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Research Article

Reproduction and Post-Natal Development of *Hipposideros pomona* Andersen, (1918) in Kyan Taing Aung Cave of Sagaing Hill Range within Myanmar

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Abstract

Studies on sizes of animal at birth and on subsequent post-natal growth are important for understanding the aspects of their life history and for understanding a wide range of ecological, behavioural and developmental patterns. The study was conducted on a colony of *Hipposideros pomona* comprising approximately 700 individuals. The colony was located at Kyan Taing Aung Cave, a renovated seminatural structure situated at 21° 53.9' N, 95° 59.959' E and at an elevation of 165m above sea level on the Saging Hill Range, Myanmar and conducted from January 2005 to December 2006. Mating of *H. pomona* occured in the last week of October and parturition occurred during April and May. The gestation period was 180 days and the reproductive activity is associated with rainfall rather than the temperature. The pup appeared to be heavy with approximately 29.1 % of the adult female weight. The pups are assumed intermediate between precocial and altricial types. At birth the young bat was found to be already provided with canine teeth to grip not only the breast nipple but also the pubic nipple. The pattern of post-natal growth and development followed the basic trend of a linear growth of forearm and body mass during the preflight period. Linear regression conducted between the mean forearm length and mean body weight of both male and female growing pups was found to be highly significant. However, positive correlation was not established between the forearm length and the nature of the epiphyseal gap in the third metacarpal-phalangeal joint of the third digit. *Hipposideros pomona* attained sexual maturity at approximately seven months (210 days) from the time of birth, whence the forearm length had grown to approximately 40mm and the body mass attained approximately seven grammes.

Keywords: *Hipposideros pomona*, reproduction, post-natal development, Myanmar

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Introduction

Bats are an essential and important component of tropical ecosystem, and in South East Asia they comprise one-third of the mammalian fauna (Cranbrook, 1987; Kofron, 1997 cited by Tay et al., 2001). There have been many studies of bat reproduction in the tropics, but very little has been reported for bats from Myanmar. In reviewing the literature, Findley (1993) observed that reproduction of both frugivorous and insectivorous bats is apparently timed to coincide with periods of food abundance, and a common pattern is seasonal polyoestry with births at the beginning of the wet reason. However, Heideman (1995) noted that rainfall patterns alone do not account for all of the variations in reproductive timing (cited by Kofron, 1997).

The conditions that individual animals face during their early development can affect survival and later reproductive success (Lindstrom, 1999). The nutritional status of individuals is one of the most important factors in their success (Metcalfe & Monaghan, 2001), and periods with good food availability are important to the regulation of reproductive cycles (Bronson, 1985a). For many bat species, the reproductive cycle is regulated in such a way that the time of lactation, as the energetically most demanding periods in a bat's life cycle (Speakman & Racey, 1987; Kurta, Bell et al., 1989), coincide with the time of maximum food availability (cited by Racey & Entwistle, 2000). Most species of mammals live in the tropics, and many breed seasonally, but little is known about the regulation and maintenance of their seasonal cycles. Mammals typically match peaks in food availability with lactation and/or late pregnancy because maternal energy and nutritional demands peak in lactation or late pregnancy. Food availability is determined mostly by the annual temperature cycle in the temperate zone, and seasonal rainfall in the tropics. In some mammals, reproduction is opportunistic; depending upon immediate climatic and nutritional conditions (Heideman & Bronson, 1994).

Bradbury (1976) listed four patterns of reproduction by bats in the tropics: (1) throughout the year; (2) extended over a period of up to 9 months; (3) one peak season; and (4) two seasonal periods (cited by Gould 1978). Fogden (1972) stated that there is little doubt that abundance of food is the ultimate factor determining the timing of reproduction in insectivorous species. Insect numbers are related to leaf production, which in turn is related to rainfall (cited by Gould, 1978). Considering the worldwide distribution of bats, remarkably limited attention has been given to reproductive status in male bats, though the testes are one of the most important reproductive organs in mammals. The physiological capacity to breed in male is always characterized

by the mass of the testes. However, publications concerning testes and epididymis mass are very scarce (Hosken, 1995). Among the tropical species, knowledge of the breeding cycle has been based on gross observations of pregnancy, birth and lactation in females, or testes and epididymis in males (Krishna, 1947-50, cited by Medway, 1971). In vertebrates, post-natal growth rates may provide a valuable index of maternal investment, and milk energy output of females during lactation (Kunz & Robson, 1995).

Investigation on the size of animals at birth and on the subsequent post-natal growth are important for understanding various internal and external factors influencing the pattern of growth (Baptista, Richardson & Kunz, 2000 cited by Sharifi, 2004). Various studies have been made on post-natal growth of bats both under natural (eg., Case, 1978; Buchler, 1980; Kunz & Stern, 1995) and captive conditions (eg., Jones, 1967; Kleiman, 1969; Taft & Hundley, 1991; Hughest et al., 1995 cited by Sharifi, 2004). Studies have shown that measurement of body size, length of forearm and length of the gap of the third metacarpal phalangeal joint (Burnett & Kunz, 1982; Kunz & Anthony 1982; Fanis & Kunz 1998; Stern & Jones 1995; Isaac & Marimuthu, 1996; Hoying & Kunz, 1998; Stern & Kunz, 1998 cited by Sharifi, 2004) during the early post-natal period are essential.

