Postnatal Growth in the Small Asian Mongoose, *Herpestes javanicus auropunctatus*, Raised in Captivity on Okinawa

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人工保育によるジャワマングース 
（*Herpestes javanicus auropunctatus*）の成長

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ABSTRACT. Two newborn Small Asian mongooses on Okinawa had thin ash-white hair. Their eyes and ears were closed. Body weights of the male and the female at two days were 24 g and 27 g. The male opened its eyes on day 15, and the female on day 20. At two weeks, the outer hair, mottled with black and yellowish-white speckles, completely covered the juveniles. All milk teeth appeared by 28 days, and all permanent teeth had completely grown in by 126 days. The male weighed 958 g at 28 weeks, and the female 520 g. The mean daily body weight gain for each four-week period peaked at five to eight weeks. The daily body weight gain increased prior to eight weeks; however, the range of daily body weight gain and loss tended to widen after eight weeks. The daily body weight change was cyclical. The male body length continued to increase up to 28 weeks; the female continued growing up to around 24 weeks. At seven weeks, differences in the body shapes between the male and female were very much evident. The claws attained their adult form between six to eight weeks of age when sexual dimorphism begins to appear and feral mongooses are weaned. This stage is crucial for the mongoose, which morphologically and functionally undergoes a significant transformation from juvenile to adult.

Key Words: Postnatal Growth, Small Asian Mongoose, *Herpestes*, Okinawa


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INTRODUCTION

The Small Asian mongoose, *Herpestes javanicus auropunctatus*, which inhabits the island of Okinawa, was introduced from India in 1910 in an attempt to control Habu snakes and rats [1]. However, those purposes were rarely achieved today, and the effects of the mongoose on agriculture and wildlife have been investigated (Ogura, unpublished). The growth of the Small Indian mongoose (*H. auropunctatus*), which is a subspecies of the Small Asian mongoose, was reported from the Hawaiian islands [2], Caribbean islands [3], and other regions [4]. However, there have been no reports for the growth of newborn Small Asian mongooses on Okinawa island. The present study was carried out to offer basic data for a project to rid Okinawa of feral Small Asian mongooses and a zoological park that breeds the mongoose.

MATERIALS AND METHODS

We used two mongooses born to a mother caught in the wild on Okinawa (Okinawa-shi, Okinawa Prefecture, 26°19' N, 127°49' E) on June 11, 1995. Mother's milk was given to the newborn mongooses for the first five days, and powdered milk for cats (Esbilac, PetAg, 0.5 g/ml, 300 ml/kg/day) from the sixth day to the eighth day, using a CUTD-OWN TUBE (0.6 mm caliber, Japan Medical Supply) and a disposable syringe. Thereafter, Esbilac was given using a nursing bottle. Weaning was accomplished at 30 days. Solid cat food (C.E.E.-2, Japan CLEA) and water were provided ad libitum after weaning. The newborn animals lived with their mother in a cage made of stainless steel wire (450 mm wide, 450 mm deep, 450 mm high) for their first five days. From day six to 26 weeks, the juveniles were let loose in a laboratory (8-m wide, 6-m deep and 2.7 m high) during the day and were confined in their cage at night. No clinical signs were observed in the mongooses during the present study. Their body weights were measured daily from days 2 to 196 (28 weeks) on an electronic scale (1 g graduation). Their total length (with the animal laid on its back and stretched out, from the tip of nose to the tip of tail) and tail length (from the upper base of tail to its tip) were measured according to the standard measuring procedure [5] at one week intervals from week 0 (2 days) to week 28 using a ruler (1 mm graduation). Their head and body lengths (total length - tail length) and tail ratios (tail length / head and body length ×100) and mean body weight gains were calculated. In addition, the opening of their eyes, tooth eruptions and replacements, and changes to their claws and fur were observed throughout the study.

RESULTS

Outward Appearance

The newborns' bodies were pinkish in color, and umbilical cords approximately 10 mm long protruded from their abdomens. The navel cord fell off at two days for the male and at three days for the female. Three pairs of nipples were observed on the abdominal areas of the male and female mongooses at two days. The male and female could be distinguished by the genitalia. The nasal plate was a light red color, and its dorsals was a dark brown.

