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Behaviour of Young Neomys fodiens in Captivity

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The behaviour of young *Neomys fodiens* (Pennant, 1771) from 4 litters was examined from the period of their leaving the nest for the first time till about the 60th day of their life. The period of intensive mother-sucking lasted for 5 weeks. Lip-licking behaviour was observed from the 24th day. A single act of licking a mother's muzzle by one young animal lasted from one second to 2 min., 21 sec. on average. Between the young themselves and between them and their mother "catching and moving" was observed. The animals caught each other's skin with their teeth and joined in this way moved one behind or beside the other, and even on top of each other. The first signs of intolerance among the young appeared on the 35th day. The animals hissed and took warning body positions, when during direct contact they disturbed each other in some activities. More than 50-day-old animals reacted hostily more often to the sheer presence of another individual. On the 52nd day the first serious fight was observed during which the animals bit each other and got locked together.

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1. INTRODUCTION

Development of behavioural characteristic of *Neomys fodiens* (Pennant, 1771) was previously studied by Michalak (1983, 1987a) and Köhler (1983a, b). In these papers the locomotive and vocal abilities, grooming and feeding of *Neomys fodiens* were throughly presented. Some attention was also paid to the occurrence of lip-licking behaviour and the length of family relations.

The purpose of this study was to describe the behaviour of young *Neomys fodiens* from the period of their leaving the nest till the moment when the increased aggressive reactions between animals made further coexistence in the same breeding cages impossible. The kind and intensivity of direct contacts between the young animals themselves and between them and their mother as well as the development of aggressiveness in a family and the ways of expressing aggression by the animals were examined.

Table 1

Data concerning the sucking of *N. fodiens* in the final stage of lactation obtained on the basis of observations of the young and their mothers after a temporary separation of the litter from the mother (see Methods and material). A — drop in a mother's weight (given in the percentage of the initial weight) within 30 minutes after her reunion with they young after a temporary separation. B, C — the number of pups sucking a mother simultaneously and the total time of sucking (in seconds) measured within the first 5 minutes after the reunion of the family, * — the size of the litter was given in brackets, ? — transitory clinging to the mother's nipples without clear sucking, E — the last day of lactation calculated on the basis of the appearance of the nipples, (E) — approximate estimation.

Age of young, days	Litter no. 261 (8) *			Litter no. 300 (7)			Litter no. 202 (11)			Litter no. 200 (7)
	A	B	C	A	B	C	A	B	C	A
24				14.1	4	50				
25	15.0	6	205	8.9	3	125				
26	19.8	6	195	11.2	2	155				
27	12.1	8	300	6.1	4	110				
28	19.8	8	300	6.4(E)	2	130				
29	13.4	8	300	7.2	2	50				
30	15.0	7	300	6.1	1	?	22.1	—	—	
31	7.8	8	300	—	0	0	—	—	—	22.4
32	14.3	8	300	8.7	1	?	23.3	8	300	16.5
33	15.8	8	300	7.1	0	0	22.5	9	300	14.9
34	10.7	8	300	5.9	0	0	24.5	10	280	14.4
35	12.8	6	215	5.9	0	0	19.7	10	300	11.2E
36	—	—	—	—	—	—	21.4	10	300	6.5
37	13.0	4	270	6.8	0	0	17.2	9	300	3.5
38	9.8	3	?	3.4	0	0	13.2	4	300	6.0
39	8.1E	0	0	3.5	0	0	10.8	4	210	3.2
40	6.0	0	0	8.5	0	0	10.3	3	—	1.7
41	—	—	—				8.2E	4	50	2.7
42	—	—	—				5.2	0	0	
43	8.5	0	0				2.9	0	0	
44	3.9	0	0				6.5	0	0	
45	—	—	—				4.1	0	0	
46	9.4	0	0				—	—	—	
47	7.1	0	0				—	0	0	
48	5.6	0	0				5.8	0	0	
49	—	—	—				2.6	0	0	
50	7.1	0	0				4.9	0	0	

2. METHODS AND MATERIAL

Four litters of *N. fodiens* born in the laboratory in 1983 were studied. The litters came from pregnant females caught in the Białowieża Primeval Forest, Eastern Poland. The conditions of breeding were described in an earlier paper (Michalak, 1983). Observations were carried out from the day the young first left the nest (the 23rd — 24th day of life) till about the 60th day. Everyday, for about an hour the animals in their breeding cages were observed (families were kept in several cages joined together by a rubber tube). The animals' behaviour was also observed after putting them in a single cage, when the young were temporarily separated from their mother. Two litters (No. 200, 202) beginning on the 30th and 31st day of the animals' life, were separated from their mother everyday for 12 hours, while two other litters (No. 300, 261) were separated for one hour beginning on the 24th and 25th day. Before the family was united again, the female was weighed and then placed with the young for half an hour in a cage in which there was nothing but a thin layer of sand. During the first 5 minutes of the reunion of family, in 3 litters the time of sucking the mother and the number of the young sucking simultaneously was recorded and only in 2 litters the time of licking the mother's muzzle by the young was measured. Afterwards, the nest-box was put in the cage. The animals were observed for 25 minutes and the duration of selected behaviour was sporadically measured. Next, the females was weighed again in order to determine weight loss during the 30-minute family reunion. When the observations had been completed, the animals were moved to their breeding cages. Also, the chance observations of the behaviour of wild-caught young *N. fodiens* were used in this paper.

