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## Postnatal physical development of the Water mongoose (*Atilax paludinosus*)

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### Abstract

The physical postnatal development of captive-bred *Atilax paludinosus* is described. Data indicate a litter size of two to three young. At birth the eyes and ears are closed and the animals are fully furred. The sequence of tooth eruption and weaning age are discussed. Comparisons with other Herpestinae indicate similar rates of development.

### Introduction

Water mongooses are solitary, nocturnal viverrids about which very little is known. SMITHERS (1983) remarks on the scarcity of information available on the reproduction of *Atilax*; apart from ZUCKERMAN's (1953) report on their breeding season and FRESE's (1981) record of births in the Berlin Zoo, little detail has been recorded. The remaining information concerning this species is presented in general references (SHORTRIDGE 1934; HINTON and DUNN 1967; DORST and DANDELOT 1970; ROSEVEAR 1974; KINGDON 1977; ROWE-ROWE 1978; STUART 1981; SMITHERS 1983). POCOCK (1916) describes some of the external characteristics of *Atilax* and DÜCKER (1965) has included some details regarding their biology in her text on viverrids.

This study describes the postnatal physical development of water mongooses in captivity, and compares it with the rate and pattern of development in other Herpestinae.

## Material and methods

The data presented here were obtained from seven water mongooses and their offspring. Of five female adults, one (A) was trapped during March 1982 in Westville North, Durban, another (B) from Hillcrest, Natal was trapped in March 1982, a further two (D; E) were obtained from the National Zoological Gardens, Pretoria in November 1982 and a fifth was collected from Hilton, Pietermaritzburg. Of two male mongooses one (C) was trapped in the Paradise Valley Nature Reserve, Durban in August 1982 and the other (F) was donated by the National Zoological Gardens, Pretoria in November 1982.

The animals were housed singly in adjacent cages measuring  $1,5 \times 3 \times 1,2$  m. Each cage was furnished with a nestbox, a galvanised iron bath which served as a pond, and several rocks and tree stumps. The base of each cage was concrete, covered with river sand. The cages occupied by A, B and C were situated within a large enclosure in the Shepstone Nature Reserve of the University of Natal, Durban, while D, E, F and K were housed within a suburban garden in Moseley Park, Pinetown. Both localities were quiet and the cages were surrounded by dense undergrowth. At the onset of spring (September) the door between adjacent cages was opened to allow a single male and female access to one another. The minimum period that the animals were allowed to remain together varied from 10,5 hours to six weeks. When it was ascertained that the female was pregnant, as shown by swollen nipples, increased girth or an observed mating, the pair was separated, except in one instance when a male was allowed access to the female throughout gestation and birth.

Standard measurements (head-body, tail, hind foot, ear and mass) of the offspring were taken as frequently as possible, usually every alternate day for the first 20 days and then at approximately three-day intervals until the animals became unmanageable (at approximately 60 days of age). Other aspects of physical development were also recorded, notably tooth eruption, eye opening, onset of audition and weaning age. Behavioural aspects of postnatal development were also noted and will be reported on elsewhere.

## Results

Six litters were born, varying in number from two to three young per litter, with  $\bar{x} = 2,5$  and  $SD. = 0,54$ . The sex ratio of the offspring was 9 ♂♂ : 5 ♀♀. This does not differ significantly from a 1 : 1 ratio ( $\chi^2 = 0,642$ ;  $0,5 > p > 0,3$ ). While six litters were born, not all aspects of physical development reported on here were monitored on each litter, owing to unmanageability of some litters born of wild parents, and also to prevent disturbance of these family groups. As a result litters A1, A2 and B1 were disturbed as little as possible to record data, whereas E1, E2 and E3 were monitored intensively through their early development. In addition to these data, the postnatal development of four other mongooses was monitored. Two of these were observed from day 104 (animals D and F) and one from day 97 (animal E). The fourth was reared in isolation from day 8 (animal K). Table 1 indicates the litters which provided the data discussed here.

Mean mass and growth data are presented in figures 1 and 2. Eye opening varied from day 9 to day 14 with  $\bar{x} = 11,4$ . The eyes usually took two days to become fully open and were initially bluish in colour, with the pupil only vaguely discernible. By day 21 the eyes were brown with a more sharply defined horizontal pupil.