There is still much to be learned of reproduction and post-natal development of bats in South East Asia. *Hipposideros pomona* is the most common and easily captured insectivorous bats on the Sagaing Hill Range in Myanmar and not much research has been done on the reproduction and post-natal development of this species. The aim of this study was to obtain baseline information on the reproductive pattern and post-natal growth of *H. pomona* from Myanmar.

Methodology

The study was conducted from January 2005 to December 2006. The study was conducted on a colony of *H. pomona* comprising approximately 700 individuals. The colony was located at Kyan Taing Aung Cave, a renovated semi-natural structure situated at 21° 53.9' N, 95° 59.959' E and at an elevation of 165m above sea level on the Sagaing Hill Range in Myanmar (Figure 1 & 2).

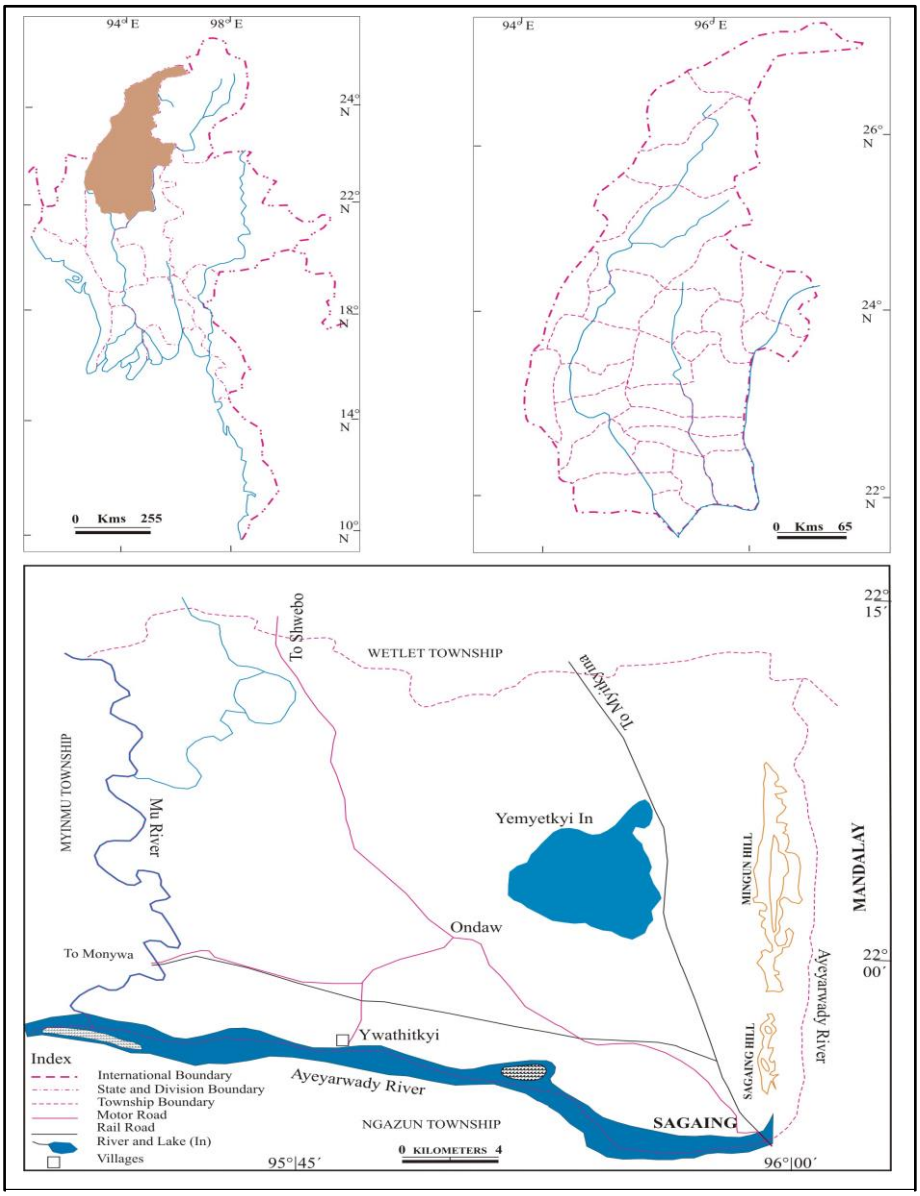

Figure 1. Map of the study area (Sagaing Hill)

