Food and Feeding Ecology of Bat Preferred Plant Species and their Mutualistic Interactions in Tirunelveli District

A. Krishnarathi*, S. Suthakar Isaac

PG&Research Department of Zoology, St. John’s College, Palayamkottai, Tirunelveli, Tamilnadu, India.

*For correspondence: rathiphd@gmail.com

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ABSTRACT

Bats, the members of the Order Chiroptera are widely distributed and the second most numerous groups after rodents in the whole world. Bats are unique among mammals not only because they are capable of true flight but also because, despite their small size, they have life history characteristics that are generally attributed to larger species. Many Chiropterologist has studied about the frugivorous bats and chemical cues of fruits eaten by bats. But only a few studies have focused on the knowledge of folivory bat research. This study has made research documentation on the feeding ecology of three pteropodid bats in Tirunelveli district. The major aim of the present study is to assess the food and feeding ecology of three pteropodid bat preferred plant species and their mutualistic interaction. Plants are more important for the survival of bats. A total of 10 species of food plants were identified during the study period. These plants provide fruits or their parts, leaves, flowers, nectar and pollen for pteropodid bats including Cynopterus sphinx, Rousettus leschenaulti and Pteropus giganteus in the study area. The bats fed on fruits, leaves, nectar and pollen. A variation of food selection was observed within the pteropodid bats. Out of the 10 species of plants preferred by C. sphinx, one provides leaves, one provides flowers, three provides leaves and flowers, and five provides leaves and fruit. Out of the 8 species of plants preferred by R. leschenaultii, one provides fruit, one provides flowers, two provides leaves and flowers, and two provides leaves and fruits. Of the 6 species of plants preferred by P. giganteus, one provides leaves, three provides leaves and fruit and two provide leaves and flowers. Opportunities in bat nutrition are abound and, in view of the diversity of the species, the information derived would improve not only our understanding of nutrient requirements and dietary husbandry of bats but also of other species with similar habits and feeding strategies.

Keywords: Feeding ecology, Cynopterus sphinx, Rousettus leschenaultia, Pteropus giganteus

1. INTRODUCTION

In an ecosystem the floral and faunal components together make up a complicated provisioning system. The plants, during growth take water and minerals from the ground, carbon dioxide from the air and energy from the sunlight producing more and more of plant materials (leaves, wood and roots). Majority of the faunal members depend and feed on the plants, while moulds and microbes (bacteria) degrade the plant left outs and recycle them back to earth [1].
The feeding habits of bats as a whole are as varied as that of other mammals, and this dietary variation is proportional to much of the morphological, physiological and ecological diversity seen in bats [2]. Most of the bats are relatively stereotyped in their foraging preferences.

Pteropodid bats are usually frugivorous but very rarely insectivorous whereas all other bats are exclusively insectivorous [3]. It has been estimated that approximately 29% of the bats, partially or wholly, are dependent on plants as a source of food [4]. Pteropodids are known to be virtually phytophagous; studies also reveal that the diet of fruit bats includes several other floral resources (largely nectar and pollen but also petals and bracts), fruits (i.e. any plant material surrounding seeds), often the seeds themselves and leaves [5]. In addition to seasonal patterns of fruit availability, frugivorous bats face highly inter-specific variations in the timing and amount of food production [6]. Although individual species have restricted fruiting seasons, several species of bat eat fruits that are generally available at all times of the year in tropical habitats.

Ecological interactions between bats and plants is mutualistic [4]. In all 966 species of bats have been reported forming a largest group of mammals. In India, 13 species of fruit frugivorous bats were identified and among them Indian flying fox Pteropus giganteus, dog faced fruit bat Rousettus leschenaulti and the greater short nosed fruit bat Cynopterus sphinx are distributed throughout the country. They usually live on trees (P. Giganteus) temples and caves (R. leschenaulti) and foliage (C. sphinx) [7] and feed on fruits, pollen, nectar and leaves. Fruit bats are mobile foragers [8], moving pollen between isolated fragments of vegetation and depositing seeds over large areas [9, 10]. They are pollinators of several nectariferous plants which flower at night. Frugivorous (fruit eating) bats feed on fleshy arils, pericarps or syconia of fruits, whereas nectarivorous (nectar eating) bats seek nectar or pollen [5, 11-13]. Detailed studies on the foraging activity of bats revealed studies on the foraging activity of bats revealed their role as pollinators of several plant species [14-16]. Although, details of their foraging behaviour is poorly known, there is no evidence that they visit commercial fruit orchards. They feed on wild fruits and disperse seeds contributing to forest regeneration.