The young were born with extended ear pinnae, but the auditory meatus was closed for the first few weeks. Opening of the meatus and onset of hearing varied from day 17 to day 28 with  $\bar{x} = 21,8$ .

The earliest that weaning commenced was day 30 and this varied up to day 46 with  $\bar{x} = 35,9$ . After the onset of weaning approximately 15 days elapsed before the young were nutritionally independent of the mother. Nevertheless they continued to suckle for approximately a further 20 days, until day 56. After this it was noted that some young suckled from their mother when settling to sleep. If mongooses were hand-raised in a group 'sibling suckling' was recorded whenever they lay down together. In one pair of animals (D and F) this continued for six months.

At birth the offspring were equipped with i 1 and 2. The order of eruption was then i 3, c 1, p 3, p 2 and p 1. The deciduous set was complete on day 43 in some animals and by day

Table 1  
Details of the animals from which data were gathered

Mongoose	Number of offspring	Sex	Postnatal physical data gathered
Litter A1	3	2 ♂♂; 1 ♀	Eye opening Onset of hearing
Litter A2	2	1 ♂; 1 ♀	
Litter B1	2	2 ♀♀	Onset of hearing Weaning
Litter E1	3	1 ♂; 1 ♀ 1 died, unsexed	Eye opening Onset of hearing Weaning Tooth eruption
Litter E2	2	2 ♂♂	Eye opening Onset of hearing Weaning Tooth eruption
Litter E3	3	3 ♂♂	Eye opening Weaning Tooth eruption
Animal D	—	♀	Tooth eruption
Animal E	—	♀	Tooth eruption
Animal F	—	♂	Tooth eruption
Animal K	—	♀	Eye opening Onset of hearing Weaning Tooth eruption

46 at the latest ( $\bar{x} = 44$ ). The order of replacement by the permanent set was I 1, I 2, M 1 after which there was considerable variation with respect to the remaining incisor, molar and premolars. In all cases both molars were present before P 3 appeared, but the order of premolar eruption was not consistent. The permanent canine was always the last tooth to appear, with the upper preceding the lower by at least five or six days, and in some instances by 15 or 16 days. The deciduous canines remained in place until the permanent canines were firmly established. The earliest that the permanent set was complete was day 227, and the latest day 270 ( $\bar{x} = 243.3$ ;  $n = 6$ ).

At birth, the young were covered in dense, short, soft, wavy black fur. Several specimens had an indistinct pale brown patch on the belly, but this was not maintained into adulthood. Pale brown/yellow fur surrounded the mouth in all offspring, and persisted into adulthood. From day 26 the fur became progressively grizzled, first around the ears, eyes and chin. On day 30 the abdomen, too, became grizzled while the dorsal regions remained black for the greatest length of time. The grizzled appearance seemed to develop as a result of loss of baby fur and replacement by the adult pelage. The crown of the head was the last region to lose the black juvenile fur, so that until day 65 the young still appeared 'woolly'. The adult pelage consisted of a dense, short underfur and longer grizzled, coarse guard hairs. At birth, the toes were separated and the claws, although soft, were well developed. Nose pigmentation varied, being either pink and black or wholly black.

At birth, males had abdominal testes and time of descent varied from day 204 to day 307, with  $\bar{x} = 255.5$ . Thereafter the testes were permanently scrotal.

