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SOME OBSERVATIONS ON THE REPRODUCTION, GROWTH AND DEVELOPMENT OF *MUS CAROLI* IN CAPTIVITY

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Keywords: Mus caroli, Post-natal growth and development, Litter size, Sex ratio.

RINGKASAN

Kajian pembesaran dan perkembangan anak tikus (*Mus caroli*) selepas lahir telah dijalankan di dalam makmal. Sifat-sifat pembesaran dan perkembangan telah dikaji dengan teliti dan diterangkan. Bilangan anak purata pada masa lahir ialah 4.3±0.4. Berat badan purata bagi jantan dan betina pada masa lahir masing-masing ialah 1.02±0.02 g dan 0.96±0.02 gram. Berat anak tikus pada masa lahir berjumlah antara 14.5% hingga 46.4% berat badan tikus betina (ibu), dengan purata 30.0±2.6 peratus. Bilangan anak tikus jantan didapati melebihi bilangan betina dengan nisbah jantina 2.2:1. Perkembangan anak tikus selepas lahir boleh dibahagikan kepada empat fasa: neonatal (1–8 hari), keadaan peralihan (9–15 hari), berkemasyarakatan (16–21 hari) dan remaja (22 hari hingga kematangan jantina).

INTRODUCTION

The rice field mouse, *Mus caroli* Bonhote, was first recorded in South Kedah, Peninsular Malayaia in 1976 (LANGHAM and LAM, 1977). It was found in the rice fields and was occupying burrows dug into the bunds separating the rice plots. *Mus caroli* is widely distributed in Southeast Asia and it has been recorded in the Ryuku Islands, Taiwan, Hainan, Yunan, Vietnam, Thailand, Sumatra, Java, Madura and Flores (ELLERMAN and MORRISON-SCOTT, 1951). It is a pest of rice fields and poultry farms in Thailand (MARSHALL, 1977). Little is known about its reproduction, growth and development. This paper presents observations made on the reproduction, growth and development of *M. caroli* in captivity.

MATERIALS AND METHODS

The laboratory colony of mice was obtained from the rice fields at Titi Batu, Kampung Perigi and Teroi Tua in south Kedah. The mice were kept in an animal house measuring 5.1 m x 10.2 m, under normal lighting and environmental conditions. The mice (9 pairs) were permanently paired in cages of strong wire (mesh 3.5 mm x 3.5 mm), measuring 31 x 31 x 21 centimetres. These cages were placed on trays with paddy husks (about 2.5 cm depth) as absorbent litter. These husks were changed at least once a week.

A commercial laboratory mouse pellet (Gold Coin Sdn. Bhd.) supplemented with unhusked rice grains were provided *ad libitum*. The specifications of the mouse pellet were given by LAM (1983).

The female mice were checked daily and when they were visibly pregnant, nesting materials such as dry grass or rice straws were provided for nest building. When the young were born, they were sexed by using the ano-genital distance (DAVIS, 1964), measured, weighed and examined. The weight of the dam was also recorded. The day of birth was designated as day one. The litter size, birth weight and head and body length were recorded. Birth weights were recorded to the nearest 0.05 gramme. Post-natal developmental characteristics of the young were studied. Daily measurements and observations were made up to 21 days and thereafter, measurements were made at weekly intervals. The young were weaned at 21 days and grouped according to sex for observation and measurement.

When removing the young for observation and measurement, care was

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Table 1. Physical measurements of *Mus caroli* at birth

Sex	Birth weight (g)	Measurements (Mean±S.E.)			
		Head & body length (mm)	Tail length (mm)	Hind foot length (mm)	Ano-genital distance (mm)
Male (n=34)	1.02±0.02	28.32±0.23	10.91±0.13	4.97±0.03	1.40±0.03
Female (n=17)	0.96±0.02	28.35±0.17	10.71±0.19	4.94±0.06	0.67±0.01

n = number of mice

taken to minimize disturbance of the nest. The parents were first removed from the cage. After examination and measurement, the young were replaced into the nest and the parents returned to the cage. As the young grew older and became very active, they were anaesthesized with diethylether to facilitate measurement. All the standard physical measurements and weight of the young were recorded in millimetres and grammes respectively.