1.1. Bat –Plant Ecomorphological Adaptations

The majority of tropical plants rely mainly on seed dispersal to guaranty natural propagation and for their maintenance in natural habitats. Tropical forests are notably dependent on fruit-eating birds and mammals for the dispersal of their seeds. A large number of plant species depend on fruit bats for either pollination and/or seed dispersal [17]. Fruit bats play a crucial role in maintaining diversity in plant communities via regeneration and genetic flow of dominant forest trees [18, 19]. Bats are the only flying mammal that can carry larger fruits sometimes equivalent to 1/3 of its own body weight to longer distance. The fruits handled and processed (seeds of bat bitten fruits, soaked with saliva, faecal seeds – treated by intestinal juices) by fruit bats show quick germination and retrieve seed dormancy.

Frugivorous bats are the most important seed dispersal agents for tropical forest seeds. Chiropterophilic plants attract and reward them through food, nutrients, minerals, secondary metabolites etc.

1.2. Bat flowers

Pollination biologists have long recognized a set of plant characteristics (syndromes) that are associated with different kinds of pollinators. The classic characteristics of bat-pollinated flowers (the ‘chiropterophilous syndrome’), as described by Faegri and van der Pijl [20] and modified by Howe, include nocturnal anthesis, drab coloration (i.e. white or green), musty smell, flowers often located on branches or tree trunks (cauliflory) or suspended on long stalks (flagelliflory), and tubular or radially symmetrical flowers, often of the ‘shaving brush’ type, that produce relatively large amounts of hexose-rich nectar. Bat flowers occupy a distinct subset of multivariate floral morphological space compared with flowers pollinated by other kinds of animals [21].

Floral characteristics associated with bat pollination appear to have evolved to attract relatively large, nocturnal, colour-blind, volant pollinators. Advertising their presence with a musty, fetid odour is a common feature among bat flowers. The colour of bat flowers ranges from white, brown and green to pink, fuchsia and yellow [22, 23].

1.3. Chiropterophilic Features of the Dependent Plants

Fruit colour, display and odor have been of particular interest among vertebrate frugivores. The classic view of bat fruits is that they are drab or light in colour, displayed openly by plants so that they are easily accessed by bats in flight and have a distinct odor [24]. Visitation and seed removal can be influenced by many traits of fruiting plants, including
local abundance of fruit resources or neighbourhood effects [25].

Bat fruits are usually exposed above or below the foliage thereby making them readily accessible to bats. Fruits produce a characteristic odor at maturity that attracts bats. Fruits remain attached to tree at maturity and are gathered in infructescences that allow them to be taken in flight. Some fruits fail to change colour at maturity that is they usually remain green or whitish. Fruits with large seeds have a curvaceous pericarp that is easily broken by bats.

Fruit-eating bats generally prefer ripe fruit to unripe or overripe unpalatable fruit, as defined by using anthropomorphic criteria [26-28]. This implies that, in nature, frugivorous bats choose fruit emitted volatile compounds within a particular range of concentrations. Moreover, Laska and Seibt. [29] suggested that fruit-eating mammals are specifically sensitive to aliphatic alcohols that are the microbial metabolite products of fruits that may serve as indicators of fruit ripeness. A wide variety of volatiles are known to be produced during microbial fermentation in fruit, including acids, alcohols, esters, aldehydes, ketones, and polyols [30].

The present study was undertaken to assess foraging behaviour of Pteropus giganteus, Cynopterus sphinx and Rousettus leschenaultii on 10 selected plant species, to determine the feeding behaviour of pteropodid bats, effect of flowering and fruiting phenology and role of these bat species in pollination and seed dispersal.