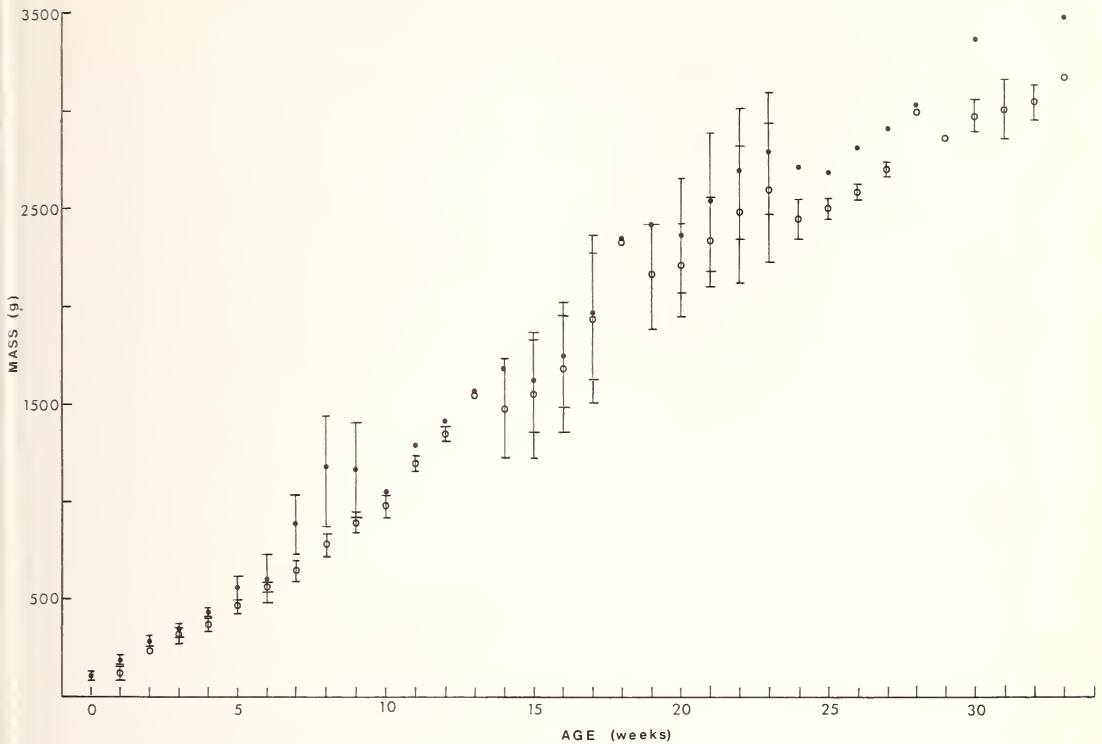


Fig. 1. Mean mass increase ( $\pm 1$  SD.) of  $\delta$  (●) and  $\text{♀}$  (○) water mongooses from birth until 33 weeks of age. Birth mass of  $\delta\delta$  and  $\text{♀}\text{♀}$  coincides

## Discussion

At birth, water mongooses were morphologically precocial, in that they were fully furred. Their physical development proceeded rapidly and the young animals were nutritionally independent of their mother by eight weeks of age. It is unlikely, however, that the mother and young would separate at this time, as the offspring require a period of behavioural learning before being entirely self-sufficient. Nevertheless the speed of their development and acquisition of independence would enable the parent to produce more than one litter per breeding season.

Adult males are slightly heavier than females ( $\text{♀}\text{♀} = 2562$  g,  $n = 9$ ;  $\delta\delta = 2956$  g,  $n = 18$  [STUART 1981]). Figure 1 indicates that this trend prevails throughout development. At thirty-three weeks mongooses were heavier than the mean mass of adult *Atilax* recorded by STUART (1981). This probably results from a plentiful food supply in captivity, as well as restricted exercise opportunities. The animals in this study reached the adult mass recorded by STUART (1981) at 27 weeks of age, but it is likely that this statistic is also affected by captive conditions, and in the natural environment mongooses may not reach their asymptote so early.

In their natural environment water mongooses are solitary, nocturnal mammals that appear to rely on crypsis for their survival. This factor, as well as their reliance on small vertebrates and crabs for food, would preclude a very large body size. Growth rate is rapid and mongooses reach adult size approximately 15 weeks after birth. This rapid develop-

