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STUDIES OF SOME ASPECTS OF POST NATAL DEVELOPMENTAL STAGES OF A SERIOUS WILD RODENT SPECIES (*Rattus sikkimensis*) IN THE LABORATORY CONDITIONS

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ABSTRACT

Among the vertebrate pests, the rodents are quite important as they have a direct interactions with the human beings and the locality. Most of the rodents are prolific breeder and breed throughout the year. This study is concerned with one serious rodent species, the Rattus sp. (*Rattus sikkimensis*) usually found in some portions of the District Nadia and North 24-Parganas, West Bengal, INDIA. Due to the wild nature of this species, it is very difficult to study the growth and process of development especially during the post natal stages. For this reason some pregnant female wild Rattus sp. were trapped with the help of some young Oraon Tribal community. Just immediate after trapping the females were taken in the laboratory and kept within separate cages in the well maintained animal house. After giving birth to the new born individuals, they were nurtured by the mother. The changes were noticed upto the age at maturity. All the changes were noticed in the laboratory conditions. As this species is a prolific breeder and causes serious types of damages to the crops so the study of various developmental stages of this species will be an important aspect for the maintenance of this rodent pest.

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INTRODUCTION

Studies of some aspects of development of any rodent species especially wild rodents are very difficult task for the researcher. Most of the rodents are prolific breeder and breed throughout the year but with two peaks, one during early summer (February and March) and the other during monsoon (July and August) of every year. The rate of pregnancy is reportedly lowest during summer (April to June). The observed percentage of pregnancy ranged from 6.6 in May to 26.4 in February (Bhat *et al*., 1987; Yasoda *et al*., 1977). In natural habitat during March- April usually the female produce 1-9 litters while August – September produce 5-8 young (Santra and Manna, 2008). In *Rattus rattus* litter number varies from 4-6 (Deoras, 1967). This species may be active all the hours of the day though they are nocturnal by habit yet they extend their burrows at the day time (Bindra and Sagar, 1968). Newly hatched *Bandicota bengalensis* were pink in color with ear and eyes closed, devoid of hair but with 1.5-2 mm long vibrissae (Srivastava *et al*., 1971). The eyes and ear were opened up 3-5th and 14-16th days respectively and become mature by 120-180 days. Different organs were also developed (Anadu, 1976). Head-body length is the most frequently employed metric for body size because it includes most of the body, is minimally affected by the nutritional state of the specimen. Body mass is a further highly inclusive, metric for body size, but is often difficult to collect from museum specimens and is subjected to the vagaries of differential metabolic rates (Reiss, 1991). As the studies belong to the Gangetic and non-Gangetic plains of West Bengal and these areas are badly infested with this particular species, i.e., the wild rat (*Rattus sikkimensis*). To gather some knowledge about this particular species, one can plan for the successful control of this type of rodent. Studies in ontogeny are critical to understand various aspects of the biology of a species setting (Bekoff, 1989). Although extensive research has been carried out at the various captive colonies (Carpenter and Hillman, 1978; Hillman and Carpenter, 1983; Thorne and Williams, 1988; Miller and Anderson, 1990; Wildt and Goodrowe, 1989; Williams *et al*., 1991; Carvalho *et al*., 1991) systematic accounts of growth and development of black-footed ferrets have never been provided. The developmental pattern of a rodent species is considered to be species specific and to be the result of a combination of genetic, environmental and maternal

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factors. The patterns which have been revealed in the laboratory found to be closely resembled under natural conditions. To control this serious rodent pest (*Rattus sikkimensis*) detailed knowledge is essential regarding its ecology and biology. To fill this lacuna some aspects of post natal developments have been studied. The systematic data will provide a key reference information of this particular group of wild rodent species.

MATERIALS AND METHODS

1. Collection of rat

Rats were trapped from the household and from the field. After trapping they were taken to the laboratory. Food and water were given to the animals' *ad-libitum*.

2. Breeding cage

Rats collected from the field were kept isolated in the laboratory for 3-4 weeks. The rats were observed twice daily. Then they were allowed to the breeding cage. We maintained 1 female 1male; 2 females 1 male; 3females 1 male per breeding cage.