Ash-white hair thinly covered the whole surface of the newborns' bodies, and tactile hair grew on the circumference of the mouth. Blackish hair grew from the dorsal head to the dorsal buttocks (Fig. 1). The outer hair began to cover the surface of the entire body at five days (Fig. 2), completely covered juveniles at two weeks (Fig. 3), and was approximately 10 mm long at five weeks (Fig. 4). Three or four black and yellowish-white bands were observed in the outer hair.
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Figure 1 Female Small Asian mongoose at two days
The eyes and the ears were closed. Thin ash-white hair covered the surface, and blackish hair grew from the dorsal head to the dorsal buttocks.

Figure 2 Male Small Asian mongoose at five days
The outer hair began to cover the surface of the body. The eyes and the ears were closed.

Figure 3 Male (right) and female (left) Small Asian mongoose at two weeks
The outer hair completely covered the surface of the body. The ears were open and the eyes began to open.

Figure 4 Male (top) and female (bottom) Small Asian mongoose at five weeks
The black and yellowish white mottled hair became approximately 10 mm long, and completely covered the surface of the body.

Body Weight and Length
The body weights of the male and female at two days were 24 g and 27 g. The female's weight was insignificantly greater than the male's up to three weeks (Table 1). However, the male began to weigh more after weaning. The weight difference between the male and female gradually increased.

At the end of the observation period (28 weeks), the body weights of the male and female were 958 g and 520 g, respectively. The average daily body weight gain (Fig. 5-a) at zero to four weeks was approximately 3 to 4 g for both the male and the female. The body weight gain was the greatest between five and eight weeks, beyond which it de-
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Table 1 Change in body measurements of the newborn Small Asian mongooses

<table>
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<tr>
<th>weeks</th>
<th>body weight(g)</th>
<th>head &amp; body length(mm)</th>
<th>tail length(mm)</th>
<th>total length(mm)</th>
<th>tail ratio(%)</th>
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<td>520</td>
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clined. There was almost no gain from weeks 21 to 24 in the female, and the male showed an insignificant weight increase from weeks 25 to 28.

At two days the head and body length of the male was 83 mm and the female's was 84 mm (Table 1). The head and body length of the male at the 28th week was 350 mm and 300 mm for the female. Most of those gains in both male and female occurred from the first to the fourth week (male, 3.4 mm; female, 3.1 mm) (Fig. 5-b), subsequently decreased. There was extremely little head and body length gain in the female from the 17th to the 20th week, and the length gain became extremely small in the male from the 25th to the 28th week. The tail length at two days was 37 mm for the male and 46 mm for the female (Table 1), and during the first four weeks gaining 2.4 mm for the male and 2.2 mm for the female, and holding steady for the next four weeks (Fig. 5-c). The tail length of the male at the 28th week was 266 mm, and that for the female was 234 mm. The average daily increases in body weight, head and body length, and tail length were greater in the male than in the female. The tail ratio at two days was around 50%, and it increased slowly thereafter, reaching about 70% at the sixth week; it increased by about 80% from the 20th week onward (Table 1). The tail ratio increase declined with the animal's growth (Fig. 5-d).

Tooth Eruption and Replacement

The milk incisors and milk canines of the male and female were visible at three days, and the milk premolars appeared in seven days. All the milk teeth were visible at 28 days, consisting of 12 incisors, four canines, and 12 premolars. The milk incisors of the male fell out from the 56th to the 84th day, and those of the female from the 56th to the 78th day. The male's permanent incisors appeared between 61 and 87 days, and the female's between 58 and 82 days. The permanent third inci-
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Figure 5 Average daily gain of four external morphological parameters for each four-week period.

A little earlier in the female than in the male. This tendency was similar for all milk teeth. The first permanent molar of the lower jaw was visible from the 84th day, and all permanent teeth in both male and female had completely grown out by 126 days. The permanent teeth consisted of 12 incisors, four canines, 16 premolars, and eight molars in both male and female, for a total of 40 teeth.

**Eye Opening**

The eyes of the male and the female were not open at birth. An eyelid boundary became clear at nine days. Eye mucus was visible for 11 days in the right eye of the male; the eye opened halfway at 12 days and was completely open at 15 days. The left eye opened halfway at 17 days and was completely open at 19 days. Both eyes of the female opened approximately 1/3 at 17 days; the left eye opened at 18 days and the right eye at 20 days.

**Claws**

The shafts of the claws were two mm long and semi-transparent white at two days (Fig. 1). The length of the claws reached 3 mm at seven days, and their tips began to curve. The claws became hard at two weeks, and the roots of the claw shafts had begun to turn black. The curve of the tip of the claws became more pronounced at three weeks, and half of the claw proximals turned black. The tips of the foreleg claws began to shorten at four weeks, and the length reached 4 mm. The claws turned almost black within four weeks and were completely black within six weeks. The tips of the claws on the hind legs chipped at six to eight weeks and began to grow sharp.