RESULTS

Litter Size and Sex Ratio

The mean litter size of 14 litters born in the laboratory was 4.3±0.4 and the litter sizes ranged from two to seven. There was no significant correlation between the weight of the dam and litter size (F-ratio; linear regression = 1.39; quadratic regression = 0.21; 1 d.f.; P>0.05). In the 14 litters observed, mean weight of the dams was 14.6±0.3 g, with a range in weights of 12.6–16.4 grammes.

The sex ratio of the young born was markedly in favour of males; 41 males *versus* 19 females, a ratio of 2.2:1, which departed significantly from the expected ratio of 1:1 ($X^2 = -4.03^*$; 1 d.f.; P<0.05).

Size at Birth

The weight of the individual male pups at birth varied between 0.75 g and 1.25 g and that of the females 0.80 g and 1.15 grammes. The head and body length (HBL) of male pups at birth varied between 25 mm and 30 mm and that of the females 27 mm and 30 millimetres. The various physical measurements of *M. caroli* at birth are given in *Table 1*. The mean weight of the males was 1.02±0.02 g and that of the females was 0.96±0.02 grammes. There was no significant difference in the mean birth weights between males and females (F = 3.97; 1 d.f.; P>0.05). The mean HBL of males was 28.32±0.23 mm and that of females was 28.35±0.17 mm (*Table 1*). There was no significant difference in the mean birth HBL between males and females (F = 0.01; 1 d.f.; P>0.05).

Gross weights of the litters ranged from 2.1 g for a litter of two to 6.8 g for a litter of six. The mean total birth weight of the litters was 4.4±0.4 grammes. When the birth weights of the litters were expressed as a percentage of the weight of the dam, the mean was 30.0±2.6%, with a range of 14.5%–46.4 per cent. However, there was no significant correlation between the weight of the dam and total weight of litter (F-ratio, linear regression = 1.55, quadratic regression = 0.27; 1 d.f.; P>0.05).

The mean weights of individuals from litters of various litter sizes are given in *Table 2*. There was no significant difference between the means of the various groups (F=2.38; 5 d.f.; P>0.05). The relationship of litter size, individual and total birth weights showed significant linear correlation (*Figure 1*). The birth weight of the young was negatively correlated with litter size ($r = -0.3^*$; 1 d.f.; P<0.05) while the total birth weight was positively correlated to litter size ($r = 0.96^{**}$; 1 d.f.; P<0.01).

Table 2. Number of young per litter and mean weight of young at birth for *Mus caroli*

	No. in litters					
	2	3	4	5	6	7
Sample size	1	4	1	4	2	1
Mean wt. ±S.E. (g)	1.05±0.05	1.03±0.03	1.09±0.04	0.99±0.02	1.02±0.03	0.91±0.03

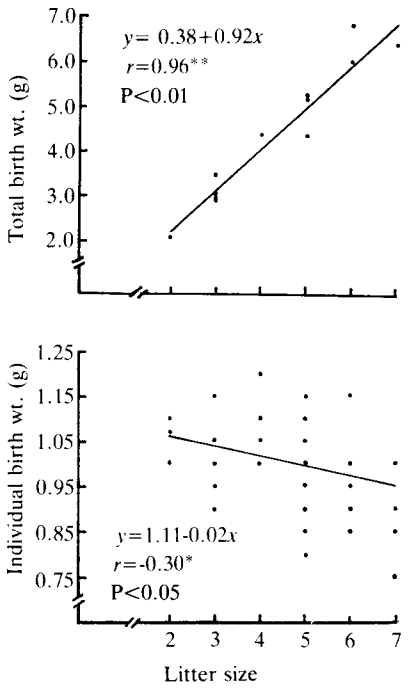

Figure 1. The relationship of litter size, individual birth weight and total birth weight in ***Mus caroli.***

Table 3. Birth sequences and intervals of a female *Mus caroli*

Birth sequence	Birth interval (days)	Litter size	Wt. of dam (g)
1		3	14.45
	114		
2		5	14.10
	33		
3		7	14.15
	37		
4		5	14.80
	33		
5		3	14.00
	36		
6		5	15.65
	27		
7		2	14.50
	23		
8		5	14.50
	36		
9		6	14.65

Birth Sequences and Intervals

One female was very prolific and had nine litters in one year (*Table 3*). The shortest birth interval recorded for this female was 23 days and the longest 114 days with a mean of 42.4±10.4 days. There was no significant relationship between the preceeding litter size and birth intervals (r = 0.25; 1 d.f.; P>0.05).