2. METHODOLOGY

The present study was carried out on foraging behaviour of the fruit bats in the wild from April 2009 through August 2010 in Tirunelveli (8° 44’ N lat, 77° 42’ E long, South India). All these observations were made selectively on campus of St. John’s College (Cynopterus Sphinx), Sankar nagar (Pteropus giganteus), and Kallidaikurichi (Rousettus leschenaultii) area. Weekly field trips were made to observe the wide range of foraging habitats of bats. Observations were made to find the food items preferred by bats. Food remnants, chewed fruits, bolus and floral remnants were collected from the bat flyways and below the day and night roosts. Once in a week the collected remnants were sorted and analyzed to identify the bat preferred plant species. For capturing C. sphinx and R. leschenaultii, mist nets (Avinet Dryden Inc. USA) with a mesh size of 3.5 x 3.5 cm were used and for capturing P. giganteus, nets with a mesh size of 16 x 16 cm were used (custom made mist nets). Apart from the bats captured through the mist nets, bats that came to the foraging trees were also monitored and noted. The mist netting exercise commenced about half an hour before dusk and was completed at 06.00hr in the morning. Mist nets were erected from a height of 1.5–30 m.

Weekly once the ejecta pellets were collected by plastic sheets spread on the floor of the feeding roosts. Once in fortnight plastic sheets were spread on the floor of the feeding roosts to collect the remains of the food items and faeces. Examination of leftover, spits and faeces help to find out the feeding habit, dietary selection (core species of plants) and the seed dispersal role of each fruit bat species. The seedlings from the feeding roost also helped to identify the plants benefited by these bat species. The collected remnants were analyzed to identify the plant species. The Phenology of the fruits and flowers preferred by bats in the study area were observed and their seasonal availability was assessed. This helps to ensure their dietary preference.

3. RESULTS

A total of 10 species of food plants were identified (Table 1). Figure 1 shows the photographic documentation of 10 selected plant species. These plants provide fruits or their parts, leaves, flowers, nectar and pollen for pteropodid bats including Cynopterus sphinx, Rousettus leschenaultii and Pteropus giganteus in the study area (Table 2). Figure 1 shows the Photographic Documentation of Selected Plant Species. Digital evidence of bat folivory on F. religiosa and C. fistula leaves has documented in Figure 2. Table 3 shows the seasonal variation in the availability of food for Pteropodid bats. The bats fed on fruits, leaves, nectar and pollen. A variation of food selection was observed within the pteropodid bats.

Out of the 10 species of plants in the study area, C. sphinx was found to depend on all the 10 species of plants, R. leschenaultia was found to depend on 8 species of plants and P. giganteus depended on 6 species of plants for their diet during different seasons of the year. Out of the 10 species of plants preferred by C. sphinx, one provides leaves, one provides flowers, three provides leaves and flowers, and five provides leaves and fruit. Out of the 8 species of plants preferred by R. leschenaultii, one provides fruit, one provides flowers, two provides leaves and flowers, and two provides leaves and fruits. Of the 6 species of plants preferred by P. giganteus, one provides leaves, three provides leaves and fruit and two provide leaves and flowers.
Bat visits to the leaves were characterized by circling flights around the tree. These flights probably allowed the bats to locate a leaf to be removed. After the circling flights, a bat entered the tree canopy and grabbed a leaf in its mouth. We observed two forms of foraging approaches, depending on the position of the leaf on the branch: 1) when the leaf was in a horizontal position, usually at the tip of a branch, the bats maneuvered their flight directly over the leaf; and 2) when the leaf was hanging down in the middle of the branch, the bat approached from below the leaf. In both approaches, the bats quickly bit the leaf, flapped wings and used its body weight to remove a piece of the leaf, descended, and flew off. When bats did not manage to remove a bite of the leaf in the first attempt, up to three additional attempts were performed. We did not observe bats removing entire leaves, but we found several leaves on the trees with bite marks on both lateral and distal regions (Plate 2).

This suggests that bats can feed on small portions of the leaves, without entirely removing them. Some leaves exhibited more than one bite and others had up to half their areas removed, indicating that a single leaf may receive more than one visit. However, we do not know whether these visits occurred during the same night or if they were made by the same individual bat.

**DISCUSSION**

Frugivorous bats exhibit two patterns of foraging behaviour with reference to plants. They are ‘sequential specialization’ and ‘individual generalization’. Sequential specialists use only one plant at a time but change food sources after several days or weeks [31]. Individual generalists will visit several species of plants for nectar, pollen or fruit in one night. Observations made in our study corroborates with similar observations of Gardner [32] that the individual-general pattern appears to be common among bats for whom fruits, flowers and leaves are major parts of the diet.

