

Maintenance and Reproduction in the White Toothed Shrew, *Crocidura russula monacha* Thomas, in Captivity¹

By SHLOMO HELLWING

Department of Zoology, Tel-Aviv University, Tel-Aviv, Israel

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Introduction

The insectivores (e. g. Soricidae) exhibit many interesting reproductive patterns, and according to ASDELL (1964) much more investigation of them is needed. Data concerning reproductive phenomena in Soricidae are derived from studies based mostly on species of shrews from the wild: BRAMBELL (1935), BRAMBELL and HALL (1936), PRICE (1953), TARKOWSKI (1957), PUCEK (1960), BUCKNER (1966), DAPSON (1968), CHRISTIAN (1969) for Soricinae; WAHLSTRÖM (1929), NIETHAMMER (1950), KAHMANN and KAHMANN (1954), FRANK (1953, 1954), ANSELL (1964), ROOD (1965) for Crocidurinae. Several available accounts, based on records of births in captivity, indicate that shrews may breed under laboratory conditions (PEARSON, 1944; DEHNEL, 1952; CONAWAY, 1958; DRYDEN, 1968, 1969; NAIK and DOMINIC, 1970; VOGEL, 1970).

Despite the wide geographical distribution (Asia, Africa and Europe) of the subfamily Crocidurinae (ca. 177 species) relatively little information concerning their reproductive biology is available. So far, only *Suncus murinus* and *S. etruscus* have reproduced in captivity and been investigated. Specific information on the subspecies of *Crocidura russula* is scanty. Two females of *Crocidura russula monacha* (distributed in Israel) trapped in April at Hulata and at Haifa were pregnant with 5 and 4 embryos respectively (HARRISON, 1964).



Fig. 1. *Crocidura russula monacha* (Photo: W. FERGUSON).

¹ This work is dedicated to Prof. H. MENDELSSOHN on the occasion of his 60th birthday.

Materials and Methods

Crocidura russula monacha, the commonest shrew of Israel, is widespread in the hills and coastal plain of the northern and central part of the country. It is a medium-sized soricid with a body weight of 7–9 g and body length of 60–75 mm (Fig. 1).

The first successful results in breeding *Crocidura russula monacha* in captivity were obtained by H. Mendelssohn, who started a breeding colony in 1953. The colony was enlarged in 1965 and is now being maintained in the Research Zoo of the Tel-Aviv University. In 1969 a second species, *Crocidura leucodon*, was introduced; its breeding was also successful (HELLWING, 1970; 1971). Most of the data presented here on reproduction in *Crocidura russula monacha* are derived from this controlled subsisting breeding colony.

The shrews used to start the breeding colony were collected mostly in Kefar Shemaryahu, Ramat Hasharon and Bet Hashitta. The colony is housed in two open-air buildings (Fig. 2). The shrews are kept in the following groups: monogamous breeding pairs, polygamous breeding groups and sibling groups. The monogamous breeding pair proved to be the best grouping for laboratory purposes; breeding is rarely successful in the polygamous breeding group. The pairs are caged in stainless steel boxes (50 × 34 × 20 cm) and provided with a bedding of sawdust and sand and with straw as nesting material. One wooden nestbox (8 × 5 cm) or a small flowerpot (diameter 12–15 cm) is placed in each cage (Fig. 3). Nest boxes and cages are periodically dusted with a contact insecticide: Opigal 5 (Abic) (carbamate derivative 5%).

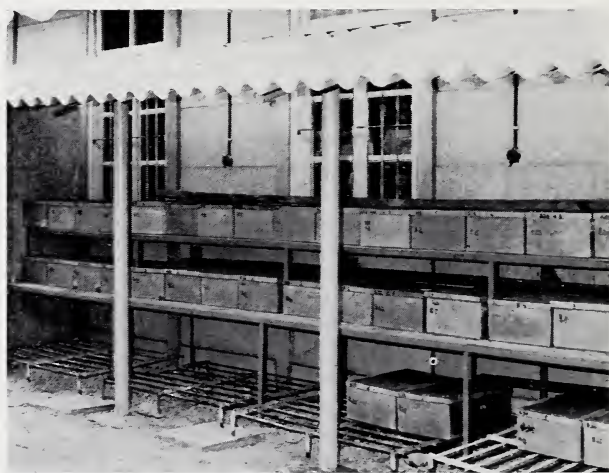


Fig. 2. Partial view of the shrew breeding colony in the Tel-Aviv University.

