often have large litters, and since they can be easily fostered, many different-sized litters can be obtained to study differences in maternal behavior due to litter size.

   (d) Ferrets can have two litters per year under normal photoperiod, but this is more than many other carnivores.

   (e) Since previous experience has little effect on maternal behavior of the ferret, studies can begin as soon as the animal reaches reproductive age.

   (f) Since this is a carnivore, it could be used to study the role the mother plays, if any, in teaching the young to hunt.

4. This is a beginning to the study of maternal behavior of mustelids, and more complete studies should be made on the other mustelids, especially mink and weasels.

5. Although aggression and protection of the young may have been selected against during the process of domestication, actual care of the young

has probably been affected little. However, much more detailed study of the ferret and the polecat needs to be made before any definite conclusions can be made.

LITERATURE CITED

LITERATURE CITED

Allanson, M. 1931. The reproductive cycle in the male ferret. J. Physiol., 71:20.

Allen, D.L. 1938. Notes on the killing techniques of the New York weasel. J. Mamm., 19(2):225-229.

Aulerich, R.J. 1975. Personal communication.

_____ and P.J. Schaible. 1965. The use of "spent" chickens for mink feeding. Mich. Agric. Expt. Sta. Quart. Bull., 47(3): 451-458.

_____ and D.R. Swindler. 1968. The dentition of the mink (Mustela vison). J. Mamm., 49(3):488-494.

Bahlcke, __. 1939. Frettchen als Nerzamme. Dtsch. Pelztierz., 14: 352-353. Also in Anim. Breeders Abst., 8:149, 1940.

Beach, F.A. and J. Jaynes. 1956a. Studies of maternal retrieving in rats. I. Recognition of young. J. Mamm., 37:177-180.

_____ and _____. 1956b. Studies on maternal retrieving in rats. II. Effects of practice and previous parturitions. Amer. Naturalist, 90:103-110.

_____ and _____. 1956c. Studies of maternal retrieving in rats. III. Sensory cues involved in the lactating female's response to her young. Behaviour, 10:104-125.

Berkovitz, B.J. 1968. Supernumerary deciduous incisors and the order of eruption of the incisor teeth in the albino ferret. J. Zool., 155:445.

_____. 1969. Supernumerary deciduous incisors in the polecat. Arch. Oral Biol., 14:863.

_____. 1973. Tooth development in the albino ferret (Mustela putorius) with special reference to permanent carnassial. Arch. Oral Biol., 18:465.

_____ and P. Thompson. 1973a. Supernumerary maxillary incisors in the ferret. J. Anat., 114:296.

Berkovitz, B.J. and P. Thompson. 1973b. Observations on etiology of supernumerary upper incisor in the albino ferret (Mustela putorius). Arch. Oral Biol., 18:457.

_____ and L.M. Silverstone. 1969. The dentition of the albino ferret. Caries Res., 3:369-376.

Bissonnette, T.H. 1932. Modification of mammalian sexual cycles: reactions of ferrets (Putorius vulgaris) of both sexes to electric light added after dark in November and December. Proc. Roy. Soc., London, B, 110:322-336.

_____. 1935a. Modification of mammalian sexual cycles. II. Effects upon young male ferrets (Putorius vulgaris) of constant 8 1/2 hour days and of 6 hours of illumination after dark, between November and June. Biol. Bull., 68(2):300-313.

_____. 1935b. Modification of mammalian sexual cycles. IV. Delay of oestrus and induction of anoestrus in female ferrets by reduction of intensity and duration of daily light periods in the normal oestrous season. J. Expt. Biol., 12:315-320.

Bond, J. 1971. Noise. Its effect on the physiology and behavior of animals. Agric. Sci. Rev., 4:1-10.

Carlier, C. and E. Noirot. 1965. Effects of previous experience on maternal retrieving by rats. Anim. Behav., 13:423-426.

Chang, M.C. 1965a. Implantation of ferret ova fertilized by mink sperm. J. Expt. Zool., 160:67-80.

_____. 1965b. Fertilizing life of ferret sperm in the female ferret. J. Expt. Zool., 158:87-99.

Curran, C.R. 1972. The behavioral response of female mink exposed to real or simulated sonic booms. In: An interdisciplinary study of the effects of real and simulated sonic booms on farm-raised mink. U.S. Dept. of Transportation Report No. FAA-EQ-72-2, p. 85.

