Chapter 3: Postnatal development and ontogeny of foraging in *Cynopterus sphinx*

**3.1: Introduction**

Postnatal growth is defined as the time of birth until the epiphyses of long bones become visibly closed (Kunz, 1987), which may extend from several weeks to several months in bats. The period can be operationally divided into three distinct stages: pre-flight, early flight, and weaning and post flight (Kunz, 1987). Bats exhibit both precocial (Kurta and Kunz, 1987) and altricial (Powers et al., 1991; Hughes et al., 1995) characteristics at birth. At the time of birth, many species of bats are unable to fly and forage independently until they are weaned.

Relationships established between mother bats and their young during lactation and the weaning period are crucial to the survival and reproductive success of both. The young of most microchiropterans suckle from their mothers until they reach 52.9% to 92.8% of adult body mass and 82.6% to 98.7% of adult skeletal size. Whereas, the young of megachiropterans typically suckle from their mothers until they reach 28.9% to 73.5% of adult body mass and 76.8% to 87.7% of adult skeletal size (Barclay, 1994; 1995). Moreover, the young of megachiropterans also may be transported by their mothers during the late lactation and weaning periods (Jones, 2000, Kunz and Hood, 2000). Apparently, the young *Cynopterus sphinx* suckle from their mothers for 10-15 days after they initiate flight (Sandhu, 1984), and are “guided” by their mothers during these early foraging flights (Radhamani, 1996).
Thus, the transition from dependence to independence in bats involves an investment in milk to support postnatal growth and development. In megachiropterans, it also involves the transport of a relatively large pup and perhaps tutoring by the mothers during early foraging flight (Gopukumar et al., 2003).

Growth and development of bats have been studied during prenatal and postnatal periods (Orr, 1970; Tuttle and Stevenson, 1982; Kunz and Hood, 2000) under both natural (Kunz and Robson, 1995; Hoying and Kunz, 1998; Stern and Kunz, 1998; Baptista et al., 2000) and captive conditions (Taft and Handley, 1991; Hughes et al., 1995; Rajan and Marimuthu, 1999; Swift, 2001). Studies on postnatal development and growth rate are particularly important in deriving equations to predict age, which is useful in behavioural, physiological and ecological studies (Kunz and Hood, 2000). Postnatal growth data have been used in studies of energy and mineral accretion (Studier and Kunz, 1995; Papadimitriou et al., 1996), milk, ontogeny of flight (Powers et al., 1991; Kunz and Anthony, 1996) and ontogeny of echolocation sounds (Habersetzer and Marimuthu, 1986; Moss et al., 1997).

Baptista et al., (2000) have studied the postnatal growth in free-ranging Myotis lucifugus using cross-sectional and longitudinal methods. They emphasize that the mark-recapture method (longitudinal sampling) is the most appropriate for deriving growth rates and to estimate age during the postnatal growth period. Body mass, length of forearm and length of total epiphyseal gap have been proved as important variables for assessing postnatal growth rates in bats (Kunz and Stern, 1995; Kunz, 1987; Kunz and Anthony, 1982). The growth rate patterns of bats have been evaluated using different growth models on very few species of bats such as Tadarida
brasiliensis (Kunz and Robson, 1995), Plecotus auritus (McLean and Speakman, 2000) and Myotis nattereri (Swift, 2001).

In ecological studies, it is often necessary to determine the exact age of an animal as otherwise, it is impossible to establish factors such as growth rates, development of various behavioural repertoires, sexual maturity and periodicity of reproduction or longevity. In vertebrates, postnatal growth rates may provide a valuable index of maternal investment and milk energy output of females during lactation (Kunz and Stern, 1995). Patterns of growth and development vary among species and families of bats (Tuttle and Stevenson, 1982; Kunz and Hood, 2000).

The rate of postnatal growth directly reflects maternal investment in juveniles (Kunz and Hood, 2000) and has often been considered as an important ‘life-history’ trait in mammals (Ricklefs, 1979). Kunz and Stern, (1995) have found a negative correlation between growth rate and body size, with smaller species growing faster than larger ones. In addition, bat species of temperate regions show higher growth rates than those of tropical regions. The fact attributed to an increased selection pressure for higher growth rates is shorter reproductive periods in temperate regions (Kunz and Hood, 2000).