3. RESULTS

3.1. Sucking

The period of intensive sucking lasting till about the 35th and 37th day of the animal's life in two litters (No. 261, 202). It was assumed that the intensive need for sucking was demonstrated by the fact that for the first 5 minutes after the mother had been reunited with a litter, the young sucked all or almost all the time, and all or the majority of the young *N. fodiens* clung to the mother's nipples simultaneously (Table 1).

The end of lactation was based on two criteria: (1) the lack of sucking within 5 minutes after the reunion of the young with their mother, (2) a weight loss of a female less than 10% after 30 minutes of her reunion with the young (provided that within the next days the loss remained below 10%) (Table 1). The length of lactation calculated in this way (with a 1—2 days' deviation) agreed with observations on the appearance of the nipples (Table 1). The litters differed considerably as to the length of lactation, since it lasted a minimum of 28 days and a maximum of 41 (Table 1).

However, an infection of the area around the nipples was discovered in the case of the female No. 300 which fed her young for the shortest time. Already on the 24th day of loctation, crusts were discovered near her nipples. On the 28th day, the young animals clinging the nipples, did not seem to show any clear sucking movements. After the 32nd day the animals stopped clinging to the nipples. They still put their muzzles under the mother's abdomen, but withdrew them immediately.

The young animals from the longest sucking litter (No. 202) accompanied their mother all the time (which was not seen in other litters). They clung to her when she was leaving the nest-box and every now and then hung on to her nipples. Also, they were often fed outside the nest (it was last seen on the 37th day). While feeding, the female usually lay on her back. Sometimes, she did not change her position for 10—20 minutes, and the young fell asleep with the nipples in their muzzles. This female, despite the intensive exploitation by 11 young animals, looked very well as far as her fitness was concerned. In other litters feeding outside the nest occurred very rarely and lasted for a very short time.

3.2. Lip-licking (LL)

The licking of a mother's muzzle by the young was called a lip-licking behaviour. It was observed only once that the mother manipulated her muzzle near the muzzles of her pups. However, it was not ascertained whether she actually licked their muzzles or not (see also chapter 3.3.1.).

The first time the pups were seen licking their mother's muzzle was on the 24th day of their life (Table 2). Sometimes, the pups seemed to suck the mother's lips and from time to time, with the help of one or two paws, opened the mother's muzzle wider and licked her palate. The most common positions during LL were: (1) a mother on her back or on her side, a pup lying on her completely or leaning the front of its body against hers or in a dorsal-up position beside or at the back of her head (Fig. 1a, b), (2) a mother in a dorsal-up position, usually with her head lifted up, a pup, also in a dorsal-up position beside or in front of the female (Fig. 1c), (3) a mother in a dorsal-up position, a pup on its back beneath, beside, or in front of her (Fig. 1d).

Usually one pup licked, more rarely two or three pups simultaneously or in turns. A single act of licking a mother's muzzle by one young pup lasted from one second to two minutes, 21 seconds on average. The LL time of two pups licking in turns (the behaviour not interrupted by

any other activity of the pups) lasted a maximum of 6 minutes (a 37-day-old litter).

LL behaviour occurred in the following circumstances: (1) a female feeding her pups, one of them stops sucking and starts LL, (2) a female feeds part of a litter, a pup not sucking at this time approaches the mother and licks her muzzle, (3) the pups with their mother sit nestled to each other, one of them starts LL, (4) a pup approaches a mother sitting alone and licks her muzzle, (5) a moving female is caught by the skin by a pup and when she stops, after a while, the pup starts LL.

In the three litters observed (Nos 200, 202, 261) sucking was most often accompanied by LL (the two first circumstances of LL occurrence mentioned above), and usually a pup licking its mother's muzzle had not sucked before. In one litter (No. 300) LL occurred totally

Table 2

Observations and the time of licking a mother's muzzle by young *N. fodiens*. For litters 261 and 300 the given LL time (in seconds) was measured within the first 5 minutes after the reunion of the young with the mother after an hour's separation: total — the total time of licking a mother's muzzle by different pups, max. and avg. — maximum and average time of a single act of LL by one pup. In the columns observations on the animals in their breeding cages have been separated by a broken line from the observations of the young in an unequipped cage, after their temporary separation from a mother. + — ascertainment of LL, − — no ascertainment of LL, (+) — unsuccessful attempts at licking the muzzle of the mother, E — the end of lactation.