Growth, Morphological and Behavioural Development from first to 98th day after Birth

Day 1 (<12 hours) The young were pink and hairless except for the presence of short unpigmented mystacial, superciliary, submental, genal and interamal vibrissae. The longest mystacial vibrissa was about 1.5 mm long. The superciliary vibrissae comprised one long and one short vibrissa. Submental vibrissae were present as two short unpigmented bristles. The upper and lower genal vibrissae were present as two short unpigmented bristles. The upper and lower genal vibrissae had one and two bristles respectively. Milk could be seen in the stomach of young. Umbilical scar was

visible. Nails were evident on the toes and the digits were fused. The skull line formation was visible through the skin. Mammae in the females were not apparent. No sign of pigmentation was found in the future scrotal region of the males. Eye pigments were apparent through the closed lids. Eye slits appeared as grooves on both eyes. The ear pinnae were folded with very slight pigmentation at the edges. The males could be separated from the females by the greater anogenital distance in the males (mean = 1.40 ± 0.03 mm for males and 0.67 ± 0.01 mm for females) and also the larger size of the penis in males compared with the clitoris in females. The average weights of the males and females were 1.02 g and 0.96 g, with the corresponding HBL of 28.32 mm and 28.35 mm respectively (*Table 1*).

Day 2

The skin colour of the young was still pink but slightly darker. Pigmentation on the dorsum at the shoulders was evident. No hair was conspicuous either on the dorsal or ventral part of the body. More unpigmented hair had sprouted at the submental region. The muzzle region was more prominent, giving the young a snout appearance. The hair papillae of the superciliary and genal vibrissae were more conspicuous. Female mammae were still not apparent. Foot pads were slightly pigmented. Umbilical scar was still present. The skull line formation was still visible through the skin.

Day 3

Pigmentation began to take form on the head and dorsum but hair had not erupted from body. No pigment was conspicuous on the front and hind legs. The tail and legs were still pink. More pronounced swelling in the muzzel region gave the young a snout appearance. The skin was more wrinkled and hair papillae on the body were more distinct. The longest mystacial vibrissa was 2.6 mm, the longer superciliary vibrissa was 1.4 mm and the shorter one was 0.7 mm; and the genal vibrissae were 0.9 millimetre. However, hair were still unpigmented. The abdominal mammae in females could be distinguished. The Y-shaped skull line on top of the head was barely visible as the skin became more opaque. The ear pinnae were still fused to the head. Young were still unable to crawl except for some circular movement. The umbilical scar and milk in the stomach were still visible.

Day 4

The young were darker on the dorsal parts and had acquired very short, sparse, unpigmented hair on the dorsal part of the head and body. No hair had sprouted in the venter of the young. Pigmentation had extended from the nose to the dorsal part of the tail. No pigment had formed on both front

and hind feet but there was pigmentation on the foot pads. Pigmentation was more prominent on the tubercles and the digital toes of the hind feet. The superciliary vibrissae were pigmented at the basal half. Ear pinnae were free with the distal portion of the pinnae pigmented. Only the abdominal mammae in the females were visible. The Y-shaped skull line was completely hidden by the intense pigmentation and hair development in the skin. Young were able to crawl with legs splayed and the abdomen touching the floor. Eye lids were more prominent with the swelling of the eyes. Milk in the stomach was still evident. The penis of the male was twice the size of the clitoris in the female. The ano genital distance for the male averaged 1.5 mm and was 0.9 mm in the female. The umbilical scar was still evident.

Day 5

The dorsal part of the head and body was heavily pigmented. Pigmentation had extended to the heel and the anterior surface of the wrist region of the hind feet. The dorsal part of the hind feet had acquired slight pigmentation. Pigmentation on the tail was more prominent but no hair had emerged. Short hair with pigmented base had emerged around the eyes and the muzzle region. The genal vibrissae had acquired slight pigmentation at the base. More short fine unpigmented hair had grown on the dorsum of the body. No hair had emerged on the venter except for the three submental vibrissae (average length of 1.5 mm) and other short unpigmented hair under the lower jaw. Venter skin was slightly darker but milk in the stomach was still visible. The young were able to crawl with their belly slightly off the ground. The future upper incisors appeared as two white spots on the gum.

