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Influence of Rhinolophus beddomei, an Insectivorous Bat in Green Management of Kalakad Mundanthurai Tiger Reserve (KMTR)

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Abstract: Forest plant protection is a chronic problem for sustainable development of our country. Hence forest ecosystem is one of the main natural bio-resources that we have to conserve. But still there are many threats causing damages to our forest greenery. The major existing threat is the damages caused by insect pests. They are the most destructive agents affecting forest and shade trees. *Rhinolophus beddomei* (Lesser woolly horseshoe bat), a forest dwelling species, being a major insect eater, play a key role in the biological control of insect pests. Being the only flying mammal, bats are capable of sustained flight and are the most gregarious and successful group of beneficial animals to the ecosystem and have lured the attention of ethologists. The present study has analysed the study species availability and its activity as 'Pest Managers'. Few sample areas from forest ecosystem of Kalakad Mundanthurai Tiger Reserve (KMTR) was taken as study site which is known for its forest ecosystem with caves, water bodies, streams and forest tree cover. Dietary habitat analysis of study species was done by faecal pellet analysis. The results explain and justify *R. beddomei*, play a potential role in green management and there by helps to conserve biodiversity in forest ecosystem.

Index Terms **- Bio- resources, Threats, *R.beddomei*, Pest managers, Green management**

I. INTRODUCTION

Kalakad Mundanthurai Tiger Reserve (KMTR), which is situated in the south Western Ghats of Tamil Nadu, India, is one among the 18 world biodiversity hotspots which is bound by different types of forests in west, north and south and by villages in the east. The study was carried out in the hilly areas of KMTR. Insect pests are the most destructive agents that affect forest and shade trees (Grindal and Brigham 1999, Douce *et al* 2002). They affect tree roots, stems, limbs, needles, leaves of healthy or weakened trees, hardwoods etc. Insectivorous bats (microbats) play a significant role of pest management in all forested ecosystems (Barclay 1985, Freeman 1979, Fenton 2003).

Microbats are primary predators of vast numbers of insects that fly at night. Foraging activity of these microbats have a regulatory effect on insect populations which may also have direct economic implications for insect pest control (Douce *et al* 2002; McCracken 2004; Cape nature 2004; Boyles *et al* 2011).Among the forest insectivorous bats, the species of the *Rhinolophus* are rich in number and play a crucial role thereby keeping the insect population under check. *Rhinolophus beddomei* (Lesser Woolly Horseshoe Bat) Anderson 1905 is chosen as the study species which is endangered and endemic to the study area. They forage and feed insects throughout its geographic range. They roost in caves and abandoned old buildings. The present study focuses on the impact of Lesser Woolly horseshoe bat as Pest manager in the Green vegetation management.

II. RESEARCH METHODOLOGY

2.1: Data collection

The field work was conducted between May 2012 and December 2014 in KMTR (8.6833o N; 77.3167o E; Elevation range 40 – 1800 m). The distribution of the study species was confirmed by erecting mist nets. Photographic record of the mist netted bats was done for closer look on morphological features. Roost searches were carried out in abandoned buildings, rock crevices, cracks, caves etc. The bats from roosting sites were collected using hand-held nets and mist nets to confirm identification. Measurements were taken following Bates and Harrison (1997). The bats were then released back in the place where they were caught.

2.2: Dietary habitat analysis

The analysis of bat droppings is generally considered to yield reliable information on the diet of insectivorous bats. Much useful data on food habits of these insectivorous bats have been gained by culled parts (Laval and Laval 1980, Belwood and Fullard, 1984). Dietary habitat analysis of study species was done by faecal pellet analysis and examination of culled parts beneath the roost. Fresh faecal pellets were collected from the day roost by spreading polythene sheets once in a fortnight. Twenty pellets were randomly selected and their dried weight (0.15gm) was taken to 0.01 gm accuracy by using digital balance (OHAUS-USA). The pellets were soaked in 70 percent alcohol and teased apart individually using fine needle under microscope. Then they were mounted in DPX on glass slides. Each slide was systematically searched for identifiable insect parts under binocular microscope (Olympus CH2Oi. Japan). The microphotographs were taken to confirm the insect parts. Identifications were made with the help of authenticated literatures (Black 1972; Chinery 1977; Nair 1989; Borror 1992; Menzel *et al* 2001).