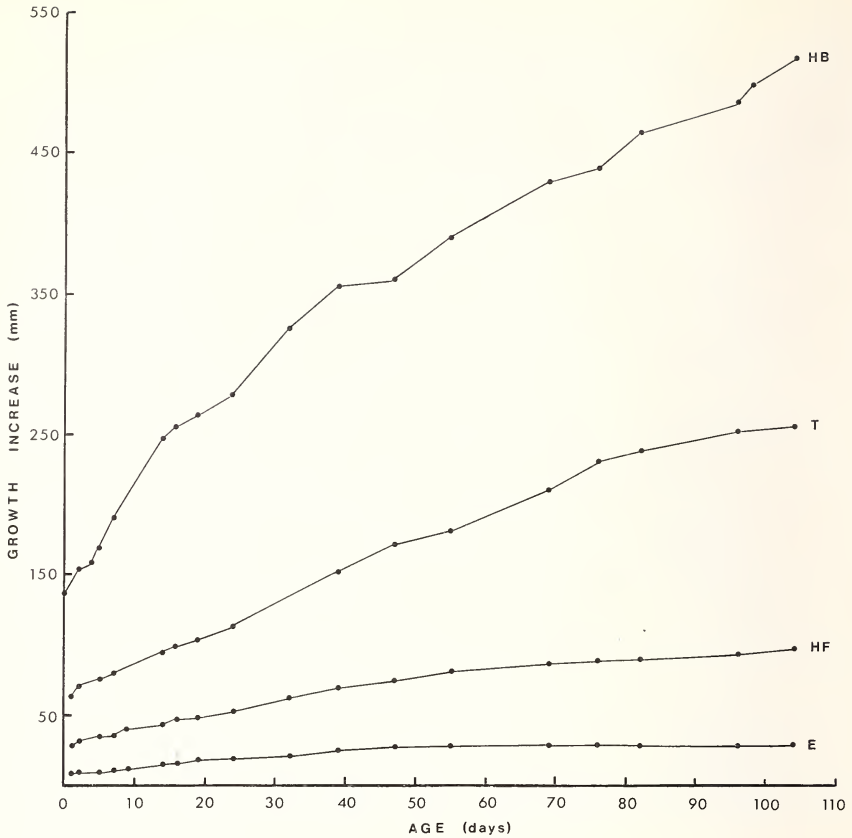


Fig. 2. Growth curves of ♂ and ♀ *Atilax paludinosus* from birth until 104 days of age

ment is adaptive as it physically prepares the animals for an early independence. Agonistic encounters between mother and young indicate that separation in the natural environment would probably occur no later than six months of age. At this time the young are almost sexually mature and the mother is ready to produce another litter. Break-up of the family unit at this time would lessen the possibility of inbreeding.

The presence of *i* 1 and *i* 2 at birth may serve to ensure adequate nipple attachment during suckling. These teeth were neither sharp nor particularly well developed and appeared to have no adverse effect on the mother's teats. It is significant that the young animals do not shed their deciduous canines until the permanent ones are fully erupted, as these teeth equip them to deal effectively with their prey. Small mammals are killed by puncturing the cranium and the carapace of invertebrate prey is similarly opened. Without the canines the mongooses would be extremely vulnerable, both from a defence point of view and also in terms of efficient exploitation of prey.

The observed extension of suckling time may simply promote security and contentment. Nevertheless, the continuation of suckling after nutritional independence may also function in maintaining group cohesion. In one instance where three water mongooses of similar age were hand-raised together, two of them suckled one another, while the third never participated in the activity. It may be significant that the pair (a male and a female) that did suckle one another were siblings, and that the third animal (a female) had different parentage. All three mongooses were compatible until they became sexually mature, when

the third animal became the focus of both aggressive and sexual activity from the other two.

In comparison with banded mongooses (VILJOEN 1982) and suricates (DÜCKER 1962), new-born water mongooses are well covered with fur. The significance of this is not clear but may be related to two factors. Firstly, the lack of sociality in this species means that the young are often left alone for extended periods while the adult forages, unlike the banded mongooses where a 'babysitter' is left with the young at the den while the group forages. While on their own the new-born water mongooses would have to independently maintain their body temperature, and while huddling would reduce heat loss, a well-developed pelage would further aid thermoregulation. Secondly, because water mongooses largely rely on crabs and aquatic frogs for food, frequent immersion in water is necessary. The adult returning from a foraging trip may be slightly damp and it would be to the advantage of the young if they were fur-covered and thus protected against becoming wet. In the adult the dense, soft underfur appears to insulate the animal and ensures the maintenance of a dry skin surface.

The persistence of the juvenile pelage in the head region may be significant in that it gives the young a youthful appearance for a period of time when in fact they are almost independent. It may prolong the period of parental care, and serve as a trigger for the release of amicable behaviour. This obviously assumes that the parent would respond aggressively to the offspring earlier if the outline of the head were not softened by the longer hair. The paleness of the hair surrounding the mouth region appears to play an important role in behavioural communication, in that attention is drawn to the anterior of the animal, and particularly to mouth movements. Because the water mongoose is dark-coloured and is active at night many forms of behavioural communication would be unnoticed unless highlighted in some way. For example many of the agonistic behaviour patterns exhibited by these animals involve a variety of intricate mouth movements. It would be disadvantageous to the animals to be unable to heed these agonistic signals.