Day 6

The anterior aspect of the upper hind legs had acquired pigmentation. Pigmentation around the head and ankle region was darker. The dorsal part of the tail was pigmented but the ventral part was still unpigmented. There was a slight indication of pigmentation on the dorsal aspect of the front feet. The upper part of the front legs was still pink. Pigmented hair had emerged on the dorsal part of head and body. Short, fine, unpigmented hair had emerged from the dorsal part of the tail and the front and hind legs. Unpigmented hair of about 1.5 mm in length was distinctly visible on the lateral aspect of the body. No hair had emerged on the venter. The distal portion of the ear pinnae was darker and more pigmented but no hair had erupted on the ear pinnae. The longest mystacial vibrissa averaged 4.2 millimetres. Hair papillae of the superciliary, genal and submental vibrissae were distinctly visible. The superciliary vibrissae were 2.8 mm in length. Mammae in the females were visible (the

mammae formula was 3+2= 10). Milk in the stomach could be discerned.

Day 7

Pigmented hair had emerged on the anterior surface of the dorsal part of the hind legs but not on the dorsal part of the feet. The front legs were still dark pink but unpigmented fine hair had erupted on the dorsal surface of the feet. The dorsal part of the tail was covered by black pigmented hair. The ventral part of the tail had acquired short, unpigmented hair. Hair tracts were distinctly visible. The young began to be active while being measured and tried to jump off the weighing pan. They were observed for the first time resting with hind legs pulled beneath the body. Crawling was much improved but the hind legs were still slightly splayed. The young were able to lift their belly off the ground when walking. The incisors had not erupted but were evident through the upper and lower gums. The digital nails of the hind feet were evident.

Day 8

Brown hair had began to form on the head and shoulder regions and along the sides of the body leaving the mid-dorsal region with black and long white hair. More unpigmented short hair, measuring approximately 1 mm, had emerged on the venter. Walking coordination was still unsteady but young were able to turn upright when placed on their backs. The incisors had not erupted. The eyes were still closed but eye slits were very distinct, measuring 2.8 mm long. Umbilical scar was still apparent. Sparsely unpigmented hair had emerged on the anterior surface of ear pinnae. Upper part of the front legs was still pink. Silvery hair on the upper surfaces of both the front and hind feet were evident. Short pigmented hair were conspicuous on the dorsal surface of the front feet.

Day 9

Young were very active and were able to run off the weighing pan. Young were able to run about unsteadily. Brown fur of about 1 mm long had covered the head and body. The long white hair were triple the length of the brown hair. Light brownish hair had emerged on the dorsal surface of the hind feet. Dark pigmented hair were evident on the dorsal (back) of the ear pinnae but the front was still hairless. Hair tracts on the venter were visible. The upper incisors had began to emerge but had not pierced the gum completely. Eyes were still closed and the auditory meatus still unopened. Milk in the stomach was still evident through the venter. Tail was bicolour, black dorsally and white ventrally.

Day 10

The dorsal pelage was very well developed with brown and black hair giving a shiny sheen. Venter pelage was more dense but milk was still visible through stomach. Young were able to grip and hang on to a bamboo stick with their front legs. Ear

pinnae were finely furred and the auditory meatus was beginning to form. Eyes were still closed. The mammae were now clearly discernable (3+2=10). The umbilical scar was barely visible and was surrounded by venter hair. Yellowish-tipped hair were found at the base of the front of the ear pinnae. The young ran about unsteadily and the hind legs were still splayed. The upper and lower incisors of the males had penetrated the gums for about 0.5 mm while that of the females had just penetrated the gums.

Day 11 — The eyes and the auditory meatus were still closed. The mystacial vibrissae measured an average of 9 mm and the superciliary 7.5 millimetres. The mean length of hair on the dorsum was 3.6 mm and the venter was one millimetre. A midline of slightly yellowish hair was evident on the venter. The venter hair were dense and greyish white. The young were aware of height and able to sense it by stopping at the edge of the measuring table although the eyes were still closed. Gripping ability of the young was improved as both front and hind feet were able to hang on to a stick. The upper and lower incisors of the females had penetrated the gums completely.

Day 12 — The eyes and the auditory meatus were still closed.

Day 13 — Auditory meatus had opened. The initial response to hearing was observed (young were startled by the snapping of fingers). Ear pinnae were covered with brownish hair.