Denenberg, V.H., L.J. Grota and M.X. Zarrow. 1963. Maternal behaviour in the rat: analysis of cross-fostering. J. Reprod. Fert., 5:133-141.

_____, G. Hudgens and M.X. Zarrow. 1964. Mice reared with rats: Modification of behavior by early experience with another species. Science, 143:380-381.

_____, S.F. Petropolus, P.B. Sawin and S. Ross. 1959. Genetic, physiological and behavioral background of reproduction in the rabbit. VI. Maternal behavior with reference to scattered and cannibalized newborn and mortality. Behaviour, 15:71-76.

Denenberg, V.H., P.B. Sawin, G.P. Frommer and S. Ross. 1959. Genetic, physiological and behavioral background of reproduction in the rabbit. IV. An analysis of maternal behavior at successive parturitions. Behaviour, 13:131-142.

_____, M.V. Wyly, J.K. Burns and M.X. Zarrow. 1973. Behavioral effects of handling rabbits in infancy. Physiol. Behav., 10:1001-1004.

East, K. and J.D. Lockie. 1964. Observations on a family of weasels (M. nivalis) bred in captivity. Proc. Zool. Soc., London, 143(2):359-363.

Eibl-Eibesfeldt, I. 1957. Inborn and acquired in the technique of killing prey (experiments with the polecat Putorius putorius L.). Zeitschr. f. Saeugetierk., Berlin, 21:135-137.

_____. 1970. Ethology: The Biology of Behavior. Holt, Rinehart and Winston, New York. 530 pp.

Ewer, R.F. 1969. Ethology of Mammals. Plenum Press, New York. 418 pp.

_____. 1973. The Carnivores. Cornell Univ. Press, Ithaca, N.Y. 494 pp.

Gilbert, F.F. and E.D. Bailey. 1970. Reproductive performance of three genetic strains of female mink visually isolated after breeding. Cornell Vet., 60:135-138.

Glover, F.A. 1943. Killing techniques of the New York weasel. Pennsylvania Game News, 13:11.

Goethe, F. 1940. Beitrage zur Biologie des Iltis. Zeitschrift f. Saugetierk., 15:180-220.

Grota, L.J. 1973. Effects of litter size, age of young, and parity on foster mother behaviour in Rattus norvegicus. Anim. Behav., 2(1):78-82.

Hafez, E.S.E.(ed.). 1968. Adaptation of Domestic Animals. Lea and Febiger, Philadelphia. 425 pp.

Hahn, E.W. and R.C. Wester. 1969. The biomedical use of ferrets in research. Marshall Research Animals, Inc., North Rose, N.Y. 52 pp.

Hamilton, W.J. 1933. The weasels of New York. Amer. Midl. Nat., 14:284-344.

Hammond, J. and F.H.A. Marshall. 1930. Oestrus and pseudo-pregnancy in the ferret. Proc. Roy. Soc., London, B, 105:607-630.

Hammond, J. and A. Walton. 1934a. Pregnancy during the anoestrus season in the ferret. J. Expt. Biol., 11:320-325.

_____ and _____. 1934b. Notes on ovulation and fertilization in the ferret. J. Expt. Biol., 11:307-319.

Hart, D.S. 1951. Photoperiodicity in the female ferret. J. Expt. Biol., 28:1-2.

Hartman, L. 1964. The behavior and breeding of captive weasels (Mustela nivalis). New Zealand J. of Science, 7(2):147-156.

Harvey, W.E. and W.V. MacFarlane. 1958. The effects of day length on the coat-shedding cycles, body weight and reproduction of the ferret. Aust. J. Biol. Sci., 11:187-199.

Heidt, G.A. 1970. The least weasel Mustela nivalis L. Publ. Mus., Mich. State Univ., Biol. Ser., 4(7):227-282.

_____, M.K. Peterson and G.L. Kirkland, Jr. 1968. Mating behavior and development of least weasels (Mustela nivalis) in captivity. J. Mamm., 49(3):413-419.

Herter, K. 1953. Uber das Verhalten von Iltissen. Zeitschr. f. Tierpsychologie, 10:56-71.