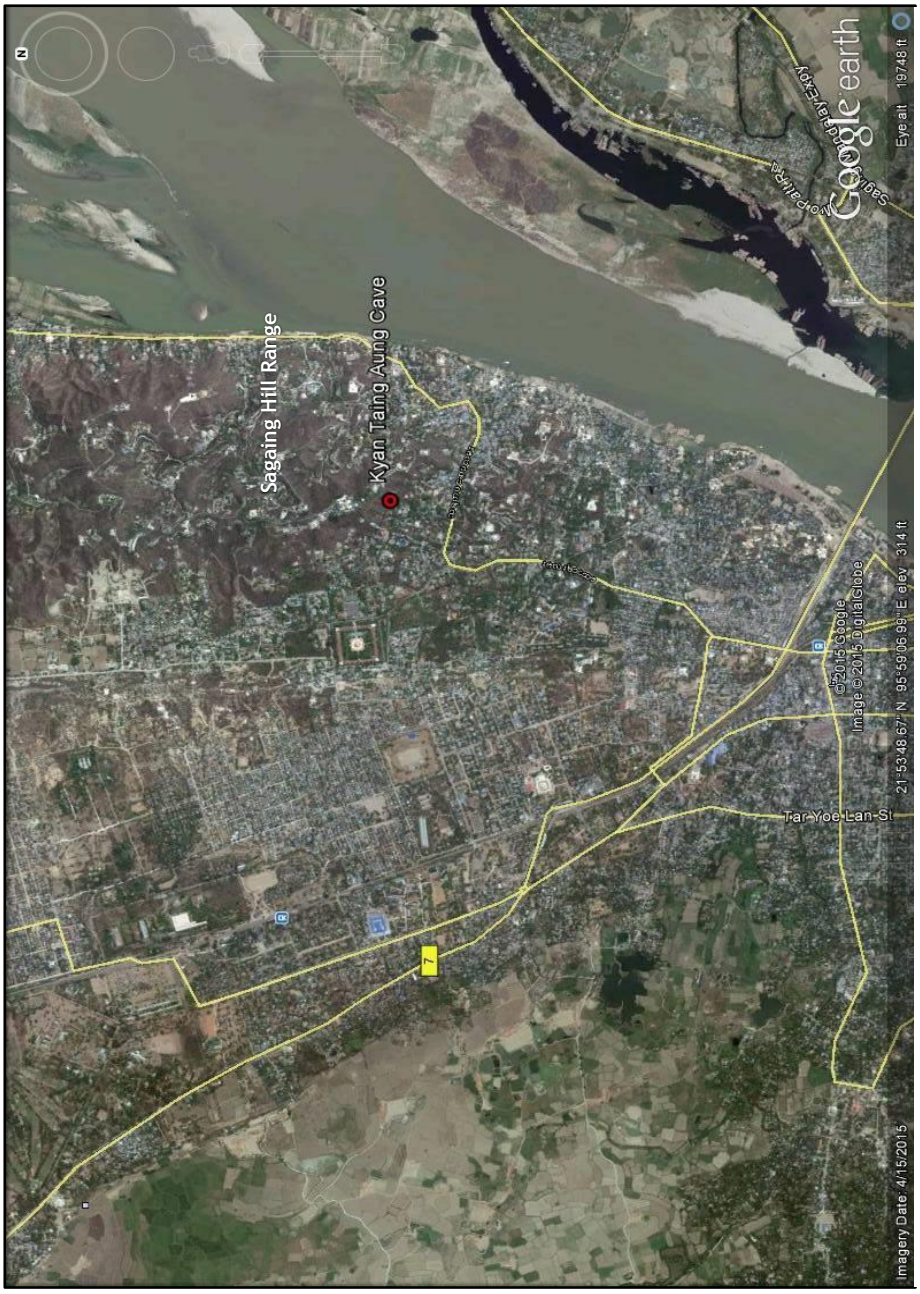

Figure 2. Map showing the cave studied

Bats were collected monthly at the rate of 20 samples by means of a modified insect net, with the mouth having a diameter of 50 cm and to which is attached a translucent nylon bag 100 cm in length, and happened to be the most convenient method of catching bats in this cave (Figure 3). Determination of sex, age and maturity based on conspicuous penis in males, and characteristic labiae and vagina in females, determination of age classes; namely pups, juveniles and adults. Pup (p) – if attached to the mother (nipples or pubic nipples) and/or cartilage continuous between the ends of the metacarpal and phalanx. Juvenile (J) – if the epiphyses of the fingers have yet to finish ossifying. Bands of cartilage still visible when trans-illuminated. Adult (A) – if the epiphyses of the finger bones have finished fusing no bands and more "nobby" joint (Anthony, 1988).

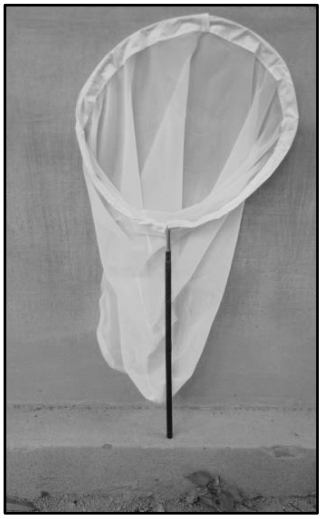

Figure 3. A modified insect net

Post-natal growth period is defined as the time from birth until the epiphyses of long bones become visibly closed (Kunz 1987; Kunz & Anthony, 1982), may extend from several weeks up to several months in bats (Ceng & Lee, 2002). Morphological "check point" such as the nature of the pinnae, eye, absence or presence of pelage and pelage coloration were also studied closely and recorded for estimation of developmental stages.