3. Food to the mother and the litters

Wild Indian house rat showed cannibalistic habit. Nutritious foods with calcium were given to the mother during and after giving birth to the litters. The young litters were provided with multivitamin (Supradyn 1000mg /litter) and Ca supplement (Vencal-D 500mg/litter) along with dairy milk for 7-30 days. After 14 days semidry foods and other food materials were given.

4. Measurements

Changes of external morphology were observed and were recorded properly. Ethological changes were observed from day to day. Age wise body lengths, tail length, body weight, head-body length, length of hind leg and fore leg were recorded. Photographs of day to day changes of rats were recorded properly. We made time to time observations regarding behavioral changes during various developmental stages.

Statistical analysis

All the data were statistically analyzed through Student t-test at both 1% and 5% level of significance. Various data were plotted through scatter diagram for the study of co linearity. For multiple comparison post-hoc was performed at both 1% and 5% level of significance and some morpho-metric data were analyzed through correlation of coefficient at both 1% and 5% level of significance with the help of the software SPSS -12. Six animals were taken in each group.

RESULTS

Observation: Postnatal growth

1 day

The mean body weight at birth of *Rattus sikkimensis* was 4.83 ± 0.68gm in male and 3.75 ± 0.52gm in female. The average body weight of the litters (both male and female) was just 2.04 % of the adult female. The mean body length and tail length was 4.16 ± 0.25cm and 1.58 ± 0.20cm in male and 4.25 ± 0.27cm and 1.66 ± 0.25cm in female. Initially the tail length of both the sexes was less than that of the body length (Table 1). The length of the hind leg at birth was 1.50 ± 0.12 cm in female and 1.48 ± 0.11 cm in male respectively. The fore leg length was 1.10 ± 0.12 cm in female and 1.03 ± 0.10 cm in male (Table 2). The average length of the fore leg (both male and female) was just 71.14% of the hind leg. The length of the vibrissae at its initial stage was 1-1.5 cm in both the sexes.

7 days

At day seven the body weights of the male and female were increased to 8.33 ± 1.03gm and 6.91 ± 0.58gm respectively. Total body lengths of the male and the female were 5.25 ± 0.52cm and 5.66 ± 0.40 cm respectively. In male, the tail length was increased to 2.66 ± 0.25cm and in female it was 2.75 ± 0.27cm. Until day fourteen the growth rate was almost equal. The length of the hind leg reached to 1.98 ± 0.07 cm in male and 1.90 ± 0.10 cm in female while fore leg length reached to 1.48 ± 0.14 cm in male and 1.48 ± 0.09 cm in female. The average fore leg length (both male and female) was just 77.89 % of the hind leg (Table 2 and 3).

14 days

Body weights of males and females were increased to 13.33 ±1.63gm and 15.416 ± 1.800gm respectively. In case of male, total body length and tail length were reached to 5.75 ± 0.524 cm and 3.083 ± 0.376 cm respectively, while in case of female those were 6.416 ± 0.376 cm and 2.916 ± 0.204cm respectively (Table 2 and 3). The length of the hind leg and the fore leg of male were 2.43 ± 0.20 cm and 1.93 ± 0.08 cm and in case of female the hind leg and fore leg length were 2.40 ± 0.08 cm and 2.05 ± 0.05 cm respectively. The average fore leg length (both male and female) was just 82.91% of the hind leg (Fig. 2 B).

21days

By the day 21, the body weight of the female increased rapidly and it was 13.33 ± 1.63gm and 15.41 ± 1.80gm in male and female respectively. Till day 21 the body length was greater than that of tail length 7.75 ± 0.27cm and 4.66 ± 0.51cm in male and 7.83 ± 0.25cm and 4.91 ± 0.37cm in female (Fig. 3A). Hind leg length of the female and the male was increased to 2.80 ± 0.08 cm and 3.05 ± 0.10 cm while the fore leg length was 2.33 ± 0.10 cm and 2.43 ± 0.12 cm respectively. The average fore leg length (both male and female) was just 81.50% of the hind leg (Table).

