



Nocturnal flying mammal act as a bio-control agent in agricultural ecosystem

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Abstract

Insectivorous bats are well known predators of nocturnal flying insects and can potentially play an important role as bio-control agent in agricultural ecosystem at free of cost. The dietary analysis of left outs from the secondary roosting site of *Megaderma lyra* confirm their role as a pest control in agro ecosystems and keep a check on major nocturnal pest. The left outs from the feeding roost of *M. lyra* showed their hierarchy in the selection and consumption of major insect order lepidoptera preference throughout the study period from August 2021 to April 2022. The major composition of food item is Lepidoptera which includes moths and butterflies. The larvae of these insects are probably more destructive to agricultural crops. Thus the carnivorous bat *Megaderma lyra* are the pest managers of agro ecosystem in Tirunelveli.

Keywords: insectivorous bat, bio control agent, ecosystem, lepidoptera

Introduction

Bats are one of the beneficial members of the animal community belongs to the order Chiroptera. They play an important role as bio control agent in agricultural ecosystem (Jeyaprabha and Addline, 2013, Jeyaprabha 2014) [13, 14]. *Megaderma lyra* is mostly carnivorous, with a diet consisting of large insects, spiders, and small vertebrates such as bats, birds, rodents, and fish. Prey are detected either by passive listening or with the help of echolocation, then gleaned from the substrate and removed to a night roost where they are consumed (Rajan and Marimuthu, 1999, Jeyaprabha, 2008) [20, 13]. They will occasionally enter houses to take prey, such as lizards and insects, from the walls (Nowak, 1994). They generally forage less than 1 meter from the ground among trees and undergrowth in tropical forested habitats (Lekagul & MCNeely, 1977) [18]. Moreover it can able to change diet and adapt it to the most abundant prey. Analysis of left-overs in their feeding roost clearly predicts the unimaginable role of *Megaderma lyra* in controlling the insect pests. Its diet includes the primary pests from order Lepidoptera and also secondary pests from Coleoptera. There have been a limited number of observation on food habits and foraging behavior of bats in India. There is no knowledge on their insect prey, but it is important for assessing the potential value of bats in controlling pests. The prey of *M lyra* has been well studied through faecal pellet analysis in India. [Bates and Harrison 1997 [4]; Hill, J.E. and Smith, 1984; Advani, 1981 [1] Whitaker, 1988 [25] and Ramanujam, and Verzhutskii, 2004 [21] The insect prey of *M lyra* has been identified upto order level only through the faecal pellet analysis, The current research work is to present the information about the consumption of insect prey at species level, based on insect left outs collected from the feeding roost of *M. lyra* and focus on their role as a bio controlling agent with an aim to conserve these beneficial Chiroptera.

Methodology

The present study was carried out in the night roosting site of *M. lyra* in Sarah Tucker College Campus, Tirunelveli (Elve; 250 ft N: 8 42.67' E:077 198') from August 2021 to April 2022 when the insect density is high in the study area.

The dietary analysis of any animal can be done by collecting the left-outs from their feeding roost. Remnants were photographed for further identification. Insect remnants were identified with the help of authenticated literatures (Ross *et al.*, 1982 [23]; Mani, 1990 and Borror, 1992; Fletcher, 1914) [8] available on Indian insects and also Entomologist from Agricultural College, helped in the identification of insect parts. Insect collections were made in parallel to remnant collection though insect traps set in the foraging area and also collected manually from nearby area during night time. Captured insects were identified and confirmed with the remnants parts of the insects. Host plants and infective stages of pest were also studied from the entomology books and journals (Fletcher, 1914 [8], Butani & Jotwani, 1984 [5] Gupta, 1990 [10]; Gaurav Sharma and Ramamurthy, 2009) [9].