Results

Courtship Behaviour and Reproduction

Incidence of courtship was first recorded in the last week of October, during both years of study period from 2005 to 2006. First a male flew towards a prospective female and took roost near her and sent the message by flapping both wings, the sound of which was quite audible. Then the male approached the female and started to muzzle her body which later shifted to the posterior part of her body. The first attempt was usually found to be unsuccessful, since the female took flight from her roost position. At times the male followed her path, however most males tried to go for other females. When the female was receptive, the male mounted rapidly and coitus was achieved. During the peak mating month of November, the flapping noise was quite audible the moment one entered the cave.

Pregnancy and Lactation

The type of uterus in *H. pomona* was confirmed to be duplex type by longitudinal slicing of the uterus and examining under a binocular microscope. During the present study, the status of each female studied was categorized in accordance with Fletcher et al.; (2002). Since the ovaries are minute, it was not possible to take their monthly weight for analysis.

Most females (80 %) were pregnant in December with a single embryo in either the right or left horn of the uterus. This was confirmed by dissecting the females caught in December during both the study period years. In February, almost all the females (100 %) of the collected specimens were recorded to be pregnant. Pregnant females dissected during the study revealed to be bearing a developing fetus in either the left or right horn of the uterus.

Pregnant females were recorded from December to the last week of April. The maximum weight of a fully porous female recorded in the last week of April 2005 and 2006 were 10 g and 10.5 g respectively, (Figure 4). During the study, results on the 20 specimens per month collected to assess the reproductive status, revealed that females were fully pregnant in March (100 %), and one day old ones were first encountered in April (20th April, 2005; 21st April, 2006). Parturition was (9 %) observed till the last week of May. Data on post-natal development was recorded from April until August till the majority of young were volant and could not be captured along the mother. Weaning was evidenced in July in some specimens and some in August.

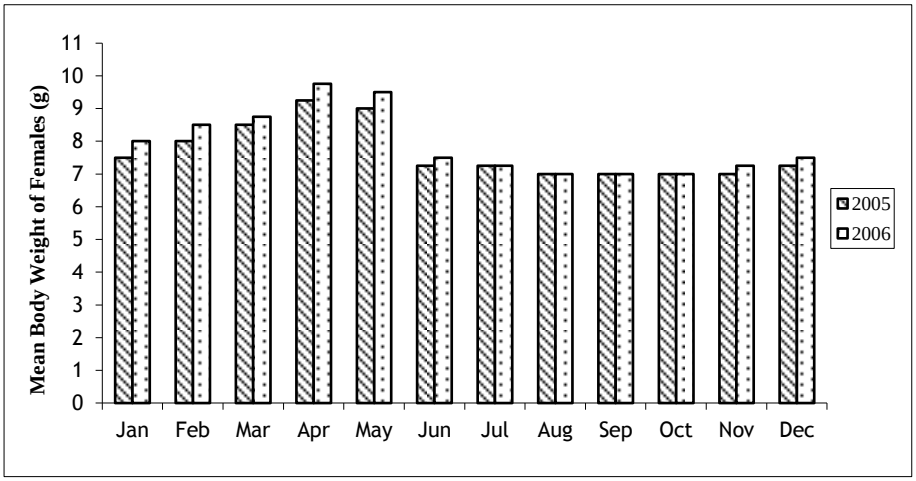

Figure 4. Monthly mean weight of the recorded female specimens (2005 & 2006)

Post-natal Development

The smallest pup with the mean body mass of approximately 2± g with the umbilical cord still attached was observed on the 20th April and 21st April of 2005 and 2006. The mean weight of one day old *H. pomona* was approximately 29.1% of the mother's mean body weight. The body was naked with a gray dorsal part and a pink ventral part. The skin was smooth and soft and the viscera were discernable through the skin of the abdomen. The skin though appearing very wrinkled and hard, was soft and pliable to the touch. There was slight dark pigmentation on the feet and tip of pinnae. The lids of the eyes were sealed, but the lines of fusion (eye-slit) were evident, and pinnae were folded over.

The presumed one day old pups have a mean forearm length of 16.6± mm, the epiphyseal gap of the third metacarpal-phalangeal joint was then recorded to have a mean of 2.8± mm. These pups were unable to right themselves when placed on the dorsum on a flat surface. The digits of the hind limb were separated and the claws were well developed and pigmented. One day old had feet nearly equal in size of the feet of an adult.

When roosting inside the cave, the pup often attached itself firmly to one of the two pubic nipples (false nipples) on the ventral side of their mother, in a head-up position with their feet grasped firmly to the axial position or sometimes wrapped its legs around its mother's neck. The pups periodically

released hold from the false nipple, slid down and suckled the pectoral nipples in the usual upside down position.

When the mean body mass was 2.5± g, the mean forearm length was 21.2± mm, epiphyseal gap of the third metacarpal-phalangeal joint had a mean of 3± mm; only a few hair were present on feet and on the dorsum of the head and scapulae and at the base of uropatagium, none on the venter. The lids of eyes were still sealed. The pups at this stage could crawl about very well and could right themselves quickly.

In pups weighing 3± g of the mean body mass and mean forearm length was 23± mm, the gap width at the third metacarpal – phalangeal joint enlarged to a mean of 3.8± mm; pelage was observed on the dorsum over scapulae, on the rump and along the flanks. The fur was short, soft and gray in colour, moreover, fur was apparent on the venter at the base of uropatagiun. The fur though still short was soft and whitish. The eyes were still closed, but the lines of fusions were evident.