60 days

At the day 60, male reached to 172.5 ± 11.72 gm and the female reached to 210.00 ± 41.59 gm of body weight. Male reached to 82.18% of female's body weight by this time (Fig 3 B). At this time fore-leg increased to 4.23 ± 0.20 cm in male and 4.20 ± 0.06 cm in female which was 83.69% of hind leg length. The tail is increased in length rapidly and exceeds the body length (Table 2 and 3). Graphically this was depicted clearly (Fig. 3 B). Significant differences of body length and tail length were observed at all the age groups in comparison to the previous age groups at both the 1% and 5% level of significance but the body length and tail length were not significantly increased in between 7^{th} and 14^{th} day.

Table 1. Data showing the body length and tail length of male and female *Rattus sikkimensis* at its various developmental stages

Day	Male		Female	
	Total body length(cm)	Tail length(cm)	Total body length(cm)	Tail length(cm)
Day 1*	4.166 ± 0.258**	1.583 ± 0.204	4.25 ± 0.273	1.666 ± 0.258
Days 7	5.25 ± 0.524 S	2.666 ± 0.258 S	5.666 ± 0.408 S	2.75 ± 0.273 S
Days 14	5.75 ± 0.524 NS	3.083 ± 0.376 NS	6.416 ± 0.376 S*	2.916 ± 0.204 NS
Days 21	7.75 ± 0.273 S	4.666 ± 0.516 S	7.833 ± 0.258 S	4.916 ± 0.376 S
Days 60	19.33 ± 1.032 S	21.166 ± 1.169 S	16.666 ± 0.816 S	16.333 ± 1.032 S

* 6 animals were taken in each group. S: Significant at both P < 0.5 and P < 0.1.
NS: Not significant. S*: Significant at P < 0.5 but not at P < 0.1. **Mean ± Standard deviation.

Table 2. Data showing the body length, head length, length of hind leg and the length of fore leg of the male *Rattus sikkimensis* at various developmental stages

Age(day)	Body length(cm)	Head length(cm)	Hind leg length(cm)	Fore leg length(cm)
1day*	2.74 ± 0.30**	1.42 ± 0.11	1.48 ± 0.11	1.03 ± 0.10
7days	3.21 ± 0.60	2.03 ± 0.10	1.98 ± 0.07	1.48 ± 0.14
14days	3.33 ± 0.20	2.41 ± 0.34	2.43 ± 0.20	1.93 ± 0.08
21days	4.73 ± 0.32 S	3.01 ± 0.14	3.05 ± 0.10 S	2.43 ± 0.12 S
60dys	14.18 ± 1.19 S	4.98 ± 0.27	5.38 ± 0.24 S	4.23 ± 0.20 S

* 6 Animals were taken in each group, S: Significant at 1% level, **Mean ± Standard deviation.

Table 3. Data showing the body length, head length, length of hind leg and fore leg of the female *Rattus sikkimensis* at various developmental stages

Age(day)	Body length(cm)	Head length(cm)	Hind leg length(cm)	Fore leg length(cm)
1day*	2.81 ± 0.24**	1.46 ± 0.08	1.50 ± 0.12	1.10 ± 0.12
7days	3.95 ± 0.43	1.88 ± 0.11	1.90 ± 0.10	1.48 ± 0.09
14days	4.00 ± 0.29	2.41 ± 0.09	2.40 ± 0.08	2.05 ± 0.05
21days	4.93 ± 0.33	2.90 ± 0.08	2.80 ± 0.08	2.33 ± 0.10
60days	11.86 ± 0.77	4.80 ± 0.12	4.80 ± 0.12	4.20 ± 0.06

* 6 Animals were taken in each group, **Mean ± Standard deviation.