Fly larvae and water are provided ad lib. A mixture of chopped meat, boiled egg, fish-meal, cereals and milk is offered as a daily supplement. Twice a week poly-vitamins (Rafa 9) are added to the food. Cages are checked daily for pregnant females and for neonates. Young are usually removed from the parental cage at 22–24 days of age (after weaning). They are assembled into groups of 6–8 individuals of the same sex and age (month of birth). Good breeding pairs are usually not separated and are allowed to complete their full reproductive life. Most of the shrews adapt well to captivity, showing high longevity (2–2½ years) and successful reproduction. Throughout the period 1965–1970, 743 litters including 2245 young were obtained.



Fig. 3. The standard cage with nest and food dishes. Note the permanent defecation places in the corners.

The male: The adult male is characterized by green pigmented testes and prominent seminiferous tubules. A fat body is present between the prostate and epididymis. The penis is covered by minute, horny spines.

The female: The mature ovarian follicles are characterized by the absence of a real antrum. The slit-like follicular cavity enlarges only after copulation. The follicle is surrounded by the thin theca, in which an external and internal part are not clearly differentiated. There are 3 pairs of nipples in the inguinal region.

Sexual dimorphism: Morphologically, the males differ little from the females. On the average they are heavier than the females (8.69 g — male, and 7.94 g — female); the differences are statistically significant. Fig. 4 represents frequency distribution of

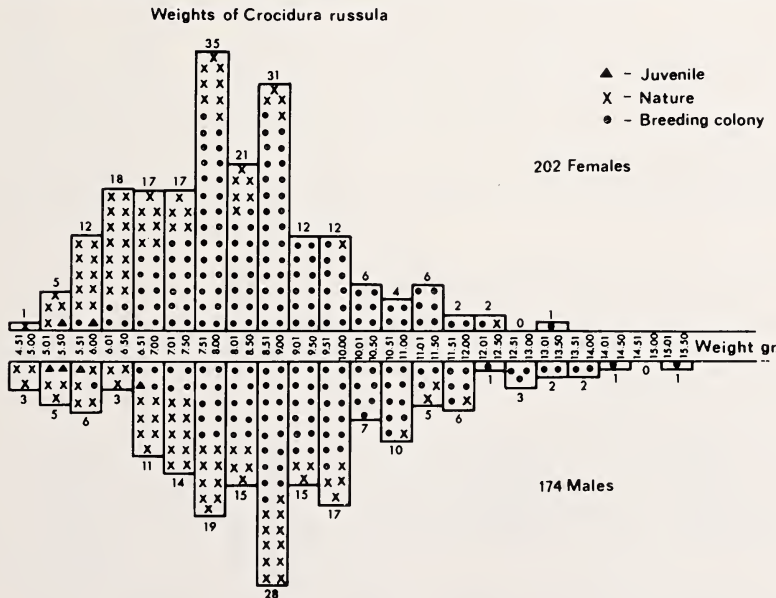


Fig. 4. Body weight in *C. russula monacha* (females and males).

the body weight for 376 animals from captivity and from the wild. The lateral scent glands are also better developed in the male and undergo hypertrophy during sexual activity.

Results

Duration of gestation: Known gestation periods in *C. russula monacha* were derived from recording interbirth intervals and from observed copulations, separating the male from the female. Data on gestation periods are given in Fig. 5. The data indicate that the most frequent gestation period is 29 days — with an average of 28.5 days (range: 24–32). The maximum interval between introduction of isolated post-partum females to active males (mating test) and the discovery of newborns was determined 16 times: there were 2 intervals of 26 days, 3 of 27 days, 7 of 28 days, 3 of 29 days and 1 interval of 31 days. These data give an indication that receptive post-partum females bred shortly after they were exposed to males.