Because only a few offspring were born with a pale patch of fur on the belly, and were neither preferentially groomed nor suckled it was assumed that it served no function.

When comparing the postnatal development of *Atilax* with the available literature on other herpestines (Table 2), the similarity in patterns of growth and development is marked. There is, however, wide variation in the modes of existence of the different herpestines (eg. nocturnal vs. diurnal; solitary vs. sociable). It is suggested that these variations result primarily from differences in behaviour patterns, as behaviour is more flexible than morphological change. However, it is not unlikely that behaviour has promoted some morphological change within the subfamily. By comparing the differences

Table 2

Comparison of postnatal development data of some herpestines

	Eye opening (day)	Hearing (day)	Weaning (day)	Source
<i>Atilax paludinosus</i>	9-14	17-28	30-46	Present study
<i>Galerella sanguinea</i>	20	-	52-65	JACOBSEN 1982
<i>Mungos mungo</i>	8-10	-	-	SIMPSON 1964; VILJOEN 1980
<i>Suricata suricatta</i>	11-14	10	49-63	DÜCKER 1962, 1965; EWER 1973
<i>Helogale undulata</i>	14	-	-	ZANNIER 1965; MICHAELIS 1972

in behaviour amongst the herpestines such as foraging techniques, parental care and communication patterns a clue to the possible direction and pattern of evolutionary change within the subfamily may be found.

It has been suggested (GORMAN 1979) that small body size and sociality are advanced characteristics amongst herpestines, whereas the ancestral type was larger and solitary. In association with sociality abundant food requirements result in a trend for omnivory (eg. *Mungos mungo* [SADIE 1984]) as opposed to ancestral, almost exclusive, carnivory (eg. *Galerella sanguinea* [BAKER 1980]; *Herpestes ichneumon* [STUART 1983]; *Atilax paludinosus* [BAKER in prep.]), thus the presence of elongated claws equips the sociable herpestines with adequate tools for seeking out subterranean invertebrates and vegetable material, which form a large part of their diet. Similarly, parental care is markedly different in sociable herpestines compared with the solitary representatives (EWER 1973; ROOD 1974, 1982, 1983; ROOD and WASER 1978; KLEIMAN and MALCOLM 1981; BAKER in prep.).

Despite the wide variation of lifestyles which are found, the similarity amongst the herpestines is particularly evident in their general morphology, and so the conservatism of the trends in their postnatal development is not a surprising feature and provides further evidence of morphological inflexibility as opposed to behavioural plasticity.

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#### Zusammenfassung

##### *Postnatale körperliche Entwicklung des Sumpffichneumon (Atilax paludinosus)*

Die körperliche Entwicklung von in Gefangenschaft geborenen *Atilax paludinosus* wird beschrieben. Ein Wurf besteht gewöhnlich aus 2–3 Jungen. Bei Neugeborenen sind Augen und Ohren noch verschlossen, die Tiere sind jedoch vollständig mit Fell versehen. Reihenfolge des Zahnausfalls beim Wechsel von Milch- zu permanentem Gebiß und Alter der Entwöhnung werden abgehandelt. Im Vergleich mit anderen Vertretern der Herpestinae hat *A. paludinosus* eine ähnliche Entwicklungsgeschwindigkeit.

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## Multivariate analysis of craniometric characters in European wild cat, Domestic cat, and African wild cat (genus *Felis*)

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### Abstract

Studied craniometric characters of Italian populations of domestic and European wild cat (genus *Felis*) including comparison with African wild cat to assess their relevant taxonomical relationships. 135 specimens were submitted to a multivariate analysis of 5 skull's traits.

Principal component analysis shows the same eigenvectors' structure in the three groups. Canonical analysis displays large overlap in the plot of sample scores. This intergradation generate a morphometrical transition among *catus*, *libyca* and *silvestris* phenotypes. The suggested conclusion is that these phenotypes belong to a single polytypical species *Felis silvestris* Schreber, 1777.

### Introduction

Systematic and phylogenetic relationships between European wild cat and domestic cat have been subjected to longlasting debates. Most authors have directly compared these two taxa without considering African wild cat, possibly the principal, if not only, form to originate the present domestic population (HALTENORTH 1953; HEMMER 1976; TODD 1978; ROBINSON 1980; CLUTTON-BROCK 1981). Furthermore, morphometric and mor-