**DISCUSSION**

Nellis and Everard [3] reported that newborn mongooses (H. auropunctatus) in the Caribbean islands were covered with hair, but ventrally there were only sparse patches of golden hair on the abdomen and thorax. Nellis [6] observed that the
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Table 2  The replacement stage of the milk canines and premolars in the Small Asian mongoose

<table>
<thead>
<tr>
<th></th>
<th>canine</th>
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<tr>
<td>upper jaw</td>
<td>112</td>
<td>107</td>
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<td>96</td>
</tr>
<tr>
<td>lower jaw</td>
<td>101</td>
<td>115</td>
<td>94</td>
<td>92</td>
</tr>
</tbody>
</table>

- : could not observe, L : left row of teeth, R : right row of teeth, unit : days after birth

Figure 6  Daily body weight gain of male and female Small Asian mongooses.

dorsal surface hair was light gray. *H. auropunctatus* are now subsumed in *H. javanicus* [7]. Two newborn mongooses, *H. javanicus auropunctatus*, on Okinawa had ash-white hair similar to that reported by Nellis [6]. In addition, the vibrissae were prominent hairs; the visible eyelashes and closed ears [3] were similar in both newborns. The nasal plates of the Okinawan adult mongooses were a light red color, and their dorsals were a dark brown. This characteristic of *H. javanicus auropunctatus* on Okinawa [8] was observed immediately after birth.

The outer hair, mottled with black and yellowish-white speckles, completely covered the animal at two weeks. This change seemed to be an adaptation associated with animals just beginning to walk.

The weight was not measured on the day of birth or the next day to prevent the newborns being killed and eaten by the mother. The body weights of the male and the female at two days were 24 g and 27 g, respectively. It was speculated that the newborn weights of the Okinawan mongooses were less than that of the mongooses of Grenada (22.3 to

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Figure 7  Relationship of total length and body weight in male and female Small Asian mongooses.
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36.4 g) [3] and the same as that of the Hawaiian mongoose (19.8 to 22.1 g) [2]. The doubling time (days needed to double birth weight) is an index used to ascertain the level of the animal's growth shortly after birth [9]. The doubling time of the mongooses from their weights at two days was eight days. We speculated that the mongooses showed initial growth identical to that of a dog or cat [10].

The male and female weights of mongooses on Okinawa exceeded 300 g at six to eight weeks, the time when feral mongooses in the Caribbean were weaned [3]. Moreover, the male in that study reached around 500 g, and the female around 400 g at 10 to 12 weeks, when the juveniles were separated [3]. These weights were near the mean weight (male) or over (female) those of feral mongooses on Okinawa [8]. Those weights reached 958 g in the male and 520 g in the female at 28 weeks, when the observation period ended. The maximum weights of feral mongooses captured thus far on Okinawa were 941 g for a male and 510 g for a female [8]. In addition, there was a large difference in the development of their body weight after 20 days in comparison with the weights of mongooses bred in an artificial environment [3]. This suggests that artificial lactation and feeding after weaning led to a hyperalimentation condition; a female that died at 3 years, 4 months (BW, 516.0 g) had a large amount of fat in the peritoneal cavity not observed in feral mongooses.

The mean daily body weight gain for each four-week period peaked at five to eight weeks (Fig. 5-a). However, the daily body weight gain continuously fluctuated in the daily observations (Fig. 6). The daily body weight gain increased prior to eight weeks. However, it was clear that body weight does increase and decrease, and that the range of such changes tended to widen after about eight weeks. This periodic change in daily body weight gain cannot be observed in a mean daily body weight gain analysis [11]. It was suggested that the daily body weight change of the adult mongoose is also periodic.

Considering only the increase in body weight (Fig. 5-a), it appears that the female mongoose continued growing to 24 weeks, while the male continued to grow beyond 28 weeks. However, there was a period of transient weight loss during this interval. The first body weight decreases were at 16 days, and they coincided with the switch from mother's milk to artificial lactation. This change in nutritional factors seemed to cause the transient weight loss. Tomich and Devick [2] reported that weight gain declines coincide with weaning at six to seven weeks after birth, independence from the mother at about 12 weeks, and approaching maturity beyond 20 weeks. Weaning was performed at 30 days in this study; there was a decrease of 10 g in the female, while in the male there was little decrease. In the mongooses that were raised, it seemed that the transition from mother's milk to solid food was the first major barrier.