The present study is an examination of the postnatal growth of pups, up to weaning and ontogeny of foraging in C. sphinx and also an observation of age of the first foraging of pups by confirming the presence of rejecta fruit pellets discarded by pups.
3.2: Materials and methods

This captive study on postnatal development and ontogeny of foraging was conducted at the Zoology Research Centre, St. John’s college Palayamkottai, India from July 2005 through September 2006. Advanced stage pregnant females (n= 13) of *C. sphinx* were captured from foraging areas on the campus of St. John’s college between 19:00 and 22:00hr by mist netting. Each pregnant female was released into a separate Nylon-mesh cages (62 cm length ×31 cm width × 42 cm height) and maintained under natural 12:12hr light-dark cycles. These bats were maintained under captivity by following the regulations laid by ethic committee of our institution. During dark periods, the bats were fed with locally available fruits such as *Psidium guajava*, *Musa paradisiaca* and *Achras sapota* and water was provided *ad libitum*. Discarded fruits and faeces were removed everyday at 09:00hr without disturbing the bats.

Weekly observations and measurements were made on pups, by gently removing them from their mothers. Morphological measurements such as body mass, length of forearm, condylobasal length (CB) and fingers length were made from day one upto the weaning stage by using vernier calipers (to the nearest 0.1 mm) and body mass was measured (to the nearest 0.1 g) using a spring balance (Avinet). The presence of an attached umbilical cord was considered to assign pups of 1-day-old status (Kunz, 1973). Mothers and pups were tagged with different colour beads for individual recognition.
a) *Cynopterus sphinx*: Pregnant female captured by using mist net in foraging area.

b) *Cynopterus sphinx*: Mother with a pup reared in captivity.

c) *Cynopterus sphinx*: Mother with juvenile reared in captivity.
PLATE 3.2

a) A day old pup of *Cynopterus sphinx* born in captivity.

b) A seven day old pup of *Cynopterus sphinx* reared in captivity.

c) Fifteen day old pup of *Cynopterus sphinx* reared in captivity.

d) Weaned juvenile of *Cynopterus sphinx* reared in captivity.
a) Rejecta fruit pellets of the juveniles of *Cynopterus sphinx* collected during their first foraging (pellets of *Achras sapota*).

b) Rejecta fruit pellets of the juveniles of *Cynopterus sphinx* collected during their first foraging (pellets of *Psidium guajava*).
Each necklace tag was prepared with a thin, flexible plastic wire with plastic beads attached. The tags were then placed loosely round the necks of mothers and pups and the two ends of the wire were jointed tightly (Balasingh et al., 1992). The bats did not show any adverse reaction to such tagging. Nocturnal observations were also made on the feeding behaviour of bats using dim red light. On completion of the study, the tags were removed and all bats were released during dark hours at the site of capture. This work has been cleared by the Institutional Ethical and Biosafety Committee.

Postnatal growth curves were constructed based on the growth of forearm, body mass and concurrent changes in the length of the finger. The linear increase in the length of the forearm, length of fingers and body mass from neonate to wean was statistically analysed to derive regression equation.

3.3: Results

A total of 13 pregnant females were captured in the wild using mist net and used for captive studies. Each female gave birth to a single pup. A total of 13 young were born in captivity and among them 3 were males and 10 were females. One male and one female pup died on the first day of their birth. All the 2 males survived beyond 24 and 34 days respectively. Among the 10 females 6 were successfully weaned and other 4 survived beyond 9, 31 and 65 days respectively.

Newborn pups were altricial at birth and they were naked, pink with closed eyes and folded pinnae. Immediately after birth, the pup crawls on mother’s body in
search of the nipple, mother also helps in this process. Once it finds the nipple, it gets attached firmly to the nipple and suckles milk.

The forearm length of a day-old pup ranged from 20.7 to 21.7 mm, the mean forearm length was 31% of postpartum females (Mean 21.3 ±0.38 mm, n= 13). The body mass ranged from 8 to 10 g (Mean = 8.8 ± 0.82g, n= 13) and the mean values of the body mass of a day-old pups were 19.5% of postpartum females. Even though body mass increased throughout the study period, growth was rapid and linear until weaning (Figs 3.1 to 3.8).