Age of young, days	Litter no. 261			Litter no. 300			Litter no. 202	Litter no. 200
	total	max.	agv.	total	max.	agv.		
24	—	—	—	21	10	5	—	—
25	+	+	+	59	48	7	—	—
26	—	—	—	27	8	7	—	—
27	—	—	—	11	9	4	+	—
28	—	—	—	32E	20	8	+	—
29	3	3	3	78	48	26	+	—
30	4	3	2	128	36	21	+	—
31	75	75	75	+	+	+	+	+
32	—	—	—	106	42	21	+	+
33	123	123	123	118	65	30	+	+
34	27	25	13	148	62	49	+	—
35	(+)	—	—	79	26	20	+	—E
36	(+)	—	—	+	+	+	+	—
37	(+)	—	—	98	68	25	(+)	—
38	(+)	—	—	29	20	7	—	—
39	(+)E	—	—	+	+	+	—	—
40	(+)	—	—	202	125	51	—	—
41	(+)	—	—				—E	—
42	(+)	—	—				—	—
43	(+)	—	—				—	—
44	92	80	23				—	—
45	(+)	—	—				—	—

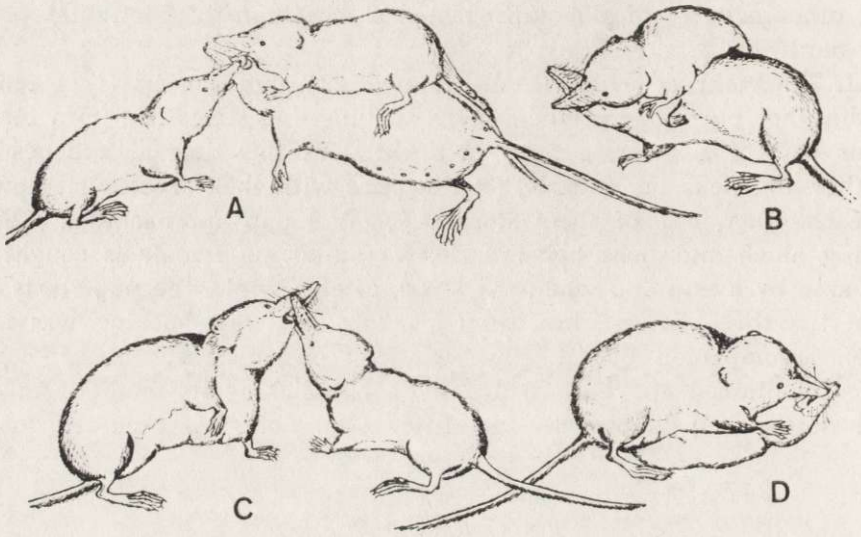

Fig. 1. Most frequently observed positions of the young and their mothers during lip-licking (explanations in the text).

independent of sucking (the 3rd and 4th circumstances). The 5th circumstance of LL concerned pups just before and after the end of lactation.

After the end of lactation LL behaviour occurred only in two litters (No. 261, 300) (Table 2). However, the behaviour of the non-feeding mothers towards the pups wanting to lick their muzzles varied.

In litter No. 261 the female, starting on the 35th day of lactation (4 days before the end of lactation), clearly avoided the ones trying LL by turning her head or moving aside. The young, however, still kept on trying to force LL. On the 44th day (5 days after the end of lactation) one pup did not leave the mother for about 15 minutes, every now and then moved its muzzle to hers and at the end pushed her down and for 80 seconds licked her lips. During the next days all the pups' attempts of LL failed. On the 52nd day the pups tried to reach the mother's muzzle for the last time.

In litter No. 300, sucking till only the 28th day, the intensity of licking the mother's muzzle did not drop till the 40th day (on the 41st day the female died). The female did not avoid such contact with the young. The frequency and the time of LL in this litter were much greater than in the others (Table 2).

The LL behaviour towards a strange female was also observed. 25-day-old pups from litter No. 300 were put together (in a unequipped cage) with female No. 261, whose own pups were 30-days old. Im-

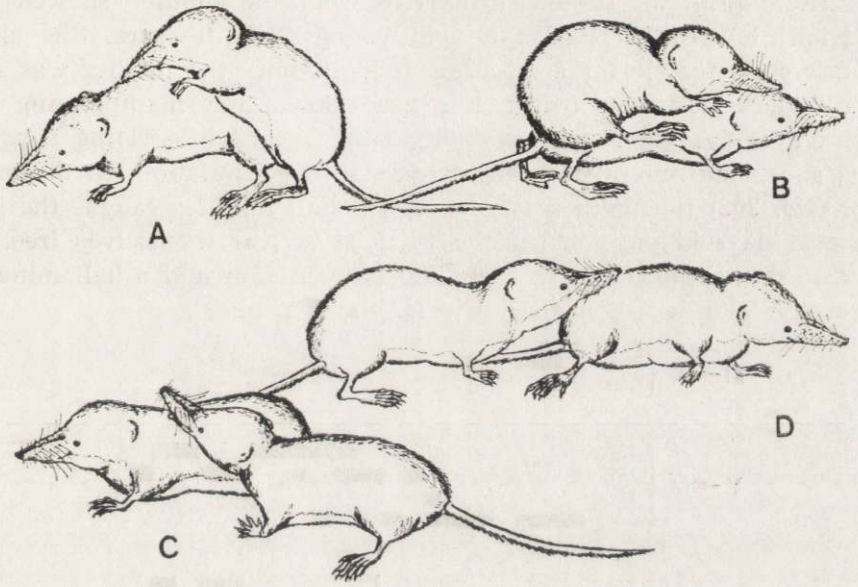

Fig. 2. *N. fodiens*' positions during "catching and moving" behaviour (explanations in the text).

mediately after being joined with strange pups, the female accepted them and allowed them to suck and lick her muzzle.