It was observed that in *C. russula monacha* there exists a tendency for the duration of gestation to be inversely related to the number of young in the litter. Most litters with one young had a gestation period of 29 days. Litters with 4, 5 and 6 young were

Table 1

Dependence of gestation period on litter size

Litter size	Gestation period in days										Total no. of pregnancies	Gestation period days	
	24	25	26	27	28	29	30	31	32	Min.		Max.	
	Number of pregnancies												
1	1	0	1	2	7	15	3	4	1	34	24	32	
2	2	1	1	5	11	21	4	1	3	49	26	32	
3	0	0	3	9	28	19	11	4	8	82	24	32	
4	1	1	4	17	33	45	6	2	2	111	24	32	
5	0	0	1	6	13	8	1	0	0	29	26	30	
6	0	0	0	0	2	2	0	0	0	4	28	29	
Total	4	2	10	39	94	110	25	11	14	309	—	—	
Significance (4 d. f.) = 94.644													

Table 2

Gestation period in 2 groups of females

Lactating	Non-lactating
1. D 67 26 days	1. D 53 26 days
2. D 66 28 days	2. D 24 27 days
3. D 67 ¹ 28 days	3. D 5 27 days
4. D 60 29 days	4. D 8 27 days
6. D 46 29 days	5. D 19 28 days
	6. D 51 28 days
	7. D 46 ¹ 29 days
	8. D 30 31 days

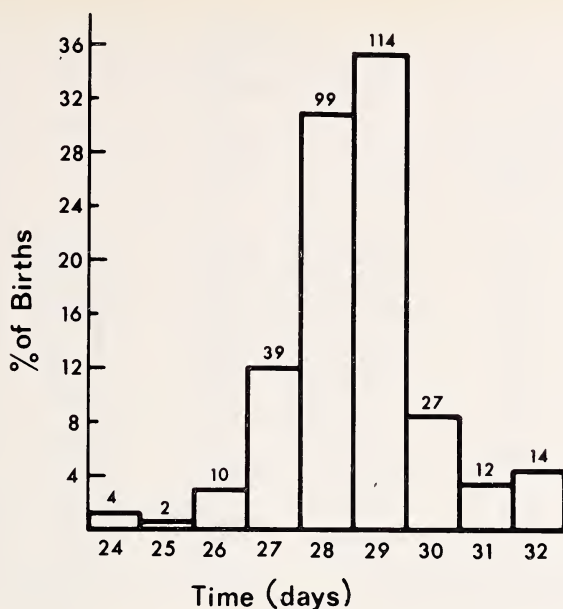


Fig. 5. Duration of gestation in *C. russula monacha*; Frequency distribution of pregnancy lengths derived from interbirth periods.

usually born earlier (26, 27, 28 days) (see Table 1). This inverse relationship was checked statistically and found to be significant. Lactation does not prolong the gestation period in *C. russula monacha*. Lactating and nonlactating shrews delivered litters at approximately the same intervals as can be seen from Table 2. There is apparently no delayed implantation due to lactation in this shrew.

Post-partum oestrus: It was observed that immediately after parturition most females of *C. russula monacha* enter a state of strong receptivity lasting for 5–6 days. Isolated, lactating females will accept males and copulate. Most of the post-partum matings are fertile, since after approximately 28–29 days the next litters are born. Permanently paired females, both lactating and nonlactating, also produce litters 24–32 days after the delivery of the previous litter. Several parous females had 4–10 successive, post-partum pregnancies at regular intervals, followed sometimes by a longer period of nonpregnancy (anoestrus).

Litter size: Data were obtained from 670 litters of shrews and from 39 pregnant females. The litter size varies from 1–7, with a mode of 4 and an average of 3 young. There were 92 litters of one, 125 litters of two, 189 litters of three, 206 litters of four, 51 litters of five, 6 litters of six and 1 litter of seven (see Fig. 6).

The litter size in *C. russula monacha* was found to be positively correlated with the age and parity of the female: the young females at age 3–6 months have small litters. Larger litters (as expressed in mean litter size) are born when the age of the mother ranges between 9–12 months (Fig. 7). It was also observed that the mean litter size tends to increase towards the 9th–10th litter; (Wurfffolge). In 39 pregnant females which were dissected the number of embryos varied from 1–5 ($M = 3.3$). Comparing the mean number of embryos with the mean litter size it appears that there is not a great embryo loss in *C. russula monacha*.