At the age of 19 days pups attained 12±1.6 g body mass and 39.06± 2.58mm forearm length and they were found attached to their mothers but hanging with their own legs (Plate 3.2). Pups started to roost separately adjacent to their mothers at this age while mother was foraging. Pups flew short distances when they were about 35 days old (forearm length 48.83±2.98, 71% of postpartum females; Body mass17±2.00, 41% of postpartum females; n=7). After developing the capacity to fly, the pups made foraging attempts by biting and licking fruit pieces. When they were at the mean age of 49 days( Between 39 and 57 days), the young bats started foraging; which was confirmed by the availability of rejecta fruit pellets of pups at the first time in the floor of each cage. At the age of first foraging, the average length of CB was 24.3±0.780mm, forearm was 50.12 ± 2.39 mm (73% of postpartum females), thumb was 14.87± 0.42 mm, second finger was 30.42± 2.29 mm, third finger was 67.52± 4.57 mm, fourth finger was 56.42± 2.63 mm, fifth finger was 55.12± 2.59 mm, foot was 19.55 ± 1.18 mm and body mass was 19± 1.33 g (45% of postpartum females).
Table 3.1: Growth parameters of *Cynopterus sphinx* during the growth period (n= 13).

<table>
<thead>
<tr>
<th>AGE (Days)</th>
<th>CONDYLO BASAL LENGTH (mm)</th>
<th>FOREARM LENGTH (mm)</th>
<th>THUMB LENGTH (mm)</th>
<th>II FINGER LENGTH (mm)</th>
<th>III FINGER LENGTH (mm)</th>
<th>IV FINGER LENGTH (mm)</th>
<th>V FINGER LENGTH (mm)</th>
<th>FOOT LENGTH (mm)</th>
<th>BODY MASS (mg)</th>
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<tbody>
<tr>
<td>1</td>
<td>21.32 ± 0.38</td>
<td>27.08 ± 2.18</td>
<td>11.4 ± 0.88</td>
<td>17.72 ± 2.72</td>
<td>35.80 ± 3.29</td>
<td>30.98 ± 2.44</td>
<td>30.63 ± 1.89</td>
<td>13.40 ± 0.69</td>
<td>8.83 ± 0.82</td>
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<tr>
<td>3</td>
<td>21.65 ± 0.50</td>
<td>29.80 ± 2.76</td>
<td>12.42 ± 1.18</td>
<td>19.92 ± 1.49</td>
<td>40.12 ± 3.19</td>
<td>34.30 ± 1.81</td>
<td>34.00 ± 2.50</td>
<td>14.42 ± 0.41</td>
<td>9.92 ± 1.63</td>
</tr>
<tr>
<td>13</td>
<td>22.25 ± 0.49</td>
<td>35.37 ± 2.56</td>
<td>12.93 ± 1.18</td>
<td>21.65 ± 1.49</td>
<td>46.45 ± 2.94</td>
<td>39.83 ± 2.19</td>
<td>40.70 ± 2.56</td>
<td>15.35 ± 0.90</td>
<td>11.50 ± 1.55</td>
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<td>19</td>
<td>22.8 ± 0.65</td>
<td>39.07 ± 2.58</td>
<td>13.45 ± 0.90</td>
<td>24.25 ± 2.53</td>
<td>49.58 ± 4.64</td>
<td>42.62 ± 3.29</td>
<td>42.70 ± 3.70</td>
<td>16.00 ± 1.08</td>
<td>12.83 ± 1.69</td>
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<td>26</td>
<td>23.07 ± 0.76</td>
<td>42.37 ± 2.60</td>
<td>13.88 ± 0.77</td>
<td>26.35 ± 1.10</td>
<td>55.52 ± 4.17</td>
<td>46.02 ± 2.67</td>
<td>46.38 ± 3.11</td>
<td>17.25 ± 0.82</td>
<td>13.42 ± 1.69</td>
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<td>28.38 ± 1.54</td>
<td>61.13 ± 4.16</td>
<td>51.85 ± 2.71</td>
<td>50.85 ± 3.29</td>
<td>18.47 ± 0.78</td>
<td>14.67 ± 1.97</td>
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<td>63.57 ± 3.71</td>
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<td>52.68 ± 3.11</td>
<td>19.12 ± 0.81</td>
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<td>19.48 ± 0.77</td>
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<td>15.0 ± 0.71</td>
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<td>70.87 ± 1.93</td>
<td>58.77 ± 1.68</td>
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<td>72.73 ± 3.77</td>
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<td>58.52 ± 1.50</td>
<td>20.43 ± 0.57</td>
<td>18.92 ± 3.09</td>
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<td>52.77 ± 2.71</td>
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<td>74.75 ± 2.93</td>
<td>61.95 ± 1.10</td>
<td>59.60 ± 1.15</td>
<td>20.80 ± 0.71</td>
<td>20.00 ± 3.45</td>
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<td>53.65 ± 2.40</td>
<td>15.80 ± 0.73</td>
<td>33.22 ± 1.28</td>
<td>76.23 ± 2.67</td>
<td>63.22 ± 1.12</td>
<td>60.60 ± 1.52</td>
<td>21.15 ± 0.70</td>
<td>20.33 ± 3.08</td>
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<td>88</td>
<td>25.62 ± 0.50</td>
<td>54.86 ± 0.73</td>
<td>16.10 ± 0.47</td>
<td>34.50 ± 0.87</td>
<td>78.84 ± 1.16</td>
<td>63.64 ± 0.99</td>
<td>61.80 ± 2.03</td>
<td>21.64 ± 2.03</td>
<td>22.20 ± 3.37</td>
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<td>55.3 ± 0.38</td>
<td>16.24 ± 0.79</td>
<td>34.66 ± 0.79</td>
<td>78.96 ± 2.62</td>
<td>64.08 ± 1.12</td>
<td>62.06 ± 2.05</td>
<td>21.70 ± 0.69</td>
<td>22.60 ± 3.21</td>
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<td>34.88 ± 0.26</td>
<td>80.43 ± 1.22</td>
<td>64.48 ± 1.20</td>
<td>63.05 ± 1.32</td>
<td>22.45 ± 0.42</td>
<td>24.13 ± 4.40</td>
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<td>110</td>
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<td>56.55 ± 0.33</td>
<td>16.38 ± 0.46</td>
<td>35.48 ± 0.10</td>
<td>81.53 ± 1.97</td>
<td>64.98 ± 1.28</td>
<td>63.50 ± 0.77</td>
<td>22.85 ± 0.48</td>
<td>24.25 ± 4.48</td>
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<tr>
<td>117</td>
<td>27.4 ± 0.90</td>
<td>57.85 ± 0.44</td>
<td>16.50 ± 0.17</td>
<td>35.78 ± 1.21</td>
<td>82.40 ± 1.33</td>
<td>65.70 ± 0.91</td>
<td>63.80 ± 0.56</td>
<td>23.25 ± 0.56</td>
<td>24.38 ± 4.19</td>
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<td>125</td>
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<td>58.05 ± 0.331</td>
<td>16.55 ± 0.48</td>
<td>35.78 ± 0.21</td>
<td>82.83 ± 1.26</td>
<td>66.25 ± 1.12</td>
<td>64.40 ± 0.56</td>
<td>23.25 ± 0.56</td>
<td>25.00 ± 3.56</td>
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Table 3.2: Linear regression and correlation analysis for various morphological parameters during the growth period.