At 3.5± g of the mean body mass, the mean forearm length was 25± mm, the mean gap at the third metacarpal-phalangeal joint enlarged to 4± mm. Pelage on the head consists of white short hairs. The hairs on the dorsum, scapulae, rump and along the flank were short, soft and gray, while those on the venter, base of uropatagium and pectoral region, short, soft and white in colour.

At 4 ±g of the mean body mass, the mean forearm length was 32.1± mm, epiphyseal gap of the third metacarpal-phalangeal joint had a mean of 3.6± mm. Pups were completely covered with darker hairs on the dorsum and long dark hairs on scapulae. In contrast to the dorsum, the fur on the venter was white. Hairs on the neck region tip were black.

In the neonate with the mean body mass 4.5 ±g, the mean forearm length was 34.4± mm, the hair on the dorsum and the scapular region, appeared longer and darker than the rest of general pelage. In contrast to the dorsum, the breast (pectoral) and flank hairs were grayish white while in the abdominal region whitish in colour. The eyes were not fully opened. Pinnae were unfolded and held erect. In this stage, the third metacarpal-phalangeal joint had a mean 3.6± mm and the pups were still attached to the mother. However, these pups could fly short distances when disturbed.

At 5± g of the mean body mass, the mean forearm length was 35.4± mm, the fur fully developed, long and dark in colour. Those on the dorsum, and the venter, grayish at tip but whitish at base. Eyes not fully opened yet. The pinnae were unfolded and held erect. Third metacarpal-phalangeal joint, had a mean of 3.5± mm. The young at this stage were still attached to their mother but could fly short distances when disturbed.

When the mean body mass reached 5.5± g, the mean forearm length was 37.2± mm, the young were covered completely with long dark hairs on the dorsum and on the venter. The fur was long, gray at the tip but whitish below. The mean epiphyseal gap of the third metacarpal-phalangeal joint was reduced to 1.5± mm. Eyes were then opened completely. The pups at this stage were observed hanging pendant from the mother's necks, with their feet grasped to the mother's neck region. In this position, the pups could stretch and flap its wing in preparation for the maiden flight. Majority of *H. pomona* were prepared for the maiden flight when their wing span was about 95 % (220 mm) of that of an adult female. Young were in the preparatory phase of maiden flight in July and weaned up pups were also encountered in July and some in early August. By this time most of the female showed worn-out elongated nipples, with no expression of milk.

During the study period, single infants were observed to be carried by the mother until it weighed about 6± g. At 6± g of the mean body mass, the mean forearm length was 39.4± mm. The third metacarpal-phalangeal joint gap was reduced to a mean of 1.2± mm. At this stage, the pelage of young and adult were similar in appearance, however somewhat darker in colour than the adult, which make them easily distinguishable from the mother's brown fur.

At 6.5± g of the mean body mass, the mean forearm length was 40.4± mm and the mean gap was 0.41± mm. At this stage the pelage colour resembled that of the adult. At that time, the young were already weaned.

At 7± g of the mean body mass, mean forearm length was 40.4± mm; no gap was seen between the third metacarpal-phalangeal joint, however appeared "knobby." The epiphyses of the remaining finger bones were also completely ossified and fused. In August, the majority of pups had attained approximately 7± g body mass (Table 1).

Table 1. Morphological development in post-natal of *Hipposideros pomona* in study period (Check Points)

Sample size	Mean Body Weight (g)	Mean Forearm length (mm)	Mean Epiphyseal gap (mm)	Pinna	Eye	Pelage, skin
13	±2.0	±16.6	±2.8	folded over	-sealed -line of fusion	• Naked, a gray dorsal part, a pink ventral part, skin smooth, soft, viscera seen through the skin of abdomen. Slight dark pigmentation of the feet and tip of pinnae.
5	±2.5	±21.2	±3.0	folded pinnae or folded pinnae at tip	-sealed -line of fusion	• Appeared hairs on the dorsum over scapulae, on the head, at the base of uropatagium, but not on the venter.
9	±3.0	±23.0	±3.8	folded pinnae at tip	-sealed -line of fusion	• On the head with short hair, on the dorsum of scapulae, on the rump and along the flank with short, soft, grey colour hairs. • On the neck region with short, white hairs. • On the venter, at the base of uropatagium with white colour.
5	±3.5	±25.0	±4	folded pinnae at tip	-sealed -line of fusion evident	• On the head with short, white hairs • On the dorsum of scapulae, on the rump along the flank, short, soft, gray colour. • On the venter at the base of uropatagium, pectoral region, short, soft, white colour
5	±4.0	±32.1	±3.6	Pinnae folded at tip	slightly open	• furred completely with darkened hairs on dorsum with long, dark fur over scapulae. -Venter was white fur in colour except neck region, which had darkened tips.
5	±4.5	±34.4	±3.6	partially erect	slightly open but no fully	• furred completely with darkened hair, hairs on dorsum with long, dark fur over scapulae. • pectoral and flank region, with grayish white, abdomen region with white fur, neck region tip had darkened.
9	±5.0	±35.4	±3.5	erect	not fully open	• Dorsum with long dark fur. Venter with fur grayish tip, whitish below.
15	±5.5	±37.2	±1.5	erect	fully open	• Long dark hair on dorsum and venter gray at tip, • whitish below.
22	±6.0	±39.4	±1.3	erect	fully open	• Completely furred in dark colour than adult.
5	±6.5	±40.4	±0.4	erect	fully open	• Completely furred in dark colour than adult.
6	±7.0	±40.4	0	erect	fully open	• Fur like adult in appearance and colour.