Male body length continued to increase to 28 weeks, and the female kept growing to around 24 weeks. The absolute growth of the tail length in this period was always greater than the head and body length. Moreover, when the relationship between body length and body weight was observed (Fig. 7), the body weight per total length gradually increased with growth, and the mongoose became rounder with growth. Differences between the male and the female began to be seen from about seven weeks, and the male reached 1.5 times greater weight per body length than the female at 28 weeks. The differences in body shape changes in the male and female were also very evident. Although artificial breeding at this time was in a glutting environment, it was obvious that the female's body shape did not develop like that of the male. There are two sexual dimorphisms in the
feral mongooses on Okinawa [8]. It was clear that the differences not only in weight and length but also in shape are observable from about seven weeks. This age corresponds to the age of 6–8 weeks when feral mongooses are weaned [3].

The eruption of teeth was reported in detail by Tomich and Devick [2] for the same species in Hawaii. The adult mongoose has 40 or 42 teeth (3/3, 1/1, 4/4, 2/2 or 2/3) [2]; there were two molars and a total of 40 teeth in the permanent teeth of the Okinawan mongooses. It was confirmed that the milk incisors and the milk canines began to grow on day three, and all milk teeth had grown in by 28 days, corresponding to the description of the same species in Hawaii [2]. When the loss of the milk teeth was compared with Tomich and Devick [2], the loss of the milk incisors beginning from 56 days was the same, but the time for the last milk incisor to drop out was 11 to 12 weeks. This was a little earlier than the 14 weeks in the study by Tomich and Devick [2]. A loss at 14 to 18 weeks for the milk canines and 13 to 16 weeks for the milk molars in the mongooses on Okinawa is earlier than that at 19 to 20 weeks and 14 to 18 weeks for the same species in Hawaii [2]. Although the permanent incisors and canines began to grow in the same weeks as those in the Hawaiian mongooses [2], the first permanent molar was slower at 12 weeks. All permanent teeth were in place by 18 weeks, four weeks earlier than in the Hawaiian mongoose [2]. Overall, teeth in the mongooses on Okinawa tended to be replaced earlier than teeth in the Hawaiian mongooses [2].

Powell [4] noted that the mongooses’ eyes opened after 16 to 17 days. Nellis and Everard [3] recorded that the eyes opened between 17 and 20 days. In the Okinawan mongooses, signs of eye opening were observed from 9 days, and they opened in 15 days in the male and 20 days in the female, similar to same species in other regions. Nellis and Everard [3] reported that the claws of newborn mongooses are well developed. However, the claws of Okinawan mongooses were not well developed at two days, being about two millimeters long and a semi-transparent white in color (Fig. 1), different from those of an adult. The claws attained their adult form between six to eight weeks, when sexual dimorphism begins to appear in the Okinawan mongooses, the same six to eight weeks that Nellis and Everard [3] report as the age of weaning of feral mongooses. This stage seemed to be a crucial period for *H. j. auropunctatus*, which morphologically and functionally undergoes a significant conversion from the juvenile to the adult stage.

要 約

飼育下で生まれた雌雄各 1 頭のジャワマングースの新生子について、人工保育を行い、生後 28 週齢までの外部形態の変化を観察した。出産直後のマングースは全身が肉红色で、腹部には長さ約 10 mm の帯状が付着していた。腹部には 3 号の乳頭が観察され、生殖器の形態から雌雄判別が可能であった。全身には灰色の被毛を有し、頭部から臀部背側には黒色の被毛を有していたが、8 週齢には成獣と同様の被毛に変化した。乳歯が生え揃ったのは 4 週齢で、永久歯は 18 週齢に萌出が完了した。開眼は雌が 19 日齢、雄が 20 日齢であった。2 日齢の体重は雌が 24 g、雄は 27 g で、28 週齢にはそれぞれ 958 g、520 g に達した。1 日増体重は 15 日齢まで連続して正の値を示したが、離乳を行った 16 日齢に初めて減少した。その後、1 日增体重は増減を繰り返し、体重増加に周期性があった。2 日齢の頭胸長は雌が 83 mm、雄が 84 mm で、28 週齢にはそれぞれ 350 mm、300 mm になった。頭胸長の増加は 1 週齢から 4 週齢の間が最も多かった。体長と体重の比は成長に伴って緩やかに増加し、体型は成長に伴って丸みを帯びた。雌雄の体型の相違は野生のマングースが離乳する 7 週齢頃より明らかになっ

キーワード：成長、人工保育、ジャワマングース、Herpes-
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References