<table>
<thead>
<tr>
<th>S. No</th>
<th>Morphological Parameters</th>
<th>Linear Regression Y</th>
<th>Correlation R²</th>
</tr>
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<tr>
<td>1</td>
<td>Age Vs Forearm length</td>
<td>Y = 0.2335x + 34.092</td>
<td>0.822</td>
</tr>
<tr>
<td>2</td>
<td>Age Vs Body mass</td>
<td>Y = 0.1325x + 9.912</td>
<td>0.7848</td>
</tr>
<tr>
<td>3</td>
<td>Forearm length Vs Thumb length</td>
<td>Y = 0.156x + 7.3928</td>
<td>0.8146</td>
</tr>
<tr>
<td>4</td>
<td>Forearm length Vs second finger length</td>
<td>Y = 0.5832x + 1.8091</td>
<td>0.9503</td>
</tr>
<tr>
<td>5</td>
<td>Forearm length Vs Third finger length</td>
<td>Y = 1.5445x – 7.9953</td>
<td>0.9661</td>
</tr>
<tr>
<td>6</td>
<td>Forearm length Vs Fourth finger length</td>
<td>Y = 1.1623x – 1.095</td>
<td>0.9638</td>
</tr>
<tr>
<td>7</td>
<td>Forearm length Vs Fifth finger length</td>
<td>Y = 1.08x + 1.5805</td>
<td>0.963</td>
</tr>
<tr>
<td>8</td>
<td>Forearm length Vs Foot length</td>
<td>Y = 0.3043x + 4.7593</td>
<td>0.9304</td>
</tr>
<tr>
<td>9</td>
<td>Forearm length Vs Body mass</td>
<td>Y = 0.5143x – 6.9184</td>
<td>0.7846</td>
</tr>
</tbody>
</table>
Fig 3.1: Empirical growth curve for forearm length of *C. sphinx* during post-natal growth period.