Day 14 — Eyes were still closed. Young were more adept at climbing.

Day 15 — Eyes of the young were still closed but one eye of a male was half opened. Young had normal walking gait like the adults. Mammae in the females were hidden by greyish-white venter hair.

Day 16 — The eyes of the young had opened completely. The young were exceedingly active and were more proficient at walking and running than before. When disturbed, the young were quick to avoid the source of disturbance, accompanied with squeeking sounds. Face washing and grooming behaviour was observed in the young. The dorsal pelage comprised brown and black hair. The basal half of the brown hair was grey and measured 6.2 millimetres. The long black hair measured seven millimetres. Venter hair were greyish white and measured 2.5 millimetres. The longest facial vibrissa was 13.5 millimetres.

Day 17 — The young were observed to drink water from spout. The eyes were more protruded.

Day 18 — Fight-play interaction among the young was observed. The mother was quick to retrieve the young when they tried to venture away from the nest. Lower molars had erupted.

Day 19 The young had learned to dehusk whole rice grains and the eating of solid food (laboratory pellets) was observed. Upper molars had erupted.

Day 20 The testes had not descended into the scrotum in the males and vaginae in the females were imperforated.

Day 21 Pelage of the young was soft and thick. Dorsal pelage was the same as on day 16. Venter hair had grown longer and the average length was 3.1 millimetres. The tail was bicolour. The males and females were separated at weaning. The mean weights for males and females were 3.67 g and 3.82 g, while the HBLs for males and females were 51.1 mm and 52 mm respectively. The developmental characteristics for the first 21 days are summarized in *Table 4*.

Table 4. Developmental characteristics of *Mus caroli* in the first 21 days after birth

Event	Age (days)
Appearance of vibrissae	1 (<12 hours)
Appearance of pigment on body	3
Appearance of unpigmented body hair	4
Ear pinnae unfolded	4
Appearance of pigmented body hair	6
Appearance of mammae (females)	6
Separation of digits	6
Appearance of brown hair	8
Upper incisors erupted	10–11
Lower incisors erupted	10–11
First hearing response	13
Auditory meatus opened	13
Hair obscured mammae	15
Eyes opened	15–16
Displaced young able to locate mother	17
Lower molars erupted	18
Upper molars erupted	19

Day 28 Testes in the males were still abdominal and vaginae in the females were still imperforated. Hair on the dorsum was about 7 mm long and the venter hair was 3.8 millimetres. The longest mystacial vibrissa was 17 millimetres.

Day 35 The colour of the dorsal pelage was brown and black while the venter was greyish white.

Day 42 Brown hair on the dorsum averaged 6.6 mm in length and the long black hair averaged seven millimetres. The length of venter hair was 4.2 millimetres. Weight of the young ranged between 8.1 g and 9.6 g and the HBL was between 61 mm and 69 millimetres. The length of the ear was 11–13 mm and that of the hind foot was 16–17 millimetres. The length of the tail was 115% of the head and body length, with a range of 63–75 millimetres.

Day 49 Adult pelage had began to appear along the facial and lateral portions of the body. Testes of the males had descended into the scrotum. Vaginae of the females were still imperforated. Hair had obscured the vaginal orifice. The mystacial vibrissae averaged 17.6 mm, with a black basal half and the upper part white.

Day 56 New coat had completely covered the dorsum and moulting into the adult

pelage had completed. Vaginae in the female still imperforated.

Day 98 Vaginae in the female were still not perforated.

Growth Characteristics of *M. caroli* from the first to 25th week after Birth

Figures 2 and *3* describe the growth of male and female *M. caroli* from first to 21st day after birth. The growth curves of weight and HBL in the first three weeks showed two breaks, on the seventh day and the other on the 14th day for both sexes. The average daily increases in weight during the first 21 days after birth were 0.13 g for males and 0.14 g for females. The mean weights for males and females at 21 days after birth were 3.67±0.22 g and 3.82±0.34 g respectively. The average daily increases in HBL for the first 21 days were 1.0 mm for males and 1.1 mm for females. The mean HBLs of males and females at 21 days old were 51.1±0.9 mm and 52.0±1.4 millimetres.