Hill, M. and A.S. Parkes. 1934. Effect of absence of light on the breeding season of the ferret. Proc. Roy. Soc., London, B, 115:14-17.

Hudgens, G.A., V.H. Denenberg and M.X. Zarrow. 1967. Mice reared with rats: Relations between mother's activity level and offspring's behavior. J. Comp. Physiol. Psychol., 63:304-308.

King, J.A. 1958. Maternal behavior and behavioral development in two subspecies of Peromyscus maniculatus. J. Mamm., 39:177-190.

_____. 1963. Maternal behavior in Peromyscus. In: Maternal Behavior in Mammals, H.L. Rheingold (ed.). John Wiley and Sons, New York. pp. 58-93.

_____, J.C. Deshaies and R. Webster. 1963. Age of weaning in two subspecies of deer mice. Science, 139(3554):483-484.

Kretchmer, K.R. and M.W. Fox. 1975. Effects of domestication on animal behavior. Vet. Rec., 96:102-108.

Lazar, J.W. and G. Beckhorn. 1971. Mother-young relationships in the ferret. Amer. Zool., 11:618. (abstract).

Lorenz, K. 1955. Man Meets Dog. Houghton Mifflin Co., Boston, 211 pp.

Marshall, F.H.A. 1940. The experimental modification of the oestrus cycle in the ferret by different intensities of light irradiation and other methods. J. Expt. Biol., 17:139-146.

Michener, G.R. 1971. Maternal behaviour in Richardson's Ground Squirrel, Spermophilus richardsonii richardsonii: retrieval of young by lactating females. Anim. Behav., 19:653-656.

_____. 1973. Maternal behavior in Richardson's Ground Squirrel (Spermophilus richardsonii richardsonii): retrieval of young by non-lactating females. Anim. Behav., 21(1):157-159.

Morris, D. 1965. The Mammals. A Guide to the Living Species. Harper and Row, New York. 448 pp.

Nacktgeboren, C. 1961. Observations of the birth of ferrets (Mustela furo). Bijdr. Dierk., 31:65-73.

Novikov, G.A. 1956. Fauna of the U.S.S.R. Academy of Sciences of the U.S.S.R., No. 62:1-284. Trans. by Israel Program for Scientific Translations, 1962.

Otis, R.E., C.D. Andrina and N.J. Clemens. 1971. Exploratory behavior in mink (Mustela vison) and ferrets (M. putorius). Amer. Zool., 11:631.

Pallen, D. 1944. Practical mink breeding methods. Fur Trade J. of Canada. November, p. 8.

Palmer, E.L. 1957. Palmer's Fieldbook of Mammals. E.P. Dutton and Co., Inc., New York. 321 pp.

Pitt, F. 1921. Notes on the genetic behaviour of certain characters in the polecat, ferret, and in polecat-ferret hybrids. J. Genet., 11:99-115.

Pocock, R.I. 1932. Is the ferret a domesticated polecat? Field, London, 159(4134):410.

Poole, T.B. 1966. Aggressive play in polecats. In: Play, Exploration and Territory in Mammals, P.A. Jewell and C. Loizos (eds.). Symp. Zool. Soc. London, Academic Press, London, No. 18:23-44.

_____. 1972. Some behavioral differences between the European polecat, Mustela putorius, the ferret, M. furo, and their hybirds. Proc. Zool. Soc. London, 166(1):25-35.

Priestnall, R. 1973. Effects of handling on maternal behaviour in the mouse (Mus musculus): an observational study. Anim. Behav., 21(2):383-386.

Rempe, U. 1957. Observations of oestrus, copulation, gestation, birth, and crosses in members of subgenus Putorius. Saeugetierk. Mitteil., 5:111-113.

Rheingold, H.L. 1963. Maternal behavior in the dog. In: Maternal Behavior in Mammals, H.L. Rheingold (ed.). John Wiley and Sons, New York. pp. 169-202.

Rosenberg, K.M., V.H. Denenberg and M.X. Zarrow. 1970. Mice (Mus musculus) reared with rat aunts: The role of rat-mouse contact in mediating behavioural and physiological changes in the mouse. Anim. Behav., 18:138-143.