**4.1. Bat feeding preferences**

Foraging studies of pteropodids in Tirunelveli District revealed that 10 species of plants were observed which provide food for pteropodid bats. Bats in our study exhibited variations in their diet selection and preference. The diet preference in bats was mainly based on the morphological and palatable characters of the fruit [33].

According to Sudhakaran & Doss [34] on studying the seasonal availability of food for the pteropodid bats, *C. sphinx* was observed enjoying a wide variety of food availability. It may have been because of their flexibility in food selection or also of opportunistic food choice. *P. giganteus* were observed to have lesser fruit choice and availability throughout the year. Most of the *Pteropus* species were observed to commute longer distances for their food sources.
foraging activity [35]. Similarly *P. giganteus* were also observed to be long distance foragers [36] to fulfill their dietary requirements and also makes it an opportunistic feeder. On studying the diet availability for bats in various months of the year, the maximum availability of food was during their breeding periods and bats switched over to different food items according to their availability. The reproductive periods of bats are ultimately determined by food availability [5]. The timing of reproductive events among plants (flowering and fruiting) may influence the bat’s reproductive cycles, foraging patterns and the intensity of competition for food resources among bat species [37].

### Table 1. List of Bat Preferred Plant Species Observed in the study area

<table>
<thead>
<tr>
<th>S.No</th>
<th>Botanical name</th>
<th>Vernacular name (Tamil)</th>
<th>Family</th>
<th>Order</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td><em>Ficus religiosa</em></td>
<td><em>Arasa maram</em></td>
<td>Moraceae</td>
<td>Rosales</td>
</tr>
<tr>
<td>2</td>
<td><em>Erythrina indica</em></td>
<td><em>Mulmurungai</em></td>
<td>Fabaceae</td>
<td>Fabales</td>
</tr>
<tr>
<td>3</td>
<td><em>Ceiba pentandra</em></td>
<td><em>Elavam pungi</em></td>
<td>Malvaceae</td>
<td>Malvales</td>
</tr>
<tr>
<td>4</td>
<td><em>Coccinia grandis</em></td>
<td><em>Kovam palam</em></td>
<td>Cucurbitaceae</td>
<td>Cucurbetales</td>
</tr>
<tr>
<td>5</td>
<td><em>Psidium guajava</em></td>
<td><em>Koyya</em></td>
<td>Myrtaceae</td>
<td>Myrtales</td>
</tr>
<tr>
<td>6</td>
<td><em>Tamarindus indica</em></td>
<td><em>Puliam maram</em></td>
<td>Fabaceae</td>
<td>Fabales</td>
</tr>
<tr>
<td>7</td>
<td><em>Moringa olifera</em></td>
<td><em>Murungai</em></td>
<td>Moringaceae</td>
<td>Brassicales</td>
</tr>
<tr>
<td>8</td>
<td><em>Albizia lebbeck</em></td>
<td><em>Vagai</em></td>
<td>Fabaceae</td>
<td>Fabales</td>
</tr>
<tr>
<td>9</td>
<td><em>Carica papaya</em></td>
<td><em>Pappali</em></td>
<td>Caricaceae</td>
<td>Brassicales</td>
</tr>
<tr>
<td>10</td>
<td><em>Cassia fistula</em></td>
<td><em>Kontra</em></td>
<td>Fabaceae</td>
<td>Fabales</td>
</tr>
</tbody>
</table>