Sex ratio: Throughout the whole period of study, a numerical predominance of males was noted. From Table 3 it can be seen that in 507 specimens where the second-

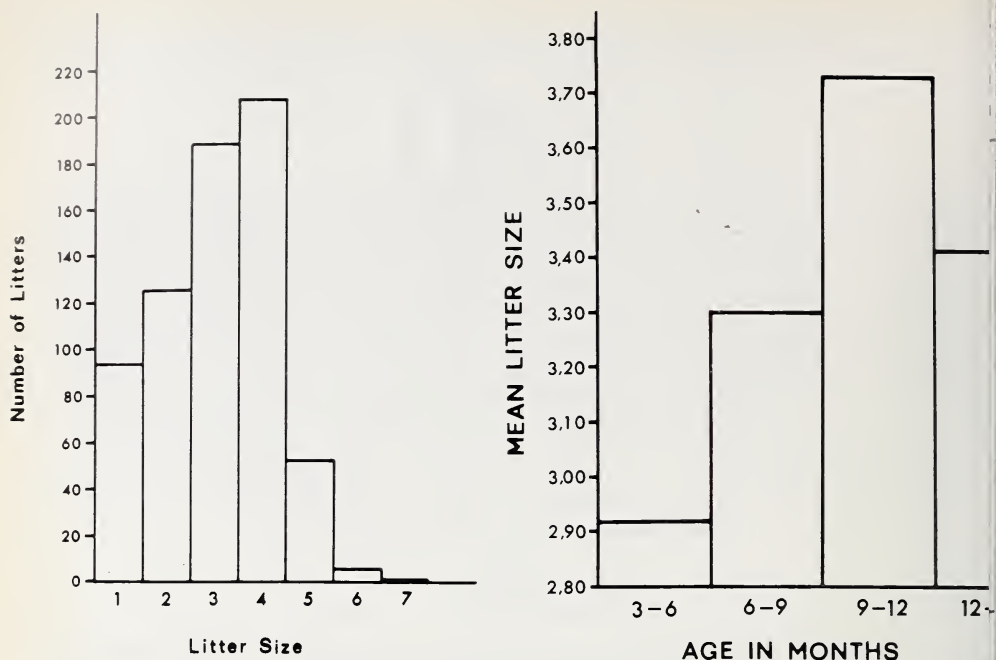


Fig. 6 (left). The litter size in *C. russula monacha*; frequency distribution of different sized litters. — Fig. 7 (right). Relation of mean litter size to age of female in *C. russula monacha*.

dary sex ratio was checked, 53.6% were found to be males. The data for the sex ratio from captivity may be considered with a higher degree of confidence when compared with the sex ratio found in the material obtained by trapping.

Sexual maturation: *C. russula monacha* in this colony display juvenile breeding. Sexual maturation, as indicated by the first fertile mating, usually occurs when the animals are 2–3 months old. Data on first known parturitions for 15 young females are given in Table 4. The data indicate that some young females breed for the first time when they are about 7 weeks (48–50 days) old. The youngest male and female (a brother-sister pair) to mate in captivity were 45 days old; after 28 days (at the age of 73 days) the first litter was born and the mother nursed and weaned the progeny

Table 3

Secondary sex-ratio in *C. russula monacha*

Year	Number of litters	Males	Females	Total	% males	% females
1968	54	109	81	190	57.4	42.6
1969	80	125	120	245	51.02	48.9
First half 1970	25	38	34	72	52.7	47.3
Total	159	272	235	507	53.6	46.4

Table 4
Age at first known breeding of captive juvenile
Crocidura russula monacha

No.	Symbol	Month of birth	Date of pairing	Date of first parturition	Age at first parturition (weeks)	Age at first breeding (weeks)
1	S 7	March	15 April	22 May	11	7
2	S 66	February	24 March	22 April	11	7
3	B 7	February	8 April	23 June	19	15
4	B 36	September	7 October	24 November	11	7
5	D 45	January	25 January	14 April	14	10
6	B 9	May	30 June	25 August	15	11
7	B 46	March	3 May	10 June	13	9
8	S 72	April	5 May	24 June	11	7
9	S 77	February	30 March	30 April	12	8
10	S 53	March	20 April	6 June	13	9
11	G 1	December	16 February	22 March	15	11
12	N 32	March	15 May	28 June	15	11
13	N 56	March	30 April	6 July	17	13
14	N 53	March	30 April	12 June	14	10
15	N 48	March	28 April	16 June	14	10

normally. Anatomical sexual maturity (large follicles and spermatogenesis) is reached much earlier (20 days in the female and 30–32 days in the male).

The breeding season (seasonality): Analysis of colony records of 5 years revealed that reproductive activity in *C. russula monacha* takes place throughout the year, showing highest intensity in spring (March, April, May) as can be seen from Table 5.