Rosenblatt, J.S. 1970. Views on the onset and maintenance of maternal behavior in the rat. In: Development and Evolution of Behavior, Lester R. Aronson et al. (eds.). W.H. Freeman, San Francisco. pp. 489-515.

_____ and D.S. Lehrman. 1963. Maternal behavior of the laboratory rat. In: Maternal Behavior in Mammals, H.L. Rheingold (ed.). John Wiley and Sons, New York. pp. 8-57.

Ross, S., V.H. Denenberg, G.P. Frommer and P.B. Sawin. 1959. Genetic, physiological and behavioral background of reproduction in the rabbit. V. Nonretrieving of neonates. J. Mamm., 40:91-96.

_____, P. B. Sawin, M.X. Zarrow and V.H. Denenberg. 1963. Maternal behavior in the rabbit. In: Maternal Behavior in Mammals, H.L. Rheingold (ed.). John Wiley and Sons, New York. pp. 94-121.

Ruprecht, A. 1965. Supernumerary premolar in Mustela putorius L. Act Theriologia X, 17:242.

Sawin, P.B., V.H. Denenberg, S. Ross, E. Hafter and M.X. Zarrow. 1960. Maternal behavior in the rabbit: hair loosening during gestation. Amer. J. Physiol., 198:1099-1102.

Sayler, A. and M. Salmon. 1969. Communal nursing in mice: Influence of multiple mothers on the growth of the young. Science, 164: 1309-1310.

_____ and _____. 1971. An ethological analysis of communal nursing by the house mouse (Mus musculus). Behaviour, 40:62-85.

Schneirla, T.C., J.S. Rosenblatt and E. Tobach. 1963. Maternal behavior in the cat. In: Maternal Behavior in Mammals, H.L. Rheingold (ed.). John Wiley and Sons, New York. pp. 122-168.

Scott, J.P. 1954. The effects of selection and domestication upon the behavior of the dog. J. Natl. Cancer Inst., 15:739-758.

Scott, J.P. 1963. The process of primary socialization in canine and human infants. Monographs of the Society for Research in Child Development, Serial No. 85, 28(1):1-47.

Shump, A.U., K.A. Shump, Jr., G.A. Heidt and R.J. Aulerich. 1974. A Bibliography of Mustelids. Part I. Ferrets. Mich. Agric. Expt. Sta., Article 6977, 53 pp.

_____, _____ , _____ and _____. 1975. A Bibliography of Mustelids. Part II. Mink. In press.

Smart, J.L. and J. Preece. 1973. Maternal behaviour of undernourished mother rats. Anim. Behav., 21(3):613-619.

Smith, L. and S. Berkson. 1973. Litter stimulus factors in maternal retrieval (Rattus rattus). Anim. Behav., 21(3):620-623.

Sorenson, M.F., J.P. Rogers and T.S. Baskett. 1972. Parental behavior in swamp rabbits. J. Mamm., 53(4):840-849.

Ucko, P.J. and G.W. Dimbleby. 1969. The Domestication and Exploitation of Plants and Animals. Gerald Duckworth and Co., London. 581 pp.

Vincent, D.S. 1970. Modification of the annual oestrous cycle of the ferret by various regimes of artificial light. J. Endrocrinol., 48:iii (abstract).

Walker, E.P. 1968. Mammals of the World. Vol. II. Johns Hopkins Press, Baltimore, pp. 647-1500.

Wiesner, B.P. and N.M. Sheard. 1933. Maternal Behavior in the Rat. Oliver and Boyd, Edinburgh.

Zarrow, M.X., V.H. Denenberg and C.O. Anderson. 1965. Rabbit: Frequency of suckling in the pup. Science, 150:1835-1837.

_____, P.B. Sawin, S. Ross and V.H. Denenberg. 1962. Maternal behavior and its endorcine basis in the rabbit. In: Roots of Behavior, E.L. Bliss (ed.). Harper and Row, New York. pp. 187-197.

Zeuner, F.E. 1955. Domestication of animals. In: A History of Technology. I. C. Singer, E.J. Holmyard and A.R. Hall (eds.). Oxford. pp. 327-352.

_____. 1963. A History of Domesticated Animals. Hutchinson and Co., London.