### Table 2. Food providing plants for pteropodid bats and parts eaten by them

<table>
<thead>
<tr>
<th>S.No</th>
<th>Botanical name</th>
<th>Bat species</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td><em>C.sphinx</em></td>
</tr>
<tr>
<td>1</td>
<td><em>Ficus religiosa</em></td>
<td>L/Fr</td>
</tr>
<tr>
<td>2</td>
<td><em>Erythrina indica</em></td>
<td>L/Fr</td>
</tr>
<tr>
<td>3</td>
<td><em>Ceiba pentandra</em></td>
<td>Fl</td>
</tr>
<tr>
<td>4</td>
<td><em>Coccinia grandis</em></td>
<td>L/Fr</td>
</tr>
<tr>
<td>5</td>
<td><em>Psidium guajava</em></td>
<td>L/Fr</td>
</tr>
<tr>
<td>6</td>
<td><em>Tamarindus indica</em></td>
<td>L/Fr</td>
</tr>
<tr>
<td>7</td>
<td><em>Moringa olifera</em></td>
<td>L</td>
</tr>
<tr>
<td>8</td>
<td><em>Albizia lebbeck</em></td>
<td>L/Fr</td>
</tr>
<tr>
<td>9</td>
<td><em>Carica papaya</em></td>
<td>L/Fr</td>
</tr>
<tr>
<td>10</td>
<td><em>Cassia fistula</em></td>
<td>L/Fr</td>
</tr>
</tbody>
</table>

*L-Leaves Fl-Flower Fr-Fruit

4.2. *Pteropodids as frugivory*

Animals that exhibit to consume a diet of fruit, the reproductive part of plants, are referred to as frugivorous. The frugivorous bats are distributed within two families: the Pteropodidae of the Old World tropics and Phyllostomidae of the New World tropics [4, 8, 38-41]. Frugivorous bats are reported to dominate assemblages in lowland forests of the neotropics. No fruit or nectar feeding microchiropternas occur in the Old World [42].
Bats play an essential role in the pollination of flowers (Chiropterogamy) and dispersal of seeds. Frugivores select fruits based on size, phenology and nutritional quality [43, 44]. A bat fares better energetically by taking a few large fruits than by selecting more small fruits, which would involve

### Table 3. Seasonal variation in the availability of food for Pteropodid bats

<table>
<thead>
<tr>
<th>S.No</th>
<th>Species name</th>
<th>Parts eaten by bats</th>
<th>Seasonal availability of food for bats</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td><em>Ficus religiosa</em></td>
<td>Leaves, Fruits</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td><em>Erythrina indica</em></td>
<td>Leaves, Flowers</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td><em>Ceiba pentandra</em></td>
<td>Leaves, Flowers</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td><em>Coccinia grandis</em></td>
<td>Leaves, Flowers</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td><em>Psidium guajava</em></td>
<td>Leaves, Fruits</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td><em>Tamarindus indica</em></td>
<td>Leaves, Fruits</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td><em>Moringa olfera</em></td>
<td>Leaves, Flowers</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td><em>Albizia labbeck</em></td>
<td>Leaves, Flowers</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td><em>Carrica papaya</em></td>
<td>Leaves, Fruits</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td><em>Cassia fistula</em></td>
<td>Leaves, Flowers</td>
<td></td>
</tr>
</tbody>
</table>
more commuting and approach flights for a similar nutritional reward [27]. Apart from the fruit choice criterion of size, found that frugivorous bats from the Old and New World use odour cues to locate and assess fruit condition.

Many fruits consumed by bats are high in carbohydrates and low in protein, Thomas [44] suggested that plant-visiting bats over-ingest fruits to meet their protein requirements and dump carbohydrates. Fruit bats in the wild appear to meet their nutrient needs by consuming large quantities of a mixture of native fruits, with some consumption of flower parts, pollen, leaves and insects [45-48]. According to O’Brien et al.,[49], given the high concentration of calcium in Ficus fruits, it is not surprising that they are preferred as food by many plant-visiting bats [50], including Cynopterus sphinx and Cynopterus brachyotis in Asia [51]. Fourteen of 17 fig species found on Barro Colorado Island in Panama are eaten regularly by bats [27]. Wendeln & Runkle [52] found that figs might be able to sustain some frugivores without additional food. The lipid concentration of figs is higher than for some other tropical fruits [52], and Morrison [53] found that protein made up of 4.8% (dry weight) of the fig juice. Figs are a source of calcium, which is critical for successful reproduction in both wild and domesticated mammals [54], and is a limiting nutrient for milk production [55]. Psidium guajava was the most frequently recorded introduced species in the diet of pteropodid bats. Some fruits consumed by C. sphinx have crude lipid content ranging from 6% to 10%, with the highest values found in Psidium guajava [56].