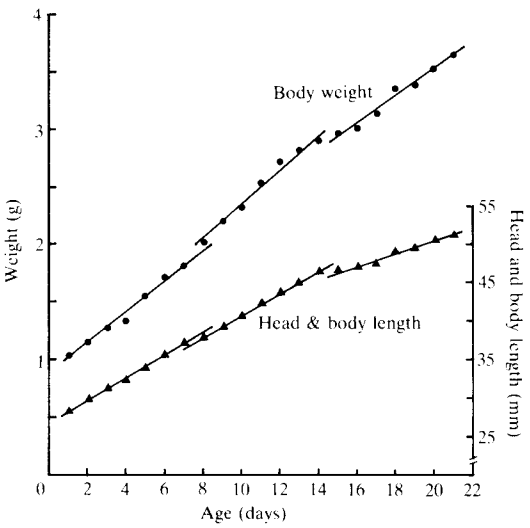

Figure 2. The relationship between age, weight, and head and body length of laboratory bred male ***Mus caroli*** *during the first 3 weeks after birth (Means from 19 males, S.E. of means too small to include in the growth curves).*

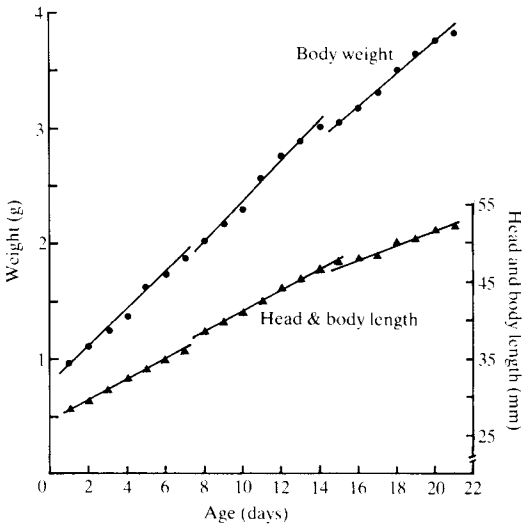

Figure 3. The relationship between age, weight, and head and body length of laboratory bred female ***Mus caroli*** *during the first 3 weeks after birth (Means from 12 females, S.E. of means too small to include in the growth curves).*

Growth curves of male and female *M. caroli* from first to 25th week are given in *Figures 4* and *5*. Growth rates for weight and HBL were most rapid during the first to fourth week. Weight gains of 1.00 g/week and 1.03 g/week were recorded for males and females respectively (*Table 5*). Increases in HBL of 6.92 mm/week and 6.87 mm/week were recorded for males and females respectively. From the fifth to eighth week, growth was slower. Weight gains in the males and females were 0.83 g/week and 0.58 g/week respectively. Increases in HBL for the males and females were 2.54 mm/week and 1.96 mm/week respectively (*Table 5*). Growth was very slow from the ninth week onwards and gains in weight of less than 0.5 g/week were recorded for both sexes. Similarly, increases in HBL were very small, less than 1.0 mm/week for both sexes (*Table 5*).

DISCUSSION

Among the rice field rodents in Peninsular Malaysia, *M. caroli* is the

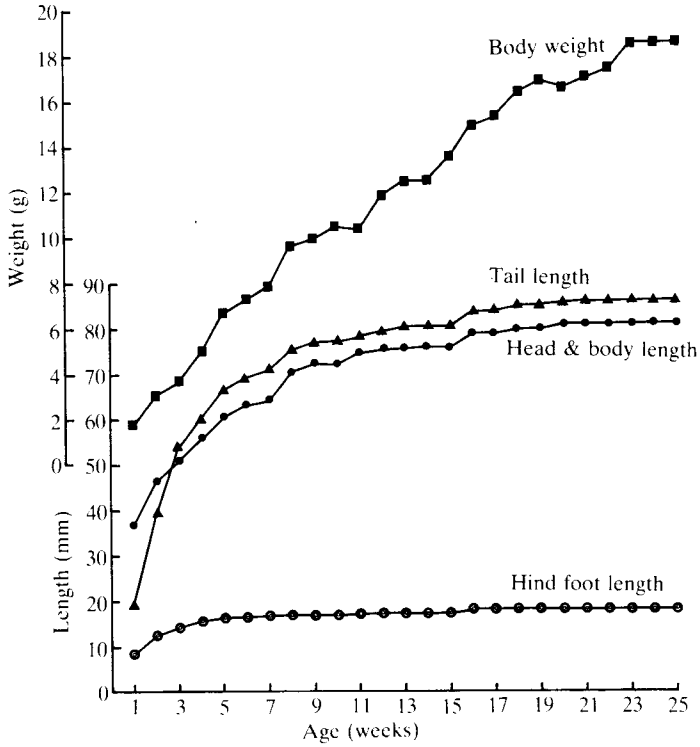

Figure 4. Growth curves of male ***Mus caroli*** *from 1st to 25th week in the laboratory.*