Results

Dietary habit analysis was done through the observation of culled parts underneath the feeding roost of *M. lyra*. Culled parts (insect remnants) under the feeding roost of *M.lyra* were shown in plate 1. Identified insects at family, order and species level, were given in Table 1. A total of 33 insect species were identified. Among them 22 species were Lepidopteran insects. Infective stage and host plant of identified Lepidoptera and Coleopteran insects were shown in Table 2.

Figure 1 depicted the status of observed insects under the feeding roost of *M. lyra*. Among all insects, Lepidoptera (66%) was the dominant group followed by Odonata (14%), Coleoptera (11%), Orthoptera (6%) and Dictyoptera (1 %). Among the five major groups, Lepidoptera (22 species) with 4 families was the most diverse group. Erebididae (8 species), followed by Sphingidae (5 species), Nymphalidae (5) and Crambidae (2) were the most abundant families (Figure 2). Frequency of insects in the study area from August 2021 to April 2022 were shown in Figure 3. More number of insect species were recorded during February (25 species) followed by 17 species during March. There is no insect during November. From December to April, more number of insect species were observed and more number of insects were recorded during March followed by February.



Plate 1: Collection of Insect remnants from the feeding roost of *Megaderma lyra*

Table 1: Identified insects at species level during the study period from August 2021 to April 2022.

S.No	Family:	Name of the species	Months 2021				Months 2022				
			August	September	October	November	December	January	February	March	April
1	Erebidae	<i>Achaca janata</i>	+	+	+		+	+	+	+	+
2		<i>Spirama helicina</i>					+	+	+	+	
3		<i>Helicoverpa armigera</i>					+	+	+	+	+
4		<i>Eudocima phalonia</i>					+	+	+	+	+
5		<i>Eudocima materna</i>		+	+		+	+	+		
6		<i>Asota ficus</i>									+
7		<i>Spodoptera litura</i>					+	+	+	+	+
8		<i>Speiredonia retorta</i>					+		+	+	+
9	Sphingidae	<i>Thretra nessus</i>			+		+		+		
10		<i>Agrius convolvuli</i>							+		+
11		<i>Hippotion boerhavia</i>			+					+	+
12		<i>Acherontia styx</i>	+	+	+		+	+	+	+	+
13		<i>Daphnis nerii</i>			+			+	+	+	
14		<i>Sphingomorpha chlorea</i>							+		
15		<i>Nephele hespera</i>			+		+		+	+	
16	Nymphalidae	<i>Acraea violae</i>							+	+	
17		<i>Melanitis leda</i>					+	+	+	+	+
18		<i>Mycalesis oculus</i>					+	+	+	+	+
19		<i>Danaus chrysippus</i>							+		
20		<i>Junonia almana</i>						+		+	
21	Crambidae	<i>Leucinodes orbonalis</i>							+		
22		<i>Spoladea recurvalis</i>		+	+						+
		Order : Coleoptera									
23	Scarabaeidae	<i>Holotrichia picea (white grub)</i>			+	+					+
24		<i>June Beetle Sp.</i>	+	+	+		+			+	+
25	Cerambycidae	<i>Two Long horned Borer</i>									
		Order:Orthoptera									
26	Tettigoniidae	<i>Microcentrum rombifolium</i>	+	+					+	+	+
27	Acrididae	<i>Cyrtacanthacris tatarica (Brown spotted locust)</i>							+	+	
		Order : Dictyoptera									
28	Mantidae	<i>Mantis religiosa</i>									
		Order : Odonata									
29	Libellulidae	<i>Tramea limbata</i>						+	+		
30		<i>Pantala flavescens,</i>						+	+		
31		<i>Diplacodes trivialis,</i>						+	+		
32		<i>Orthetrum sabina,</i>						+	+		
33		<i>Crocothemis servilia</i>						+	+		
			4	7	10		13	16	25	17	15

Table 2: Infective stage and host plant of identified Lepidopteran and Coleopteran insects.