Certain fruits may have a hard outer coat, which may be difficult to eat for certain small frugivores, certain fruting trees may not facilitate the flying movements of some bats, but it may be preferred by others. Such a variation in the diet strategy may help the bats to avoid competition amongst themselves. Dietary selection in frugivores was documented by several authors [57, 58].

4.3. Pteropodid as Nectarivory

The present study has recorded Erythrina indica, Ceiba pentandra, Albizia lebbeck and Cassia fistula are the flowers mainly visited by the fruit bats for nectar feeding. It is generally agreed that bats visit flowers for nectar, pollen and floral parts [59, 5]. Rasweiler suggested that pollen may provide an important source of dietary protein for plant-visiting bats. Nectar and ripe fruits are generally rich in carbohydrates and water, but low in protein and fats [33, 56, 60]. Carbohydrates and water should be preferred by bats following a prolonged day roosting period, during which they have no access to these resources.

The study has observed that the pteropodid bats fed most intensely on Erythrina nectar between 06:30 and 07:30 hours. Fruit bats of both species hanging on branches to feed at flowers, also inserting their mouths into blossoms to lick nectar, and occasionally consuming petals. The present study has observed that C. sphinx, R. leschnaulti and P. giganteus were the principal visitors of C. pentandra, but R. leschnaulti, was visited rarely. The study has supports a recent report Singaravelan & Marimuthu [61] describing pteropodid bats visiting inflorescences of C. pentandra. According to Nathan et al., [15], C. sphinx and P. giganteus foraged in groups. Study clearly shows that bats such as P. giganteus and C. sphinx are important pollinators of C. Pentandra [61, 62].

4.4. Pteropodids as Folivory

The collections of discarded leaf parts, whole leaves and rejected leaf pellets beneath roosts of Ficus religiosa and captures of mature males carrying fresh leaves provide additional evidence for folivory, by leaf-fractionation, by plant visiting phyllostomids. Folivory in C. sphinx [51] and the nutrient analysis in leaves fed by C. sphinx were well expressed [56]. P. giganteus were observed to feed only on the leaves of Ficus religiosa. Lowry [63] refers to the phenomenon ‘green leaf fractionation’ whereby whole leaves are seldom consumed, but chewed and the whole liquid extract is consumed.

Our result suggests that pteropodid bat selected leaves high in protein and calcium content. Previous studies reported that Erythrina sp. have high protein content compared with leaves from other plant species consumed by plant visiting bats [64, 65]. Leaves of Erythrina poepiggiana consumed by Artibeus jamaicensis, and leaves of Cassia fistula consumed by Cynopterus sphinx had protein content of 19.0% [55] and 17.2% [56], respectively. Similarly, Erythrinaexceles, which is consumed by Neotropical primates, has a protein content of 14.2% [66].

Leaves can be relatively high in protein and calcium, and may be an important source of these nutrients for phytophagous bats [46, 56, 67]. This is particularly relevant for females, which face significant losses of calcium during pregnancy and lactation [55, 56, 67]. Kunz & Diaz [55] found that the bat A. litturatus needs two leaves of Erythrina
poepigiana (Walp.) (Leguminosae) to satisfy their daily protein requirements.

5. CONCLUSION

The research finding has suggested that folivory (by leaf fractionation) may reflect high protein and low phenolic content of leaves. In general, fruits provide an energy source (carbohydrates) to phytophagous bats, and leaves may be an important source of protein, minerals, and steroids. Pollen is also a protein-rich food and perhaps leaves are consumed to a greater extent when pollen is unavailable. Future studies should investigate the nutritional composition of the fruits, leaves and flowers eaten by these bats. The results of the present study indicated that pteropodid bat species may be able to meet its protein and calcium requirements by consuming leaves of selected plant species. Although plant visiting bats must fly to obtain both leaves and insects, less energy would be expended in the pursuit of leaves (a relatively ubiquitous and stationary resource) as compared to insects (active pursuit of a mobile resource) [55]. Kunz &Ingalls [65] suggested that fractionation of leaves minimizes the ingestion of pulp and fiber and hence should reduce wing loading. Thus, plant visiting bats may be able to reduce their daily energy expenditure, especially during late pregnancy and lactation, when energy and nutrient demands are expected to be the highest.

Conflict of Interest

The authors declare that they have no conflicts of interest.

References