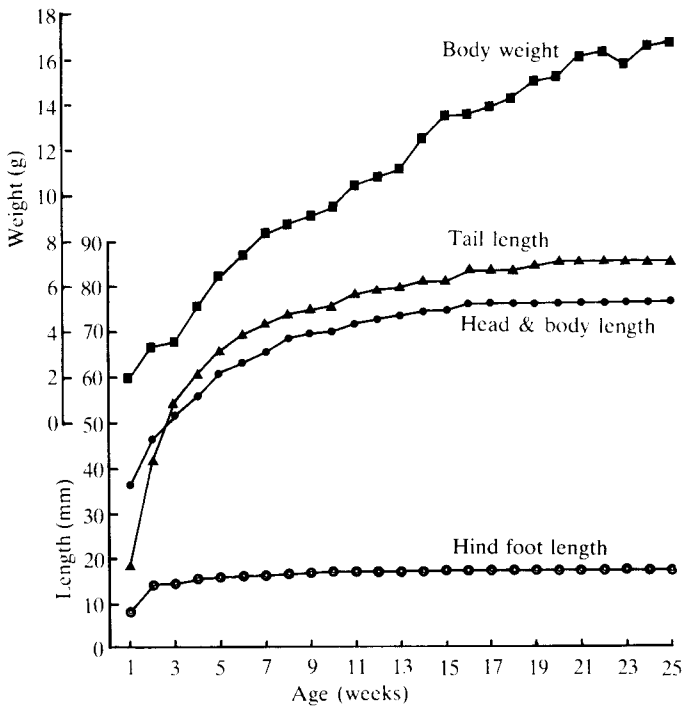

Figure 5. Growth curves of female ***Mus caroli*** *from 1st to 25th week in the laboratory.*

Table 5. Growth rates of *Mus caroli* from 1st to 25th week after birth

Age (weeks)	Wt. gain (g/week)		Increase in HBL (mm/week)	
	Male	Female	Male	Female
1-4	1.00	6.92	1.03	6.87
5-8	0.83	2.54	0.58	1.96
9-12	0.49	0.82	0.46	0.71
13-25	0.48	0.48	0.43	0.29

smallest member. Adult mice hardly reach a weight of 20 g and HBL of 90 mm (LANGHAM and LAM, 1977). Being the smallest member, it also has the lowest birth weight. At birth, the young weighed only about one gramme. The common rice field rat, *Rattus argentiventer* (ROBINSON & KLOSS) has birth weights of 3.9 g and 3.6 g for males and females respectively (LAM, 1979). Mean litter size of *M. caroli* was 4.3, with a range of two to seven. For wild *M. caroli* females, a range in litter sizes of three to eight had been recorded (LANGHAM and LAM 1977). It is likely that captive *M. caroli* females have slightly smaller mean litter size compared with those of the wild females. This lower mean litter size for zoo females were similarly observed in two other rice rodents in captivity, *R. argentiventer* (LAM, 1980; 1983) and *Bandicota indica* (LAM, 1985).

Two breaks were observed in the growth curves of body weight and HBL of *M. caroli* during the first three weeks after birth. Scudder, KARCZMAR and LOCKETT (1967) reported two similar breaks for the house mouse, *Mus musculus* Linnaeus. ENZMANN (1933) reported that in *M. musculus* these breaks were due to changes in the maternal milk supply, where the quantity of milk increased rapidly up to the fifth day after parturition, increased very slightly further up to the 12th day, and declined rapidly thereafter. This same mechanism is thought to account for the changes in the growth of *M. caroli*. The second break correlated with the opening of the eyes and an acceleration in body weight gain suggested an increase in the consumption of solid food. The young were observed to dehusk and consume rice grains two days after the eyes opened.