S.No	Family	Order : Lepidoptera	Infective stage	Host plant
1	Noctuidae	<i>Achaca janata</i>	Larva and adult	Castor, Pomegranate, Rose, Zizyphus, Euphorbia, Tridax, Cardiospermum, Ficus, Bauhinia, Citrus, Mango, etc.,
2		<i>Spirama helicina</i>	Larva	Flowering Plants and Fruiting trees.
3		<i>Helicoverpa armigera</i>	Larva and adult	Cotton, tomatoes, maize, chick peas, alfalfa and tobacco
4		<i>Othreis fullonica (Eudocima phalonia)</i>	Larva	Amaranthus, Tomato, Chillies
5		<i>Eudocima materna</i>	Larva	Citrus, guava, mango, papaw, carambola, kiwifruit, lychee, persimmon, Banana
6		<i>Asota ficus</i>	Adult	<i>Ficus sp</i>
7		<i>Spodoptera litura</i>	Larva	Cabbage, beetroot, peanuts, geranium, cotton, banana, fuchsias, acacia, papaya, orange, mango
8		<i>Speiredonia retorta</i>	Larva and adult	apples, pears, and grapes
9	Sphingidae	<i>Thretra nesus</i>	Larva	Amaranthus, Barringtonia, Discorea, Amorphophallus, Impatiens, Citrullus, Arathis, Boerhavia, Knoxia, Morinda, Oldenlandia, Pongamia, Spermacoce, Glossostigma and Camellia.
10		<i>Agrius convolvuli</i>	Larva and adult	Ipomoea, long trumpet like flowers such as Nicotiana Sylvestris
11		<i>Hippotion boerhavia</i>	Larva	<i>Impatiens</i> species, <i>Spermacoce stricta</i> , <i>Spermacoce hispida</i> , <i>Glossostigma spathulatum</i> , <i>Boerhavia repens</i> and <i>Boerhavia diffusa</i>
12		<i>Acherontia styx</i>	Larva	<i>Sesamum indicum</i>
13		<i>Daphnis nerii</i>	Larva	Oleander (<i>Nerium oleander</i>), periwinkle (Vinca), grape (<i>Vitis vinifera</i>)
14		<i>Sphingomorpha chlorea</i>	Larva	<i>Vachellia tortilis</i> , <i>Vachellia karroo</i> , <i>Pisum sativum (Fabaceae)</i> , <i>Azanza</i> , <i>Thespesia spp. (Malvaceae)</i> , <i>Citrus spp. (Rutaceae)</i> , <i>Malus domestica (Rosaceae)</i>
15		<i>Nephele hespera</i>	Larva	Carissa carandas
16	Nymphalidae	<i>Acraea violae</i>	Larva	Leaves of <i>Hybanthus enneaspermus</i>
17		<i>Melanitis leda</i>	Larva	Rice (<i>Oryza sativa</i>), bamboos, <i>Andropogon</i> , <i>Rotboellia cochinchinensis</i> , <i>Brachiaria mutica</i> , <i>Cynodon</i> , <i>Imperata</i> , and millets such as <i>Oplismenus compositus</i> , <i>Panicum</i> and <i>Eleusine indica</i> .
18		<i>Mycalesis oculus</i>	Larva	leaves of flowering plants.
19		<i>Danaus chrysippus</i>	Larva	Asclepiadaceae family (the Milkweed family).
20		<i>Junonia almana</i>	Larva	Hygrophila auriculata, Phyla nodiflora and species in the genera Acanthus, Barleria and Gloxinia
21	Crambidae	<i>Leucinodes orbonalis</i>	Larva	<i>Solanum melongena</i> , Tomato, potato, nightshade, Sodom apple, Ethiopian nightshade, potatotree, nipplefruit, black nightshade, turkey berry, tropical soda apple, <i>Solanum anguivi</i> , <i>Solanum xanthocarpum</i> , cape gooseberry, and <i>Physalis minima</i>
22		<i>Spoladea recurvalis</i>	Larva	Spinach, beet, cotton, maize and soybean.
Order : Coleoptera				
23	Scarabaeidae	<i>Holotrichia picea (white grub)</i>	Larva	Roots of plants
24		<i>June Beetle Sp.</i>	Larva	Corn, sorghum and sugarcane
25	Cerambycidae	<i>Two Long horned Borer</i>	Adult	Trees and destroying the quality of the wood,
Order : Orthoptera				
26	Tettigoniidae	<i>Microcentrum rombifolium</i>		
27	Acrididae	<i>Cyrtacanthacris tatarica (Brown spotted locust)</i>		
Order : Dictyoptera				
28	Mantidae	<i>Mantis religiosa</i>		
Order : Odonata				
29	Libellulidae	<i>Tramea limbata</i>		
30		<i>Pantala flavescens</i> ,		
31		<i>Diplacodes trivialis</i> ,		
32		<i>Orthetrum sabina</i> ,		
33		<i>Crocothemis servilia</i>		