3.3. Catching and Moving (CM)

The behaviour termed "catching and moving" means the catching of the skin on the back of one animal by the other with its teeth and the moving of the animals joined in this way. The catching animal usually leaned the front of its body against the back of the caught one and pushed itself from the ground only with hind legs (Fig. 2a). In this position the animal on top played, in a way, the role of a "rider". Sometimes, the "rider" lay on the back of the caught animal with all its body, its legs not reaching the ground (Fig. 2). Less frequently one animal caught an other by the skin of the rump or the side of the body and then the animals moved one behind or beside the other (Fig. 2c, d). CM behaviour was observed both between a mother and pups, and between the pups themselves.

3.3.1. CM between a Mother and the Young

Only four times (four separate days of observation) a mother was seen clinging to the skin of the young. Such behaviour occurred in

two litters (Fig. 3). In one litter (No. 200) the mother showed CM behaviour towards a few 32-day-old young of both sexes. She clung to one young female for 3 minutes. Several times the mother was seen in a "rider" position turning her head down and manipulating her muzzle near that of a pup (probably LL). Once, while riding a young male, she made several movements resembling copulation. In the other litter (No. 202) the mother for one and a half minutes caught the skin of the 32-day-old pups which clearly tried to tear themselves free. On the 33rd day she behaved in a similar way for four and a half minutes, and on the 36th day she showed CM for the last time.

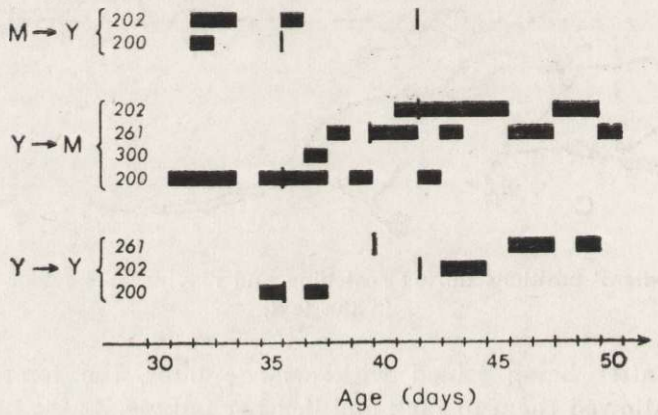

Fig. 3. Observations of the occurrence of "catching and moving" behaviour in consecutive days of life of young *N. fodiens*. 3 categories of this behaviour have been presented: M→Y — a mother clinging to the skin of the young, Y→M — the young clinging to the mother's skin, Y→Y — the young clinging to each other. The numbers of the graph stand for the numbers of the litters. The end of lactation has been marked by a vertical line.

More often, (during 23 separate days of observation) the young of sexes were seen clinging to the mother's skin (Fig. 3). Such behaviour occurred in all litters, although in one (No. 300) only once. This occurred 1—5 days before the end of lactation (Fig. 3). It often was accompanied by the need for sucking or LL. Many times a young pup, clinging to its mother's skin, put its muzzle under her abdomen or tried to lick her muzzle immediately after she stopped. When the mother started to move the pup again started to catch her by the skin. Sometimes, a pup in a "rider" position caught the mother's skin nearer to her muzzle and then, not getting off her back, turned its head down and started LL.

In one litter it was noticed that always the same pup clung to the mother's skin and somehow initiated such behaviour in the other pups

towards the mother. In other litters no animal was similarly conspicuous.

Sometimes, three pups at the same time caught the mother by the skin, but only one of them remained in the CM position for a longer time. CM of a single pup lasted from 1 second to three and a half minutes.

Before the end of lactation the mothers tolerated the pups clinging to their skin, but afterwards they reacted to such behaviour more and more aggressively.

3.3.2. CM between the Young

CM between the young was observed a few days later than between the pups and their mother (Fig. 3). It occurred either independently of CM of the pups towards the mother or simultaneously. A pup clinging to or wanting to cling to the skin of an escaping mother, in a way diverted its interest to CM with the other pup passing nearby.

The movement of two pups in CM caused the same behaviour by the other pups. All combinations of the sexes of the young appeared in this position, *i.e.* a female clung to a male's or female's skin, and the male caught a female or another male by the skin. During CM the young changed roles and partners. It happened that a "rider" pup caught another one jumping on it from above. Sometimes, it jumped on from the front of the body and then the animals tossed about till the upper animal took a position parallel to the other one. It was always only one individual that clung to the skin of the other. The pups remained in CM from one second to three minutes. Sometimes, they went to the nest box in this position and came out joined together in the same way. In one case of CM among the pups, a 37-day-old male, clinging another male's skin, made movements resembling those of copulation.