Table 4. Multiple Comparisons of body length of male and female *Rattus sikkimensis* at various developmental stages

Body length (male)	Body length (female)	Mean Difference	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
1day male Body length (cm)**	7days male Body length(cm)	-.47500	.32104	.894	-1.5377	.5877
	1day female Body length (cm)	-.07500	.32104	1.000	-1.1377	.9877
7days male Body length(cm)	14days male Body length(cm)	-.11667	.32104	1.000	-1.1794	.9461
	7days female Body length (cm)	-.73333	.32104	.417	-1.7961	.3294
14days male Body length (cm)	21days male Body length (cm)	-1.40000(*)	.32104	.002	-2.4627	-.3373
	14days female Body length (cm)	-.66667	.32104	.552	-1.7294	.3961
21days male Body length (cm)	60days male Body length (cm)	-9.45000(*)	.32104	.000	-10.512	-8.3873
	21days female Body length (cm)	-.20000	.32104	1.000	-1.2627	.8627
60days Male Body length(cm)	60days female Body length (cm)	2.31667(*)	.32104	.000	1.2539	3.3794

*Significant at 5% level. ** 6 animals were taken in each group.

Figure 1. Photograph showing the litters of the *Rattus sikkimensis*. The young were in clumped condition when they were in nest

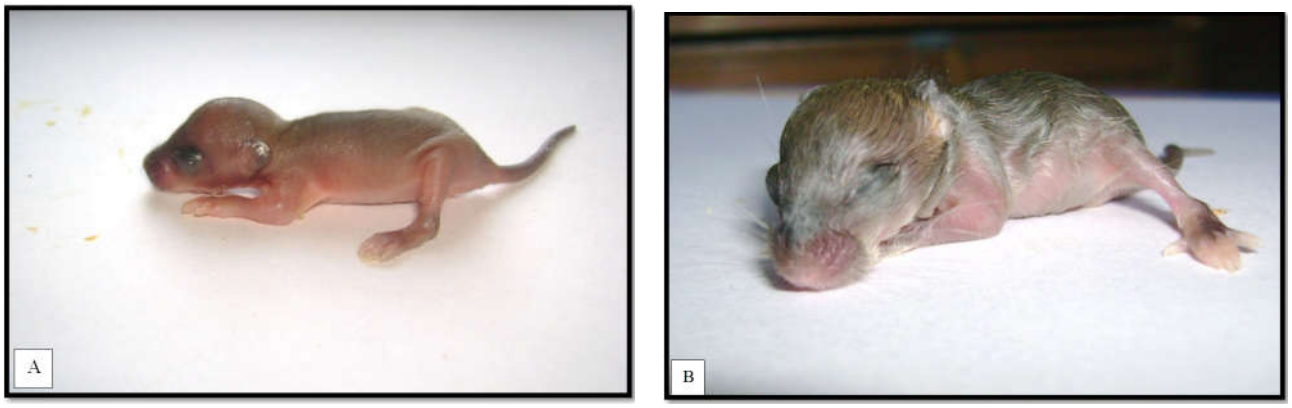

Fig. 2. A, 7 days old litter of *Rattus sikkimensis* when both the eyes and the ear plug were closed. B, one 14 days old litter of *Rattus sikkimensis,* eyes and ear were about to open