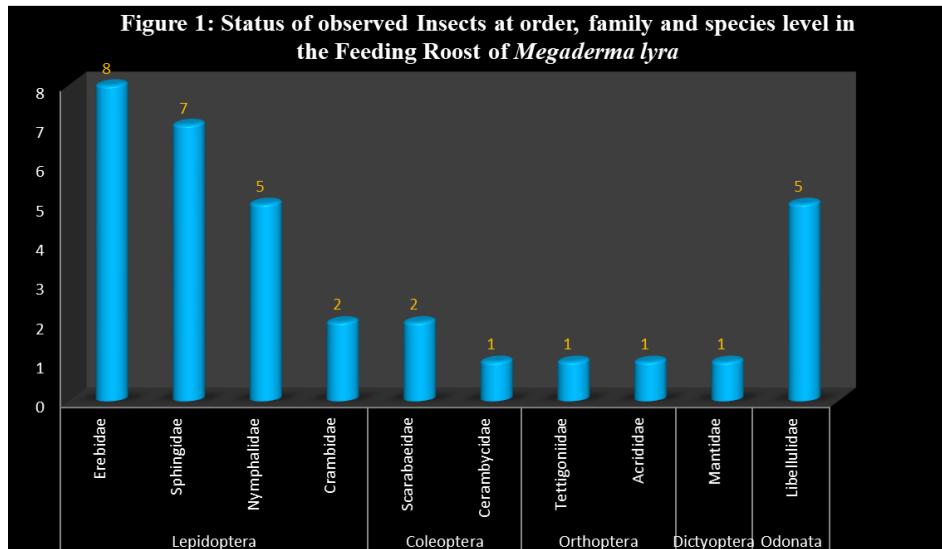


Fig 1: Status of observed Insects at order, family and species level in the Feeding Roost of *Megaderma lyra*

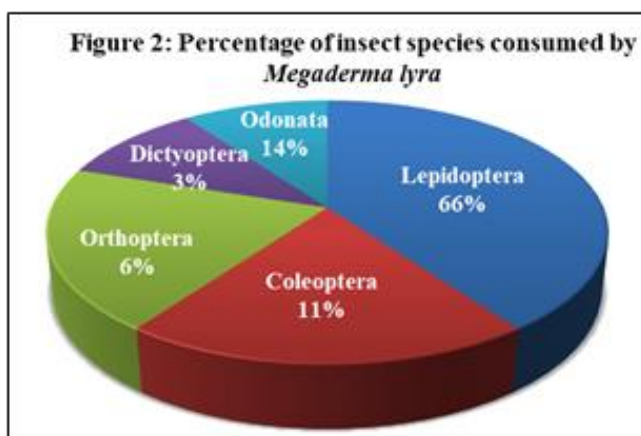


Fig 2: Percentage of insect species consumed by *Megaderma lyra*

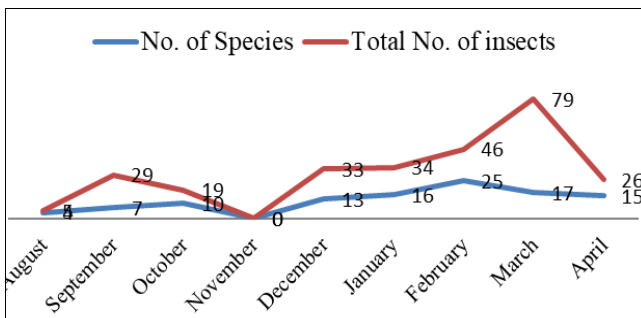


Fig 3: Frequency of insects consumption by *Megaderma lyra* from August 2021 to April 2022