The last time CM was seen among siblings was on their 49th day of life (Fig. 3). The older pups sometimes clung to the skin of animals not from their own litter. This was observed when non-sibling were put together in one cage or when outside pups were put in cages occupied by other litter. However, it was not a typical CM. One or several siblings at a time clung to the skin of the outside, escaping animal for not more than a few seconds. Such behaviour discontinued after the muzzle and the sides of the newcomer's body were sniffed. Twice CM behaviour between the wild-caught young shrews was observed. By their appearance it could be seen that they had left the nest recently. In one case three males caught on the same day were put in one cage. On the 5th day of captivity it was noticed that one pup showed CM behaviour towards the other two. In a "rider"

position, it also made copulationlike movements. In another case two young males, after 2 weeks of captivity were let free. After having been freed, the pups stopped and one of them climbed onto the other one. After about two minutes, the pup lying underneath moved and the other one caught it with its teeth by the skin of the rump. The animals joined in this way walked a few metres before disappearing from view.

3.4. Aggressive Behaviour among the Young

No symptoms of aggression among the young were noticed until the 35th day of life. Occasional squeaks of a pup pushed for example, by a jumping individual, were not taken into account.

The first sign of mutual intolerance of the young was a warning, hissing voice (Fig. 4). Usually, a few days later the pups took warning-defensive body positions: (1) standing on 4 paws, they raised heads with their muzzles in the direction of an opponent ("stance"), (2) they raised one front paw, with the paw down or up and the toes spread out ("tripedal"), (3) sitting on their rumps they raised the front of the body or stood on outstretched hind legs ("upright"), (4) lay on the side of the body with one front and one hind leg raised up ("sideways") (the names

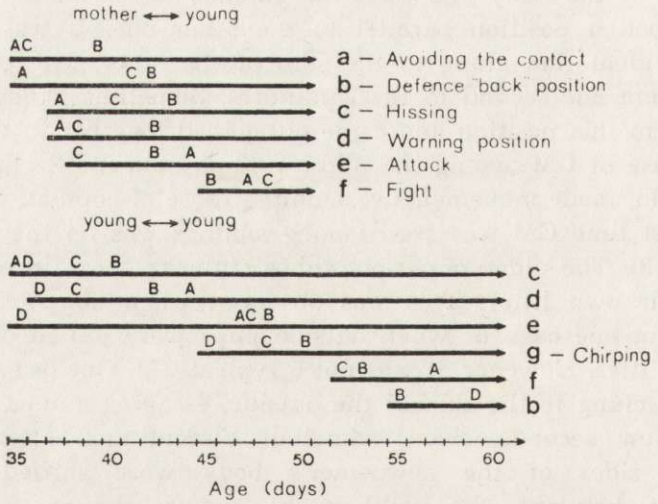

Fig. 4. The development of family aggressive reactions in *N. fodiens* showing a mother's aggressive behaviour towards the young (mother-young) and aggression between the pups (young-young). a—g: antagonistic reactions A, B, C, D ⊢ indication of the animals' age in which a certain kind of reactions was observed for the first time in particular litters (No. 200, 202, 261, and 300 respectively).

of the positions according to Olsen, 1969 are given in brackets) (Fig. 4). In each of the listed positions the animals usually opened their muzzles wide. Sometimes, they simultaneously hissed or when older (from about the 45th day) they loudly chirped ending with a hiss (compare the voices of young *N. fodiens*, Michalak, 1987).

The animals vocalized or took warning body positions in the following situations: (1) the pushing of a sleeping or resting animal by another one, (2) mutual pushing of jumping or running pups, (3) the encounter of young in a tube joining the cages, (4) the entering of one animal into a nestbox already engaged by one or more pups, (5) importunate CM among the young.

The longest mutual aggression of the young occurred when they meet in the tube joining the cages. The animals entering the tube from the opposite sides (the tube was 2 cm in diameter), had no possibility of going past each other. After meeting in the tube, they usually hissed and moved back to its ends, sat there and remained alert. The reneved attempt of going through by one of the pups caused the hissing of the other and its entering entirely or partially into the tube. After a while the pups moved back again and sat at the openings of the tube. Such behaviour sometimes repeated itself several times until one of them gave up or passed through the tube pushing out the other one.

At the beginning, when an animal came into an already engaged nest box, sometimes only single squeaks or hisses from the nest were heard. Older pups (from about the 45th day) showed caution when they entered the nest. First, they put their head in and then, if there was no reaction from the pups inside, they entered the nest slowly. Sometimes they immediately jumped out of the nestbox when repeated hissing and chirping could be heard.