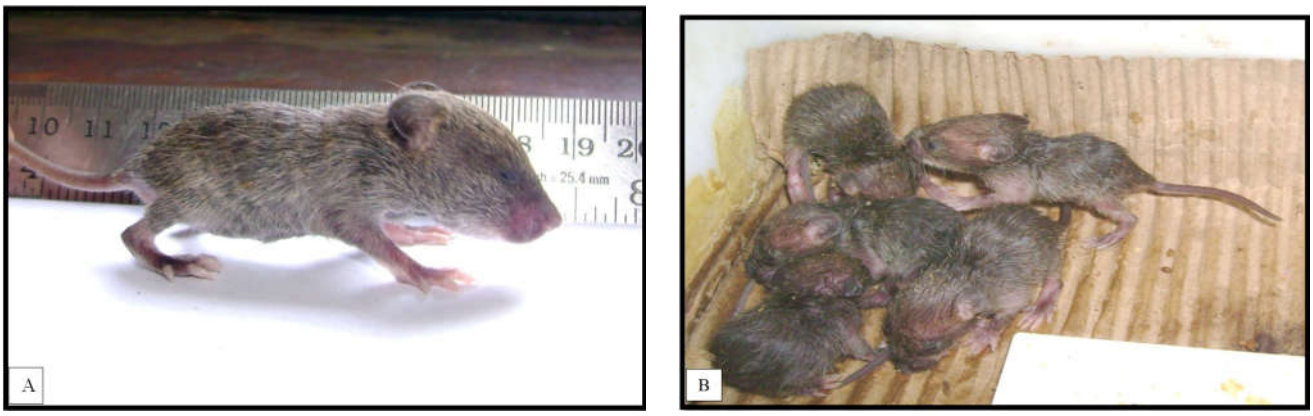

Fig. 3. A, 21 days old litter of *Rattus sikkimensis*. B, Just immediate after eyes open their activity and the movement were increased manifold

2. External changes

In the laboratory condition about 4 to 5 litters were produced in both the breeding seasons while in natural habitat they produced 6-7 litters at a time. Neonates were bright pink in colour (Fig. 1). This pink colour was due to vasodilation during parturition. This colour was faded within a few hours of birth. Skin colour of the young was pink to reddish in colour and almost devoid of hairs except vibrissae. The mystacial vibrissae were 5-6.5mm long at birth. A slight amount of pigment was observed in the scrotum of males. Initially the skin colour was so translucent that the liver, stomach and some other major organs were clearly seen through it. No teeth were erupted at birth. Gradually incisors were increased in size. At 14th day, lower incisors were found to be larger than that of upper incisors. Skin colour gradually turned grayish through dorsum and approached towards neck region only the inguinal portion of the young took few more days to turn gray. Teats appeared by day 7. The hair became dense and spread across the whole body. By the day 14 young showed their juvenile colour pattern. Some time when there were some sorts of nutrition hairs began to cast off by the day 21 and reappeared by 26-28 day. At birth the ear and eyes were closed. The ear pinnae were folded over the presumptive ear aperture and looked like an elevated mass of tissue. By the day 20-21 the ear plug was opened and ear aperture was clearly visible for the first time. Eye lids were also opened up by the day 14. Just after this phenomenon young litters showed their activity at a faster rate (Fig. 2B). Initially the gums were devoid of incisors. By the day 14, incisors began to erupt out. Lower incisors were erupted slightly earlier than that of the upper incisors. Initially the digits of both fore and hind legs were fused. At the day 7 outer digits was separated and gradually the other digits were separated (Fig. 2A).

Behavioral development

Wild Indian house rat, *Rattus sikkimensis* showed cannibalistic habit. Immediate after giving birth if mother is not supplied with highly nutritious food materials then they feed upon their young cubs, while in the natural habitat they produced 6 to7 individuals. At hatching the litters were inert. Newborn litters were made a little coordinated movement and faint cries were also made in response to physical disturbances. They started crawling by the day 3 and their large head helped them to crawl over the nest. Always they forwarded their body by keeping the pressure on hind legs. Until eye lids were opened up they don't exhibit remarkable behavioral pattern; all the day they actively feed and took rest (Fig. 2 A). After the eyelids were opened they started running. Sound was produced from the very beginning. Burrowing habit was observed by the day 21 when they used to make mock practice for digging up burrow (Fig. 3A).

DISCUSSION

The developmental pattern of a rodent species is considered to be species specific and to be the result of a combination of genetic, environmental and maternal factors (Morison *et al*., 1977; Calvert *et al*., 1984; Creighton and Strauss, 1986; Millar and Millar, 1989). Furthermore, the patterns revealed in the laboratory studies are found to be closely similar that are under

natural conditions (Millar and Threadgill, 1987). Limited number of studies have been done in some laboratories regarding the development of *Rattus rattus, Rattus exulans* and other *Rattus sp* but the development of some other species, i.e., *Rattus sikkimensis* in the laboratory conditions has not been done till date. Thus the data regarding the development will add some new information regarding the pattern of development in other rodent species. The developmental pattern largely depends upon some factors like temperature, rainfall and food availability. In the laboratory condition, the number of offspring's was little lesser than that in the natural condition. It may be due to stress and some other factors present in the laboratory conditions. Similar results were also mentioned by Santra and Manna (2008).