Gain in mean body mass and mean forearm length during postnatal development recorded during (2005-2006) indicated that growth as rapid during the first three months after parturation, followed by slow regular linear growth in the following months (Figure 5,6).

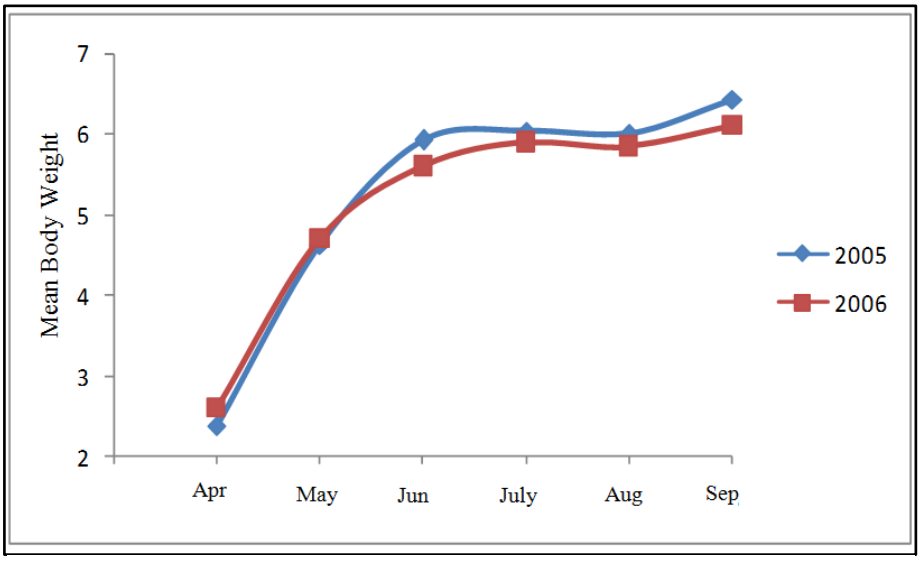

Figure 5. Gain in mean body mass during postnatal development (2005 & 2006)

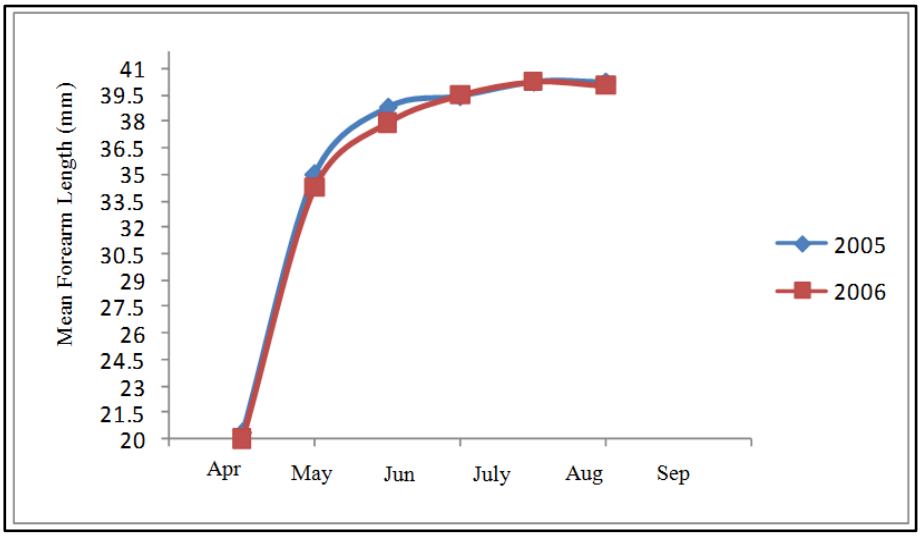

Figure 6. Gain in mean forearm length during post-natal development (2005 & 2006)

Regression analysis conducted between the mean forearm length and the mean body weight of the growing pups was highly significant (r^2=0.938) and in between the mean forearm length and width of the epiphyseal gap revealed negative correlation at r^2=0.325 (Figure 7, 8).