The young attacking each other was seen for the first time on the 35th day (Fig. 4). The pups pushed each other while jumping in an empty cage and for a moment they attempted to bite each other ("attack" according to Olsen, 1969). Such an early attack occurred only in one litter, while in the other ones it took place after the 46th day (Fig. 4). At the beginning the young attacked each other only when pushed or during an importunate CM.

Until about the 50th day of life the pups' aggresiveness was rather low. Very seldom did they take warning body positions and attacked each other only occasionally. The conflicts among them finished usually with a squeak or a hiss. The animals reacted hostilely only if during a direct contact one disturbed another in some activity, for example, scratching or resting. In this period of life, the young still slept in groups of several animals in one nestbox, in spite of the fact that there

were other empty nestboxes in the cages. Moreover, they showed contact behaviour *i.e.* mutual nestling to each other in or outside the nest (Michalak, 1983). Such behaviour still occurred in older pups, though not in the cages inhabited by the animals, but only when a litter was put into an empty cage. At the beginning, the young treated each other aggressively, but after about 20 minutes, 2—3 animals nestled to each other. The last time they behaved in such a way was on the 61st day of their life.

When the pups were 50-days old, only then was their aggressiveness caused by the mere presence of another individual. Two, not previously noticed, antagonistic reactions were observed: (1) a fight in which the fighting animals got locked together ("combat"), (2) taking the position on the back with the paws raised up ("back") (Fig. 4). The stronger animals clearly dominated over the weaker ones. The threatening behaviour of a presumed dominant or, more rarely, his attacking the subdominant, most often caused the subdominant's escape or sometimes its taking a position showing the abdomen ("back", "sideways"). When the young had no possibility of hiding from each other, then it was enough for the dominant to come closer to cause the weaker individual to lie on its back and sometimes remain in such a position for about a minute after the opponent had receded. Putting the pups in an empty breeding cage or a newly equipped one, led to repeated attacks and fights. The severe aggressive reactions ended when the animals made themselves at home in new places. After the 60th day of life, the young avoided all direct contacts (Michalak, 1983).

3.5. Food Rivarly among the Young

During the first days of eating solid food (from the 28th day of life) (Michalak, 1987), very often the young were seen together eating meat from one food container. Later, more and more often they tore off pieces or from under the paws of the eating animal. This mutual snatching emitted by one animal caused another to approach it, going past or even through the container with food, and to take the meat from the muzzle or from under the paws of the eating animal. This mutual snatching of food did not cause any protest by the other pup. For example, it was observed that a 38-day-old animal climbed on another one's back and turning its head downwards bit the meat piece by piece straight from the muzzle of the animal sitting underneath. The last time the shrews were seen eating one piece of meat together was on the 41st day. Older animals, after taking away a piece of meat from the container, clearly hid from the other ones. They still did not attack others trying to take away their food. Only sometimes did they take warning

body positions or hissed, though most often went away with the meat in their muzzle, each time to a new place.

On the 48th day it was observed for the first time that one pup attacked another defending a piece of meat. During the following days the young, while eating, no longer tolerated the presence of other individuals. Usually they came to the food containers alone. It still happened that they ate from one container, but only when very hungry or when they were put in a single, new cage.

3.6. Aggressive Behaviour between a Mother and the Young

In the last days of loctation the females started avoiding contacts with the young (Fig. 4). More and more often they left behind the young trying to suck or lick their muzzles. Only in one litter a female attacked her young pup (during CM) before the end of lactation (Fig. 4).

After lactation had finished, the dominating form of the mother's defence from importunate pups was escape. Also, they often lay on their back in the "back" position (Fig. 4). Put together with the young in an empty cage, they sometimes became still as if isolating themselves from the surroundings. They nestled down snugly into the corner of the cage, with their back to the middle of it and their muzzles raised up, or they clung flat to the bottom of the cage.

Seldom did the females take warning body positions or attacked the young (Fig. 4). The first fights with the young were observed only after the 44th day (Fig. 4). They occurred sporadically and only after a long harassment of the mothers, during repeated attempts of CM.

Aggressive reactions of the females did not have any influence on the later behaviour of the young, which after a while renewed their attempts of contact with the mother.

4. DISCUSSION

4.1. Methods

It was difficult to ascertain sucking and lip-licking behaviour of water shrews while observing the animals in breeding cages due to the animals' secretive habits (hiding under the litter and in the nestboxes) and the limited time of observation. Rare observations of LL and sucking outside the nest (except in one litter) made it impossible to determine the intensity of these particular needs of the young and their duration.

Moving the animals from their breeding cages to an unequipped cage was not advantageous for an observation of this kind either. Stressed animals were either chaotically running around the cage or lay still,

nestled to each other. It was not until the shrews were observed in an empty breeding cage, after a periodical separation from the mother, that positive results were obtained. During the separation from the mother, the needs for sucking and LL increased so much that despite the stressfull circumstances, they started to suck immediately after the family had been reunited.