2.3: Formula used

The percentage frequency of insects consumed during the study period were calculated applying the following formulae. (Kunz 1988).

$$\textit{Percentage frequency} = \frac{\text{Number of occurrence of categories}}{\text{Total occurrence of all categories}} \times 100$$

2.4: Statistical analysis

A significance test was done to find the food selection and food consumption using ANOVA. Analyses were performed in SPSS 13 software.

III. RESULTS AND DISCUSSION

3.1: Study area

The study area KMTR, stands out as one of the important Protective Areas (PA) in the Indian peninsula that attracts International Conservation Communities. Plate 1 shows the beautiful study area (Sengaltheri and Mundanturai). This area serves as an ecological benchmark to accomplish biological and ecological research.

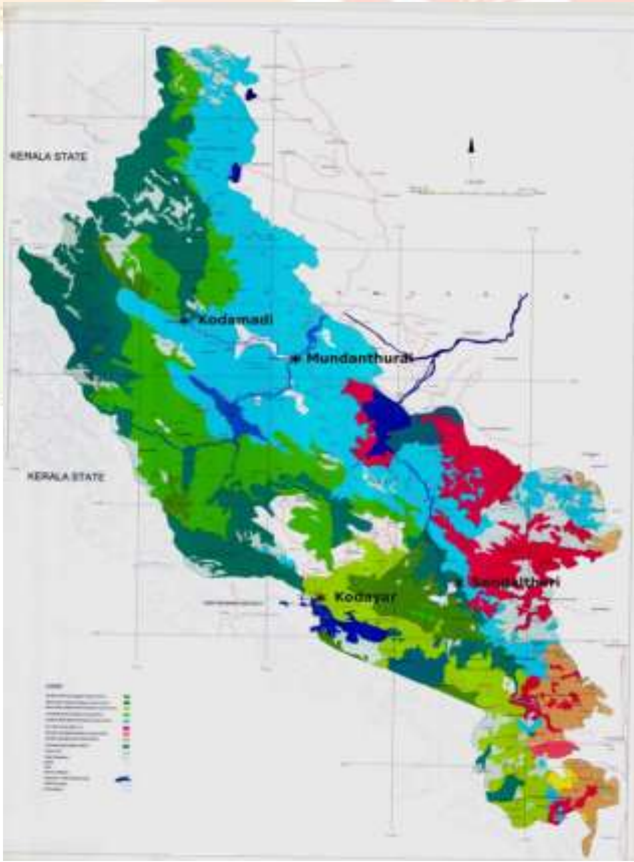

Plate 1: Study area

3.2: Study species

These horseshoe bats have leaf-like, horseshoe-shaped protuberances on their noses. They emit echolocation calls through these structures, which may serve to focus the sound. Their wings are broad, making their flight particularly agile. These Rhinophids are brown and grayish black in colour. Their forearm ranges from 37 – 58 mm, body mass from 4.4 – 22.5 g and head and body length (HB) from 36 – 72 mm. Figure 1 shows the study species *Rhinolophus beddomei*. Figure 2 shows wing morphology of the study species.

Figure 1: Rhinolophus beddomei

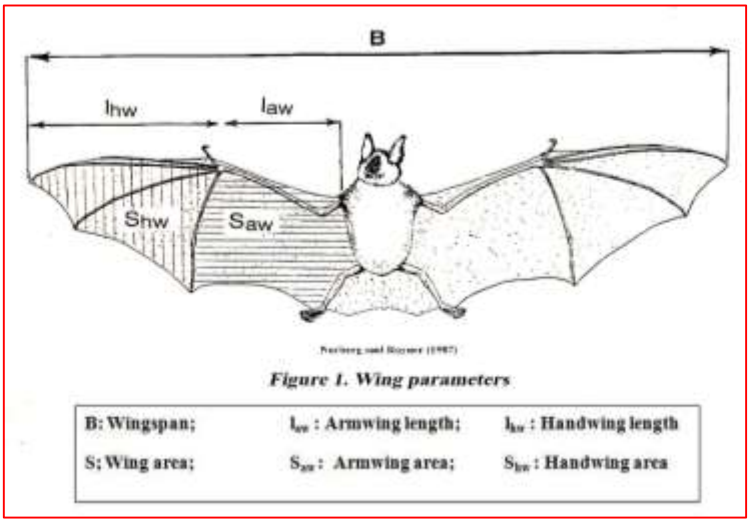

Figure 2: Wing morphology

3.3: Foraging and feeding strategy

A suite of morphological factors influences foraging behaviour in insectivorous bats, including body mass and the size and shape of the skull, jaws and wings (Freeman, 1979). Large bats with large jaws are capable of eating a wider range of prey sizes than small bats, resulting in a broader feeding niche. When food resources are plentiful, such differences are less apparent (Anthony and Kunz 1977).