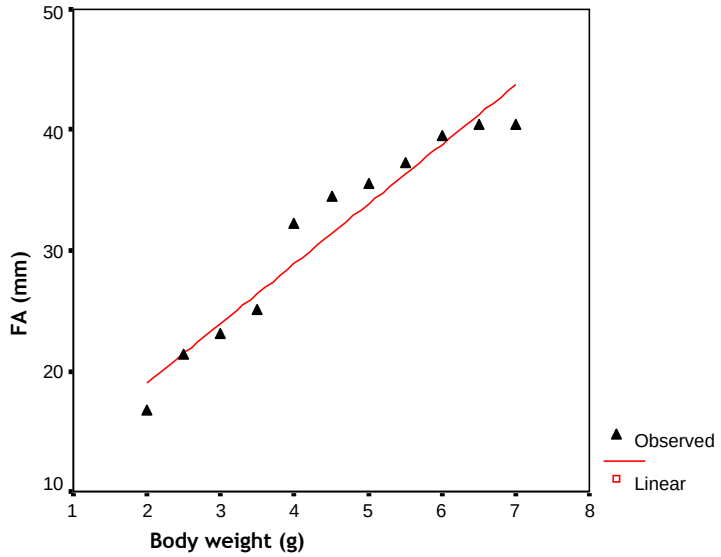

Figure 7. Regression analysis between the post-natal mean body weight and mean forearm length (2005 & 2006)

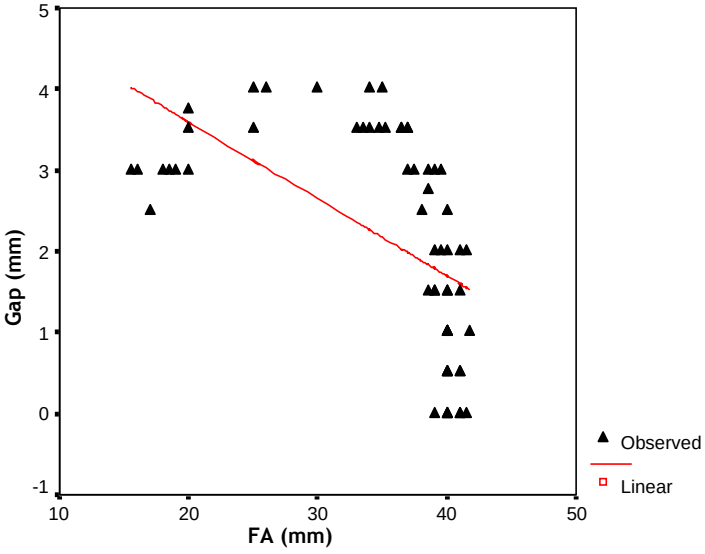

Figure 8. Regression analysis between the post-natal forearm length and epiphyseal gap (2006)

Discussion

Hipposideros pomona is a small insectivorous bat. With respect to reproduction in bats, it is said that seasonality of food resources is probably the most important single factor in determining the reproductive patterns of tropical bats (Wilson & Findley, 1970; Humphrey & Bonaccorso, 1979 cited by Racey, 1982). It therefore pointed out that for microchiropteran bats such as *Hipposideros pomona*, the species under study, being an insectivorous bat, the reproductive timing must coincide with the abundance of insect prey on which to forage in preparation for the successful propagation of the species. The relationship between rainfall and reproduction activity, therefore is not direct, but mediated through the effects of rainfall on leaf production and flowering of trees on insect abundance. Although there is no data for the seasonal changes in abundance of insects with respect to rainfall from the study area, studies elsewhere have shown that there is a positive relationship between rainfall and insect abundance (Fogden 1972; McWilliam, 1988; Happold & Happold, 1990). The same phenomenon could occur in the study area, since Sagaing, which is situated on the western bank along the Ayeyarwaddy River is lush green, and has a variety of edible fruit trees.

Racey (1982) described that in most species of bats, parturition generally takes place at the onset of rains and lactation is during peak rainfall. The results of the present study on the reproductive activity of *H. pomona* revealed that courtship and mating occurred during the last week of October through November and parturition took place in April and May. Since April is the onset of the rainy season, the result coincides with that of Racey's. Similarly lactation was also recorded during the rainy season. It also proved that reproductive activity is associated with rainfall rather than temperature cycle. The results above indicate that the gestation period in *H. pomona* is approximately six months (180 days) since mating was recorded from the last week of October and parturition occurred in April and May. Energy demands of bats are much higher during lactation than pregnancy and thus it is an advantage for lactation and weaning to coincide with a time of food abundance (Speckman & Racey, 1987). Moreover, for insectivorous microbats, adequate food supply during lactation and weaning is the most important factor in times of reproduction (Racey, 1982; Happold & Happold, 1940).

The same holds true for *H. pomona* since parturition occurred at the onset of the rainy season and lactation during the period of the rains and weaning and post weaning during the peak rainy months of August and September. Mammary glands of lactating females can usually be recognized by the whitish

tissue that lies directly beneath the skin (Racey, 1988; Kunz et al.; 1996). These glands are typically flattened, disk-shaped structures that extend from the mid-thoracic to the axillary region. Over the course of a female's annual life cycle, mammary glands progress from being undeveloped during the non-breeding season to well developed at peak lactation (Heideman, 1988 cited by Kunz & Hood, 2000). In mammals, lactation demands for more energy than pregnancy (Migula, 1969) and such an energy demand is exacerbated in smaller species owing to scaling effects (Hanwell & Peaker, 1977). Although many mammals including bats have evolved various mechanisms to distribute the energy cost of pregnancy over a longer period, lactation once initiated, does not tend itself to interruption or modulation, so adequate food supply during lactation and weaning is the most important selection pressure in the timing of the mammalian reproductive cycles (cited by Cumming & Bernard, 1997).