4.2. Lip-licking

So far lip-licking behaviour has been ascertained in three shrew species, *i.e.: Suncus murinus* Linnaeus, 1766 (Stine & Dryden, 1977), *Myosorex varius* (Smuts, 1832) (Baxter & Lloyd, 1980), *Neomys fodiens* (Köhler, 1984a). It is interesting that a young mouse (*Mus musculus*) adopted by a feeding *S. murinus* also licked the muzzle of a shrew nestmate (Dryden, 1980).

Young *Suncus murinus* licked their mother's muzzle from the first day of their life (Stine & Dryden, 1977). In the case of *N. fodiens*, when the young left the nest, *i.e.* from the 22nd day of life, only then was LL behaviour observed (Köhler, 1984a) and from the 24th day (the present study). However, it is probable that younger *N. fodiens* already show LL, but it is very difficult to observe since when a closed nest is opened the pups grow cold and become still or, when older, escape.

In *S. murinus* LL behaviour finished on the 18th day together with the end of lactation (Stine & Dryden, 1977). Köhler (1984a) saw young *N. fodiens* licking the mother's muzzle for the last time on the 5th day after the end of lactation, *i.e.* on the 41st day. Also, in my breed of *N. fodiens*, in two litters out of four, after weaning the young showed LL behaviour. However, in one of these litters the female clearly avoided this kind of contact with the young. In another litter, it was probably the mother's illness that influence the quick end of lactation and the exceptional tractability of the females towards her young. In two other litters of *N. fodiens* the pups did not even try to lick the mother's muzzle after weaning.

Stine & Dryden (1977) ascertained that in *S. murinus* in 91 out of 99 observed acts of lip-licking, the behaviour was directly proceeded by sucking which indicates that there existed the immediate sequence of both these activities. In *N. fodiens* LL behaviour often occurred also as an activity accompanying sucking, though usually a pup licking a mother's muzzle did not previously take part in sucking (other individuals were sucking at that time). Moreover *N. fodiens*, after weaning, licked or tried to lick a mother's muzzle. These facts indicate that sucking and lip-licking of this species are not strictly connected activities.

An average single act of LL lasted 21 seconds in *N. fodiens* and 1

minute 9 seconds in *S. murinus* (Stine & Dryden, 1977). It is possible, however, that these differences are not the result of an interspecies difference, but are connected with the conditions of observation and the age of the observed animals.

The function of shrews' lip-licking behaviour has not been explained so far. Köhler (1984a) investigated the contents of a *N. fodiens* female's muzzle during LL and did not notice any remains of food, but only that the amount of saliva between the teeth was grater than usual. He suggested that the young take the mother's saliva as a source of fluid needed for diluting solid food. In his opinion this was confirmed by the fact that young *N. fodiens*, after eating solid food, did not drink water, but looked for the mother and licked her muzzle. Also Stine & Dryden (1977) noted that a mother's saliva taken by young *S. murinus* during LL may (among many other functions suggested by the authors) be a source of fluid diluting a mother's condensed milk. My observations of *N. fodiens*' behaviour deny, to some extent, the fact of LL being a form of transfering fluid for diluting food. This does not seem to be the basic function of this behaviour. Young *N. fodiens* showed LL behaviour while with the mother in an empty breeding cage, thus not taking food, but still licking the mother's muzzle. Moreover, it has not been ascertained that, as in the Köhler's breeding colony (1984a), young *N. fodiens* sought lip-licking contact with the mother after receiving solid food. On the other hand, the licking of the mother's muzzle by young that have not previously sucked the nipples and the occurrence of this behaviour in pups after weaning indicate that it is not a matter of diluting a mother's milk.

4.3. "Catching and Moving"

"Catching and moving" behaviour seems to be multifunctional. Prior to weaning and just after weaning CM of the pups towards the mother appeared as if the pups' wanted to stop the mother's escape from them, in order to suck her or lick her muzzle (CM often directly proceeded attempts of sucking and LL). On the other hand, CM behaviour (especially among the young) looked like pseudoplay because the animals mutually imitated such behaviour, changed partners and roles during CM. Futhermore, CM ended when the family bonds declined. Treating CM as a play behaviour, one could suppose that it includes such functional aspects as: fighting, hunting and sexual behaviour.

With CM behaviour the matter of the probable occurrence of a "caravan" behaviour of *Soricinae* is also connected. In recent years there have been published some short reports about creating the sort of "caravan" by some young *Soricinae, i.e.* by: *Sorex cinereus* (Goodwin,

1979), *Clarina brevicauda* (Martin, 1982), probably *Sorex araneus* (the species was not precisely defined, Harper, 1977).

Between CM behaviour of young *N. fodiens* towards a mother and caravan behaviour of *Crocidurinae* there exists some similarity as to the animals' position and their way of shifting. One could, for example, imagine that a mother and one pup in CM position make a minicaravan and 2—3 pups clinging to the mother's skin (a "cluster caravan" Vlasák, 1972). It does not seem, however that CM could be taken for the equivalent of a caravan. Caravaning in *Crocidurinae* is a form of transport of the young by the mother and occurs from about the 6—10th day of the pups' life till the end of lactation at the longest. CM behaviour in *N. fodiens* occurs only just before and after the end of lactation. In this period of young shrew's lives, their outside-the-nest activity and their ability of orientation are developed well enough to exlude treating CM behaviour as a from of transport of the young by the mother, the more so because the mothers avoid the young which try to cling to their skin after weaning.