Fig 3.2: Empirical growth curve for body mass of *C. sphinx* during post-natal growth period.

P.F= Mean value of postpartum females.
Fig 3.3: Empirical growth curve for thumb length of *C. sphinx* during post-natal growth period.

Fig 3.4: Empirical growth curve for second finger length of *C. sphinx* during post-natal growth period.

Fig 3.5: Empirical growth curve for third finger length of *C. sphinx* during post-natal growth period.
Fig 3.6: Empirical growth curve for fourth finger length of *C. sphinx* during post-natal growth period.

Fig 3.7: Empirical growth curve for fifth finger length of *C. sphinx* during post-natal growth period.

Fig 3.8: Empirical growth curve for foot length of *C. sphinx* during post-natal growth period.
Fig 3.9: Regression line of age and forearm length during the linear growth period of *C. sphinx*.

Fig 3.10: Regression line of age and body mass during the linear growth Period of *C. sphinx*. 
Fig 3.11: Regression line of forearm length and thumb length during the linear growth period of *C. sphinx*.

Fig 3.12: Regression line of forearm length and second finger length during the linear growth period of *C. sphinx*.

Fig 3.13: Regression line of forearm length and third finger length during the linear growth period of *C. sphinx*. 

- **Forearm length Vs Thumb length**
  
  $y = 0.156x + 7.3928$  \  \ $R^2 = 0.8146$

- **Forearm length Vs Second finger length**
  
  $y = 0.5832x + 1.8091$  \  \ $R^2 = 0.9503$

- **Forearm length Vs Third finger length**
  
  $y = 1.5445x - 7.9953$  \  \ $R^2 = 0.9661$
Fig 3.14: Regression line of forearm length and fourth finger length during the linear growth period of *C. sphinx*.

Fig 3.15: Regression line of forearm length and fifth finger length during the linear growth period of *C. sphinx*.

Fig 3.16: Regression line of forearm length and foot length during the linear growth period of *C. sphinx*. 
Rejecta fruit pellets left by the foraging pups resembled rejecta fruit pellets of adults in their shape, but smaller in size and they also had no teeth impressions. It took another two weeks for producing rejecta fruit pellets with clear teeth impressions similar to the adults (Refer Chapter 2). At starting foraging, the pups engaged themselves in both suckling milk and feeding upon fruits. After weaning, the young stopped suckling totally and engaged in independent foraging. They were completely weaned from their mother at the mean age of 65 days (60- 70 days). After initiating to wean, the average length of CB was 25±0.22 mm, forearm was 54.37 ± 2.57 mm (79.578% of postpartum females), thumb was 15.65± 1.07 mm, second finger was 32.45± 1.50 mm, third finger was 73.75± 1.49 mm, fourth finger was 61.45± 1.64 mm, fifth finger was 59.05± 0.78 mm, foot was 20.6± 0.28 mm and body mass was 20± 0.71 g (48.2% of postpartum females).

The regression analysis was made on morphological parameters of neonate upto the weaning stage of pups and the results has been tabulated (Table 3.2). The growth parameters of pups were found to increase in a linear manner from the neonate to the weaning stage (Figs 3.9 to 3.16).

3.4: Discussion

Most of the studies carried out so far on postnatal development and age estimation have been restricted to microchiropterans; for example, on Vespertilionidae (De Fanis and Jones, 1995; Hughes et al., 1995; Isaac and Marimuthu, 1996; Hoying and Kunz, 1998; Swift, 2001), Molossidae (Kunz and Robson, 1995), Phyllostomidae (Stern and Kunz, 1998), Megadermatidae (Rajan and Marimuthu, 1999) and
Hipposideridae (Cheng and Lee, 2002). Studies on growth aspects in megachiropterans are much limited (Kunz and Stern, 1995; Kunz and Hood, 2000).