With respect to post-natal development, most of the studies carried out so far on post-natal growth and development of bats have been restricted mainly to microchiropteran bats; for example on Vespertilionidae (Tuttle & Stevenson, 1982; Kunz, 1987; De Fanis &Jones, 1995; Hughes et al.,1995; Isaac & Marimuthu,1996; Hoying & Kunz,1998; Sharifi, 2004), on Molossidae (Kunz & Robson, 1995), on Phyllostomidae (Stern & Kunz, 1998) on Megadermatidae (Rajan & Marimuthu, 1999), and on Hipposideridae (Cheng & Lee, 2002) (cited by Elangovan et al., 2002).

In this study, the gestation period of *H. pomona* lasted approximately 6 months. The weight of the infant *H. pomona* was approximately 29.1 % of the mother's weight, an indication that bats produce relatively larger offspring compared to other mammals. Females eat the placentae and umbilical cords and lick the young very soon after birth. Placentae were eaten first, then umbilical cords were eaten within 2 or 3 mm of the naval area (Jones, 1967). In this study among bats captured by insect net, a bat (mother) was observed with a pup in which both the umbilical cord and placenta were still attached. They were put into a bag. However, when the mother was taken out for measurement, only part of the umbilical cord was found to be attached to the pup. This incidence clearly demonstrated that the mother had eaten up the placenta and part of the umbilical cord.

It is said that at day one of age, the young could crawl about only feebly and were unable to right themselves when placed on the dorsum on a flat surface (Jones, 1967). The same phenomenon was seen in the present study. With respect of *H. pomona*, although the weight of the young bat was heavy,

approximately 29.1 % of the adult female weight, the young were born naked with eyes closed, and from the results cited above, *H. pomona* may be taken both as precocial and altricial in nature. Thus, the nature of *H. pomona* at birth clearly indicate that they are intermediate in nature.

According to Neuweiler (2000), horseshoe bats, hipposiderids and megadermatids are not born with milk teeth, their permanent canine teeth are already in place. Milk teeth are present in these species during development but are reabsorbed before birth. The young of these species use their permanent canine teeth to grip not only breast nipples but also the pubic nipples, located in the fold of hip. Pubic nipples are found in these three families of bats.

In the present study, the incidence of canine teeth in the one day old support Neuweiler's statement that Hipposiderides are born with permanent canine teeth already in place. According to Barclay (1995) and Kunz & Robson (1995), the pattern of post-natal growth and development showed the basic trend of a linear growth of forearm and body mass during the preflight period.

Similar conclusion could be drawn on *H. pomona* from the time pup started to open its eyes when body mass reached 4g and the forearm length attained a mean of 32.1± mm, while at 4.5g, the forearm elongated to a mean of 34.4± mm, during which the pinnae of young become completely erected.

At 5g body mass, the development of fur almost over the entire body was recorded. The length of the forearm was recorded to have attained approximately 35.4± mm and attained the adult proportion when the body mass reached approximately 7g. Thus, regression analysis conducted between the mean forearm length and mean body weight of both male and female growing pups was highly significant (r^2=0.938, P<0.01), indicating linear growth of forearm and body mass during the preflight period.

However, regression conducted between the mean forearm length and the width of epiphyseal gap in the third metacarpal digit revealed negatively correlated (r^2=0.323) since the gap became fully ossified, replacing the unossified gap.

It is further reported that juvenile of several species of microchiropteran bats typically began to fly when they attain 70 % of the adult body mass and over 95 % of adult skeletal size and wing dimension (Kunz & Robson, 1995). In the present study, the juveniles *H. pomona* began to take flight when they

attained 81 % of the body mass and 95.23 % of adult skeletal size and wing span. Age of sexual maturity is highly variable between males and females of a single species, and sometime even between individuals of the same sex (Tuttle & Stevenson, 1982). In both micro and mega bats, sexual maturity is normally reached within 1-2 years (Altringhan, 1996). In some species, females may be sexually mature within a few months, for instance in megachiropteran; 5 to 6 months for *Hypsignathus monstrosus* and *Rousettus leschenaultia* and in microchiropteran; and 3 months for *Rhinolophus hipposiderous* (Tuttle & Stevenson, 1982) (cited by Cheng & Lee, 2002). Climate (latitude) is also important in impacting the age of sexual maturity and temperate species mature earlier than subtropical species (Kunz & Stern, 1995 cited by Cheng & Lee, 2002).

During the course of the study, the false nipples or pubic nipples of some females caught in December were not fully discernible and therefore assumed as the ones that had parturated during the previous breeding season and had attained adulthood. These females were regarded as nulliparous, since it is disclosed that in a live bat, if pubic nipples are very small and appear unused, there is a good chance the bat is nulliparous, in contrast to the development but flaccid condition in parous females, though they may not be reproductively active (Reiter, 2004).

Moreover, when some of these females were dissected, they were found to be bearing developing embryo in either the left or the right uterine horn. This incidence ascertained their maturity and their nulliparous state. Since almost all the females caught in the second week of April were fully pregnant and incidence of parturition was recorded at the end of April till the end of May, it is suggested that *H. pomona* attain sexual maturity at approximately 7 months.

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