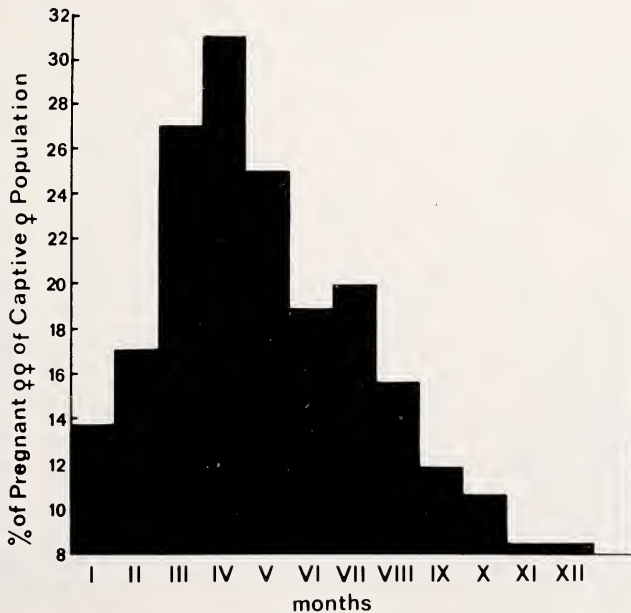


Fig. 8. Monthly distribution of pregnant females in the breeding colony of *C. russula monacha*.

Table 5

Number of litters born (by month)

(calculated for total number of litters during the period 1965—1970)

Month	Number of litters	%	Month	Number of litters	%
January	39	5.7	July	69	10.1
February	49	7.2	August	58	8.5
March	81	11.9	September	45	6.6
April	97	14.2	October	38	5.5
May	81	11.9	November	29	4.2
June	64	9.4	December	30	4.4

In April, 31.1% of the permanently paired females were pregnant, in contrast with November and December, when only 8.9% of the paired females were active in reproduction (see Fig. 8). In an attempt to correlate climatic factors and seasonality in reproduction, we combined in one figure 9 the mean percentage of pregnant females per months, mean temperature and mean percentage of relative air humidity. A high incidence of pregnancies can be noted in spring when air humidity decreases from 71.0% to 62.2% and when temperatures rise from 13.1° C to 18.2° C.

Breeding performances: The number of litters born from one female ranges from 1—19. The active reproductive period in the life of a shrew lasts 16—24 months. An average breeding pair can be expected to produce 10—15 litters during its life cycle. Tables 6 and 7 present the breeding performances of females B5 and B8, from which it can be seen that most of the litters were conceived during post-partum oestrus; the number of young born during the reproductive life cycle of the two females ranges from 49 to 51 young. The number of young per litter decreased as the mother's age increased.

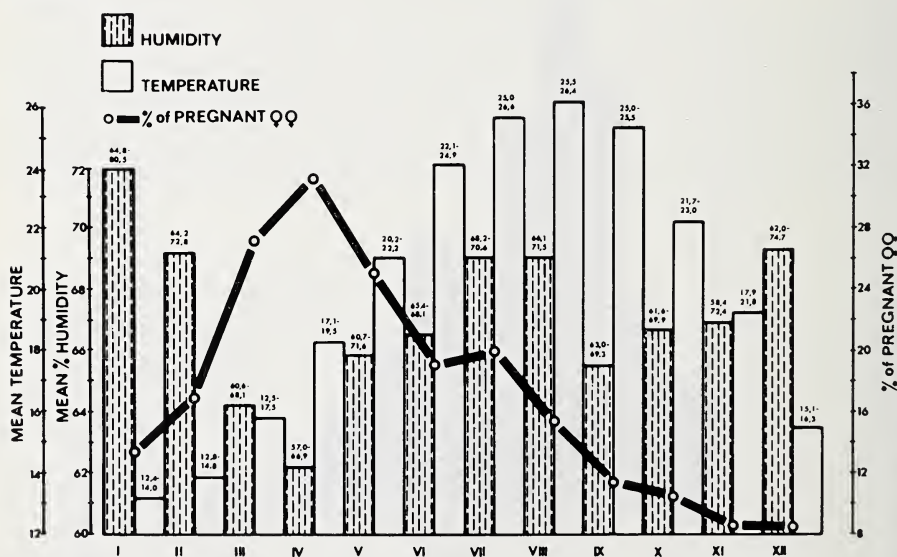


Fig. 9. Relation of births to monthly mean temperature and mean relative humidity.