4.4. Tolerant and Aggressive Behaviour

In an earlier study (Michalak, 1983) the stability of the family relations compared to the other *Soricidae* was discussed. There still remains the need for considering what factors may be conductive to the tolerant behaviour of young *N. fodiens* towards each other.

The mutual smell recognition of the animals certainly plays an important role here. It seems that by sleeping and resting in one nest and contact behaviour outside it expressed by mutual nestling of mother and young and also of the pups themselves in a position in which one individual lies on its mate or beside it the young obtain the common family smell (Michalak, 1983). An identical contact behaviour was ascertained by Hutterer (1976) in *Sorex minutus* Linnaeus, 1766. Stine & Dryden (1977) described the occurrence of the "drape" behaviour in *Suncus murinus* which is also similar to the contact behaviour of *N. fodiens*. Young *S. murinus* climbed their mother's back and rested in this position. Such behaviour occurred also among adult *S. murinus*. According to Stine & Dryden (1977) "draping" in *S. murinus* is supposedly the way of smell signing within a family and the form of signing social partners. In *N. fodiens* a contact behaviour has never been seen among adult individuals and thus may only be the mechanism of acquiring a common family smell.

Tolerant coexistence of young water shrews is also connected with a widely developed threat behaviour in this species which may limit the occurrence of more given aggressive reactions of the animals to a

considerable extent. Young *N. fodiens* do not attack straight away in conflict situations. They take warning body positions or emit warning noises which gives them time for mutual recognition and restraining from the attack. If older, it makes possible the escape of a weaker individual. A submissive body position restrains the stronger animal's aggression.

First aggressive reactions among siblings were observed on their 35th day of life. The observations of the behaviour of the animals harassed by people showed, however, that some models of threat behaviour had occurred much earlier than it was ascertained in relationships among animals. Young *N. fodiens* caught in the hand, kept in it or annoyed by some object (for example a stick) emitted warning hisses or chirping already from the 21st—22nd day (Michalak, 1987) and from the 27th—30th day took some of the warning body positions *i.e.* "stance", "tripedal", "upright" (Michalak, unpublished). Hence, it is possible that the living conditions of the animals in captivity delay the moment in which aggressive behaviour in a group of siblings in manifested. The main factors weakening the animals' vigilance and their mutual distrust could be: the lack of encounters with strange animals and the threat caused by them, excess food, the animals' good mutual acquaintance and the possibility of avoiding too frequent encouters among them (several cages, nestboxes, eating places).

After the end of lactation *N. fodiens* females appeared to be dominated by their own young. It was shown by their escaping the pups and frequent submissive positions ("back", "sideways"). Even the fights with the pups were rather the form of the mothers' defence, not the attack, for they occurred only after a long torment by the young. Low aggressiveness of non-lactating females was also ascertained towards outside young of the same age as their own pups or younger. However, lactating females, feeding the litter still in the nest severely attacked young that had been weaned (Michalak, unpublished). It is possible that they would also attack their own weaned young, if they were already feeding the next litter.

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ZACHOWANIE SIĘ MŁODYCH *NEOMYS FODIENS* W NIEWOLI

Streszczenie

Obserwowano zachowanie się młodych *N. fodiens* (4 mioty) w okresie od opuszczenia przez nie po raz pierwszy gniazda do około 60 dnia ich życia. Młode intensywnie ssały matkę przez 5 tygodni (Tabela 1). Od 24 dnia życia wylizywały pysk matki. Czas pojedynczego seansu lizania pyska matki przez jednego osobnika wynosił od 1 sekundy do 3 minut, średnio 21 sekund.

W okresie tuż przed i po zakończeniu laktacji do ok. 50 dnia życia młodych obserwowano między nimi a ich matką oraz między samymi młodymi zachowanie nazwane „chwytaniem i przemieszczaniem się". Polegało ono na tym, że jedno zwierzę chwytało zębami drugie za skórę grzbietu i tak zczepione osobniki chodziły po klatce (Ryc. 2). Zachowanie to było wzajemnie naśladowane przez młode tzn. pojawienie się w ten sposób połączonych ze sobą osobników wywoływało takie samo zachowanie się względem siebie innych młodych.

Pierwsze objawy wzajemnej nietolerancji między młodymi obserwowano w 35 dniu ich życia (Ryc. 4). Zwierzęta przyjmowały ostrzegawcze pozycje ciała i wybezpośredniego kontaktu jeden przeszkadzał drugiemu w jakiejś czynności. Po 50 dniu życia coraz częściej wrogo reagowały na samą obecność w pobliżu drugiego osobnika. W 52 dniu obserwowano pierwszą, ostrą walkę między młodymi, podczas której gryzące się zwierzęta zczepiły się ze sobą. Dwumiesięczne młode unikały już wszelkich wzajemnych kontaktów.