Discussion

The dietary selection of many micro chiropteran bats has been well documented through faecal pellet analysis. Several studies revealed that the major prey of *M. lyra* includes coleopterans, lepidopterans, dipteran, orthopteran and hemipteran group of insects (Advani 1981 [1], Anthony and Kunz 1977 [3], Fenton 1988 [6], 1992, Whitaker *et al.*, 1999, Jeyaprabha and Viji 2018) [20, 16]. In faecal pellet analysis, Lepidopterans were represented by scales. The identification of the moth species is a very difficult task in pellet analysis. But from the left outs, lepidopteran insects were identified upto species level.

The present study confirmed the major dietary selection of *M. lyra* is Lepidoptera (22 species). Lepidopteran insects

such as butterflies and moths play an important role in the natural ecosystem as pollinators and as food in the food chain; conversely, their larva are considered very problematic to vegetation in agriculture, as their main source of food is often live plant matter. Every year 15% of the total agricultural production in India is lost by the insect pests (Krishnan 1993) [17]. The larvae of many Lepidopteran species are major pests in agriculture. In the present study 22 lepidopteran species were identified. The culled spit outs and moth wings collected from their feeding roost have confirmed the carnivorous bat *M. lyra* consumed different lepidopteran species which were available in their foraging area. Among all, lepidopteran insects such as *Achaca janata* and *Acherontia styx* were regular consumed by *M.lyra*. Since lepidopterans are their major dietary item, these microbats prevent the increasing population of pest species. it automatically prevent 200–400 eggs from being laid, reduces the pest population, and keeps tabs on nocturnal pests if it consumed just single moth,

M. lyra is known to take large size insects and transport them into underground shelters where they are consumed (Whitaker *et al.*, 1993). In the present study also they consumed the large size prey Lepidoptera, Tettigoniidae and Mantidae such as *Acherontic styx*, *Daphnis nerii*, *Nephele Hesperia*, *Micro centrum Rom bifolium* and *Mantis religiosa* in the secondary roost.

Food availability indicates the timing of Parturition in insectivorous bats. The period of parturition fell between January and May (Balasingh *et al.*,1998) [12]. In the present study among 33 species, 25 insect species were consumed during February followed by 17 species in March. More number of insects were consumed from December to April, and 79 insects during March followed by 46 in February. Raphaël *et al.*, 2001 [22] stated that most of the insectivorous bats give birth when the food resources is plentiful normally in late spring or early summer. Moths are dependent on particular habitats and vegetation types and increasing plant species richness should allow for an increase in the number of species of moth larva that may be sustained. All lepidopteran insects are available during the whole year and fluctuated with the highest peak at the fruiting period. Moreover, the increase in temperature and decrease in humidity is correlated with the high numbers of these insects (Ahmed Abd, 2022) [2].

The list of valuable plants subject to damage by lepidopterans is a long one, including many grains, sugar beets and sugarcane, cotton, tobacco, some root crops and leaf crops, many fruits, and timber and shade trees. Agricultural pests of grains and vegetables are numerous and include the armyworms and cutworms of the Noctuidae. The culled spit outs and the moth wings collected from the roosting site of *M.lyra* have proved that lepidopteran pests seem to be the major food items of *M.lyra*. The result of the current study will highlight the role of *Megaderma lyra* in the agroecosystem is indispensable and play major role in the Indian Economy.

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