Table 6
Breeding performance of female B 5

No.	Birth date of litter	Days since last litter	Number of young born	Number of young surviving
1	20 February	—	4	3
2	20 March	29	4	4
3	17 April	29	5	5
4	14 May	28	5	5
5	10 June	28	5	5
6	7 July	28	5	5
7	8 September	65	4	4
8	5 October	28	1	1
9	2 November	28	5	5
10	29 November	28	3	3
11	27 December	29	1	0
12	24 January	29	1	0
13	21 February	29	1	0
14	4 April	44	1	0
15	4 May	30	1	0
16	6 June	32	1	1
17	13 July	37	2	1
Total number born		17 litters	49	—
Total number weaned			—	42
Averages			2.8	2.4

Table 7
Breeding performance of female B 8

No.	Birth date of litter	Days since last litter	Number of young born	Number of young surviving
1	4 July	—	2	2
2	30 July	27	4	4
3	10 October	72	2	2
4	6 November	28	3	3
5	3 December	28	3	3
6	30 December	28	4	4
7	25 January	27	3	3
8	24 February	30	4	4
9	23 March	28	4	4
10	17 April	26	4	4
11	15 May	29	3	3
12	11 June	28	3	3
13	8 July	28	3	3
14	6 August	30	1	1
15	3 September	29	1	0
16	30 September	28	3	3
17	1 December	61	2	2
18	9 March	99	1	1
19	23 April	44	1	1
Total number born		19 litters	51	—
Total number weaned			—	50
Averages			2.6	2.6

Conclusions

Captive females of *C. russula monacha* are polyoestrus animals exhibiting post-partum oestrus. A similar normal occurrence of gestation and lactation proceeding simultaneously was reported for several other shrews (*Suncus murinus*, *S. etruscus*, *Cryptotis parva*, *Sorex araneus* *Neomys fodiens*) but not for *Blarina brevicauda* (Pearson, 1944). The mean litter-size in *C. russula monacha* as well as in other *Crocidae* is generally smaller than that in the *Soricinae*. The 4-week gestation period in *C. russula monacha* conforms to that of other *Crocidae* (*C. leucodon*, *C. suaveolens*, *Suncus murinus* and *S. etruscus*), but differs from the shorter, 3-week gestation period in the *Soricinae*. The gestation period of the *Crocidae* represents the "archaic" gestation time (28–45 days), typical for the nidicolous mammals (PORTMANN, 1965). Captive *C. russula monacha* become sexually mature early, similar to captive *Suncus murinus* and wild *C. suaveolens cassiteridum*, but in contrast with wild *Sorex araneus*, in which sexual maturation is usually attained in the second year of life (BRAMBELL, 1935). *C. russula monacha* is able to breed in captivity throughout the year, but the marked seasonal fluctuations in breeding activity indicate the existence of a certain correlation between the breeding season and the environmental conditions.

Successful breeding of *C. russula monacha* adds a representative of the Insectivora to the spectrum of non-conventional laboratory mammals so much needed in the physiology and comparative biology of reproduction.

A detailed account of other aspects of reproduction in *C. russula monacha* will be published elsewhere.

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Summary

Crocidae russula monacha THOMAS, a shrew widely distributed in Israel, was bred in captivity and its reproductive biology studied. The average gestation period was found to be 28.5 days (24–32) and the mean litter-size was 3 (1–7). Post-partum matings occur within a few hours after delivery. Sexual maturity is attained at 2–2½ months of age. Breeding in captivity takes place throughout the year, showing highest intensity in spring.

Zusammenfassung

Crocidae russula monacha THOMAS, eine in Israel weitverbreitete Spitzmaus, wurde in Gefangenschaft gezüchtet und ihre Fortpflanzungsbiologie erforscht. Die durchschnittliche Schwangerschaftsdauer ist 28,5 Tage (24–32), und die mittlere Wurfgröße beträgt 3 Junge. Ein post-partum oestrus setzt einige Stunden nach dem Wurf ein. Geschlechtsreife wird im Alter von 2–2½ Monaten erreicht.

Die Fortpflanzung in Gefangenschaft findet während des ganzen Jahres statt, weist aber im Frühling einen Höhepunkt auf.

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Address of the author: SHLOMO HELLWING, Department of Zoology, Tel-Aviv University, Tel-Aviv, Israel

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