Postnatal growth and behavioral development

The overall utility of standard measures, and other linear measurements, collected from mammalian specimens were questioned by Green and Fekete (1934). We examined several standard measures such as total body length, head-body length, tail length, hind leg length and fore-leg length. A strong positive correlation was observed in between head length and hind leg length, which follow almost linear curve along with developmental stages. Other parameters did not show such co linearity. During the development process of *Rattus norvegicus*, hind foot length was the worst proxy for body size (Green and Fekete, 1934). The growth of most rodent species found to be divided into two stages pre weaning stage, when every influence of external environment got by the litter from mother and the second phase, the post weaning phase, when the juvenile received influence of the environment directly (Eisen, 1975). Sometimes the whole developmental phases were divided into four phases – the neonatal phase, transition phase, socialization phase and juvenile phase.

Our observational data regarding development clearly depict the four characteristic phases:

1. Neonatal phase- when there was no such behavioral development, only growth and strengthening of the body occurred.
2. Transition phase- changes of sensory capacities up to the opening of eye.
3. Socialization phase- at the onset of eye opening the young *Rattus sikkimensis* starts weaning and socializes them.
4. Juvenile phase- extended from socialization phase to the sexual maturity.

We observed that the neonatal phase lasts by 0-7 days, transition phase by 7-14 days, socialization phase by 14-21 and juvenile phase by 21-60 and onwards. Neonate 0-6, transition 6-14, socialization 15-24 and juvenile 25-sexual maturity were also observed in *Apodus semotus* (William and Scott, 1953). At the transition phase the noise produced by most of the litters seems to be the mother seeking sound (Smith, 1972). By the day 21 the tail length and body length were not significantly different from the day 14 but the behavioral development significantly increased. This was the period of eye opening. They became more active just immediate after eye opening. This was the phase of socialization. During socialization phase the body weight and the body length decreased slightly at around the age of eye opening (Lin *et al*., 1992). At the end of the socialization phase the body weight of both the sexes began to increase rapidly. During the period they feed on almost all food stuffs. All mammals pass through a transitional weaning period during which they acquire independence from taking maternal milk (Fortman *et al*., 2005). Interestingly, it was noticed that the body weight of the female began to increase more rapidly than the male. Young juveniles were recorded to 25-30 gms. and increased up to 200 gms. when sexually mature. Young juvenile became adult by the day 60 (2 months period). In the field, juvenile weighing approximately 20-30 gms. were often found. Such juveniles became adult within 2-3 months of their emergence (Bhat, 1987). The R value of body weight and body length was 0.9928 in male which indicates a strong positive correlation. Similar result was also observed in case of female (R, =0.9832).

Along with this the brain length increases highest by the day 14-21 which clearly depicts the development to socialize behavioral development and the data also support this pattern in both the sexes. The length of the hind leg was similar with that of the head length which was increased in length at a regular fashion throughout the developmental stages. The length of the fore leg was just 71.14% of the hind leg which was also increased regularly. A rapid growth was observed in the first 3 weeks and then decreased a little. Rapid growth for the first 3-4 weeks of *Rattus exulans* was also observed by Wirtz (1972).

External changes

The young litters at birth were pink to reddish in colour which may be due to vasodilation during parturition. Gradual transformation of skin colour from pink to gray was mainly for the development of the hair follicle within the skin and the development of hair (William, 1973). Initially the length of the vibrissae was 5-6.5 mm and gradually increased and finally attained 20-22mm. in case of *Rattus exulans.* The length of the vibrissae at birth was 5-6 mm and increased to 20mm. Eyes were opened at about 14 days while the ear plugs were opened at about 20-21days. In case of *R exulans* eyes were opened between 12 and 14 days and earplugs were opened at 21days (William, 1973).Outer digits were separated by the day 7, in case of *Rattus exulans* outer digits were separated by the day 6. The data which have been presented in the present study are more or less similar to the other wild rodents. One thing may be mentioned here that *Rattus sikkimensis* is not usually found in the southern portion of West Bengal. Naturally, the study of various aspects of development of this particular species will be helpful in taking precautionary measures against this rodent species. To gather more information about other aspects of developmental processes further investigations may be required .

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