This is the first report confirming the foraging flight and feeding behaviour of pups by the availability of rejecta fruit pellets of pups in captive rearing. The pattern of postnatal growth and development showed linear growth of forearm and body mass during the pre-flight period. Juveniles of several species of microchiropteran bats typically began to fly when they attained 70% of adult body mass and over 95% of adult skeletal size and wing dimension (Maeda, 1972; Barclay, 1995; Kunz and Stern, 1995). Swift (2001) has also argued that no juvenile bats of any species yet have shown to exhibit flight before they attain at least 90% of adult skeletal size. In the present study, the young *C. sphinx* begins to fly when they achieve about 41% of adult body mass. This report also confirms the reports of Elangovan, et al., (2003), they have provided the first record in their studies that young *C. sphinx* begin to fly when they achieve about 40% of adult body mass and nearly 79% of adult skeletal size.

Such an occurrence of early flight suggests that megachiropterans presumably do not need to manoeuvre so accurately during their foraging as microchiropterans do. Elangovan, et al., (2003). Kunz and Stern, (1995) have found that the growth rates in the body mass are negatively correlated with asymptotic body size. Thus the smaller species grow faster than larger ones. Length of forearm should be an appropriate choice to predict age until its growth pattern becomes nonlinear (Elangovan et al., 2003).
This study supports the findings of Sandhu, (1984) that young *C. sphinx* continues to suckle from their mothers after they initiate flight. Following separation from their mothers, young *C. sphinx* engages itself in practice flights. Thus, in addition to provisioning their young ones with milk during the weaning period, female *C. sphinx* also appears to tutor their young as they transport them to foraging areas before accompanying them on foraging flights. Interestingly, bats are the only mammals in which mothers feed their pups until they are almost adult size (Kunz, 1987; Barclay, 1995; Hayssen and Kunz, 1996; Hood et al., 2001).

Young *Pteropus giganteus* is able to fly after 9-12 weeks, but weaning does not occur until 15-20 weeks of growth (Neuweiler, 1962). In contrast, the large and precocious young of emballonurids often fly after two weeks, but apparently are not weaned until the completion of 6-8 weeks (Brosset, 1962; Bradbury and Emmons, 1974). Tuttle and Stevenson, (1982) list out weaning periods ranging from 28 days in some emballonurids and up to 140 days in *Hipposideros commersoni*.

Several investigators have reported that lactating female bats forage closer to their day roosts when they are nursing their pups (Swift, 1980; Racey and Swift, 1985). Vaughan and Vaughan, (1987) suggest that increased energy expenditure imposed on adult females following the birth of pups in *Lavia frons* reflect the high cost of lactation and the added cost of carrying the young.

The association between mothers and their pups at the time of weaning suggests that mothers may tutor their young ones in foraging skills. By sharing the same foraging area with their pups during early stages of flight, a mother may also contribute to the development of search images, which could help young bats learn the
location of important food sources (Gaudet and Fenton, 1984). It may be concluded
that plant-visiting megachiropterans such as *C. sphinx* learn the locations of preferred
food resources or preferred food patches as young bats accompany their mothers on
foraging flights.

Knowledge of productive foraging sites gained through maternal tutoring
should increase survival and ultimately decide their fitness. If knowledge of food
resources is learned and reinforced over time, young bats should benefit from
knowledge gained by initially accompanying and later following their mothers as they
forage to assess and locate profitable food patches. Young *C. sphinx* either follow or is
guided by their mothers. This is further supported by results of mist netting studies
which show that captures of lactating females are often followed immediately by
captures of volant young ones (Nathan et al., 2001). Mother-infant associations
during the weaning period in the megachiropterans appear to be sufficiently developed
to ensure successful weaning and the attainment of independent foraging skills. To
understand fully the role that mothers play in the development of early foraging
success of their pups, however, will require additional studies where the foraging
activities of both mothers and pups are monitored simultaneously by radio tracking.
Ultimately, studies on parental effort in bats should be extended to investigate how
investments by mothers are adjusted to benefits gained by their offspring and how
costs to the mothers are reflected in their relative fitness (Kunz and Hood, 2000).

In the present study it is evident that, when the pups are at the mean age of 49
days, they start foraging, it is confirmed by the availability of rejecta fruit pellets of
pups for the first time in each cage. After starting foraging, the pups engage
themselves in both suckling milk and feeding on the fruits. They are completely weaned from their mother at the mean age of 65 days. When the rejecta fruit pellets of pups are compared with that of the adults, the rejecta fruit pellets of adults are more intact and compressed. Generally, bats extract nutrients by chewing the fruits, so it is planed to biochemically analyse locally available fruits and its rejecta fruit pellets and to calculate the efficiency of extraction of major nutrients from these fruits by different age group of the short-nosed fruit bat *Cynopterus sphinx* (Refer Chapter 4).