WILLIAMS and SCOTT (1953) divided growth and behavioural development of *M. musculus* into four distinct natural periods: (a) the neonatal period during which development is mainly in growth and strength, with the appearance of very few overt behavioural patterns not present at birth, (b) the transitional period, marks by changes in sensory and motor capacities which make possible the development of adult behaviour patterns, (c) the socialization period which begins with the opening of the eyes and includes the first extensive activity outside the nest, and ends with final weaning, and (d) the juvenile period, in which all behaviour is essentially adult with the exception of sexual behaviour and care of the young. The period extends from weaning to sexual maturity. For *M. caroli*, these periods could be defined as follows: neonatal (1–8 days), transitional (9–15 days), socialization (16–21 days) and juvenile (22 days to sexual maturity).

The neonatal period is a critical time for survival in the young and is characterized by neonatal nutrition and rapid growth (WILLIAMS and SCOTT, 1953). Deaths often result from failure to compete for maternal care and nursing or the cannibalism by adult females. There were numerous instances of complete loss of litters due to cannibalism by the dam. *Mus caroli* is very sensitive to disturbances of the nest and cannibalism usually occurred when the brood was disturbed during the course of examination and measurement. Cannibalism of the young by adult females was also common

during the neonatal period in *R. argentiventer* and *R. tiomanicus* but uncommon in *B. indica* (LAM, 1985).

In rodents, it has been generally accepted that the testes descend into the scrotum as the male becomes sexually mature and the vaginal orifice becomes perforated as the female approaches maturity. Sexual maturity in male *M. caroli* was attained in an early age of less than two months. Males had scrotal testes at the age of 49 days but the vaginae of females of the same age were still imperforated. The moulting into adult pelage had began at 49 days and this was completed at 56 days of age. Female mice, *M. musculus*, become sexually mature at around six weeks and later under unfavourable conditions (CROWCROFT and ROWE, 1957; 1958; BARNETT and COLEMAN, 1959). Males attain puberty later than females but are less affected by environmental fluctuations (BERRY, 1970). Thus, it is likely that *M. caroli* females would be sexually mature at about two months of age under normal conditions.

Vaginae of female *M. caroli* were still imperforate when they were examined at 98 days of age. This could be due to the physical separation of the sexes at weaning and they were kept separated throughout the study. Female mice *(M. musculus)* were known to require chemical cues (priming pheromones) for ovulation and induction of puberty in young mature females (BRONSON and COQUELIN, 1980). In mice, both sexes mark their home substrate with urinary pheromones. Urinary cues emanating from males accelerate the process of ovulation and urinary cues from females decelerate it (BRONSON and COQUELIN, 1980). It has also been shown indirectly that the exposure of immature females to an adult male would result in precocial vaginal opening and mating (VANDENBERGH, 1967; VANDENBERGH, DRICKAMER and COLBY, 1972). The precise cue involved in the induction of precocial puberty is probably pheromonal in nature (VANDENBERGH, 1969). In deermice, females show oestrus infrequently when caged in groups in a male-free environment. Incidence of oestrus is increased, in some cases more than two folds, following exposure to the presence of a deermouse male or to his urine (BRONSON and DEZELL, 1968). The above phenomenon probably explains the delay in puberty (perforated vagina) of females *M. caroli*, due to its isolation from the pheromonal cues of males.

The sex ratio of young born in the laboratory was greatly in favour of males, *i.e.*, about twice as many males were born. This reproductive strategy would facilitate the sexual development of the females in the wild. The large number of males produced would increase the chances of females meeting males which is a prerequisite for the induction of puberty in females, thus ensuring the reproductive success and survival of this species.

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ABSTRACT

Post-natal growth and development of *Mus caroli* ware studied for litters born in the laboratory. Detailed observations on the growth and morphological development were made and the physical development of the young was described. Litter size of captive females varied from two to seven, with a mean of 4.3±0.4. Mean birth weights for males and females were 1.02±0.02 g and 0.96±0.02 g respectively. The total birth weight of litters varied between 14.5% and 46.4% of the weight of the dam, with a mean of 30.0±2.6 per cent. Sex ratio in the litters was markedly in favour of males, with a ratio of 2.2: 1. The post-natal development of *M. caroli* can be divided into four phases: neonatal (1–8 days), transitional (9–15 days), socialization (16–21 days) and juvenile (22 days to sexual maturity).

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