Table 1: Diet and source of R. beddomei

Name of the bat species	Eco morphology	Diet	Source
Rhinolophus beddomei	Hard eaters	Moth, Caddish fly, Cicada, Tree hoppers, Leaf hoppers, Aphids, Mealy bugs, Beetle, Damsel fly, etc	Forest tree foliage, Shoot, Root, etc

The flight mechanism in bats are associated with partitioning of food resources among bats (Norberg and Rayner 1987). Bats with different wing designs, varied flight style and performance show considerable diversity in diet preference (Neuweiler 1984; Fenton 1990). Table 1 shows the diet of study species and its source. The *R. beddomei* has higher wing loading, lesser maneuverability and forage in open uncluttered habitat. The diagrammatic view of predicted foraging habitat of studied species is depicted in Figure 3

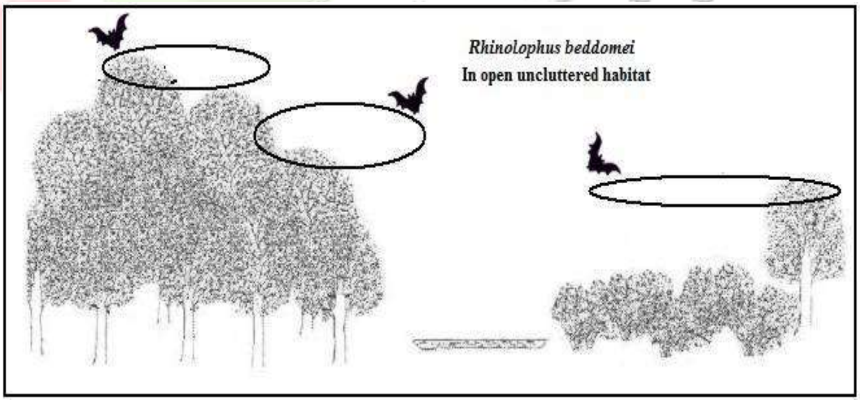

Figure 3: Foraging path of study species

3.4: Dietary selection and feeding impact

The dietary preference of the study species shows that they prey predominantly on lepidopterans (39%). Sharifi and Hemmati (2001, 2004) also reported that lepidopterans were the most consumed and preferred prey item of *Rhinolophus* species. Previous studies of Robinson and Stebbings (1993), on *Eptesicus serotinus* forest bat of U K also shows that the scales of moth wings were very conspicuous in faeces. The major nocturnal pest for the flora of any ecosystem is the caterpillars of moths (Whitaker 1993). In addition, coleopteran and lepidopteran insects appear to be the second most important insect orders in the diet of Indiana bats (Kurta and Whitaker 1996). The present study also shows that there is high frequency of lepidopteran and coleopteran fragments in the faeces. The larvae of many lepidopteran species are considered as major pests. By preying a single lepidopteran, the bat really protects the vegetation from 200 to 600 caterpillars a female lepidopteran can produce. Table 2 depicts the selective dietary items found in the pellets and remnants.

Table 2: Selective dietary items found in the pellets and remnants

Insect order	Lepidoptera	Orthoptera	Coleoptera	Isoptera	Diptera	Acaridae	Hymenoptera	Odonata	Hemiptera	Homoptera	Neuroptera
Rhinolophus beddomei	✓	X	✓	X	✓	X	✓	X	X	✓	✓

The ranking of insect order consumed by these bats are Coleoptera (27%), Diptera (12%), Hymenoptera (9%) and Homoptera (7%) and Neuroptera (6%). Almost all the coleopteran beetles are hardwood pests and they infest the trees which cannot be even saved with insecticide treatments. Thereby, to limit pest population, the predation by bats on these insects in the forest ecosystem is very beneficial. The dietary preference, thereby confirms the impact of these horseshoe bats as pest controllers in the green ecosystem.

Plate 2: The identified insect parts

The documented insect parts from the faecal pellet analysis shows the undigested parts of wing fragments, body fragments, leg parts etc. of various pest insects of the forest. The identified insect parts are represented in plate 2 and the percentage frequency of insect consumption in the dietary components of studied species are represented in Figure 4. Being a dry tropical country, India has an incredible diversity in bat sp. In tropical ecosystems the insect eating bats fulfill key ecosystem services as control agents of arthropod populations (Kalka *et al.* 2008, Williams-Guillén *et al* 2008).

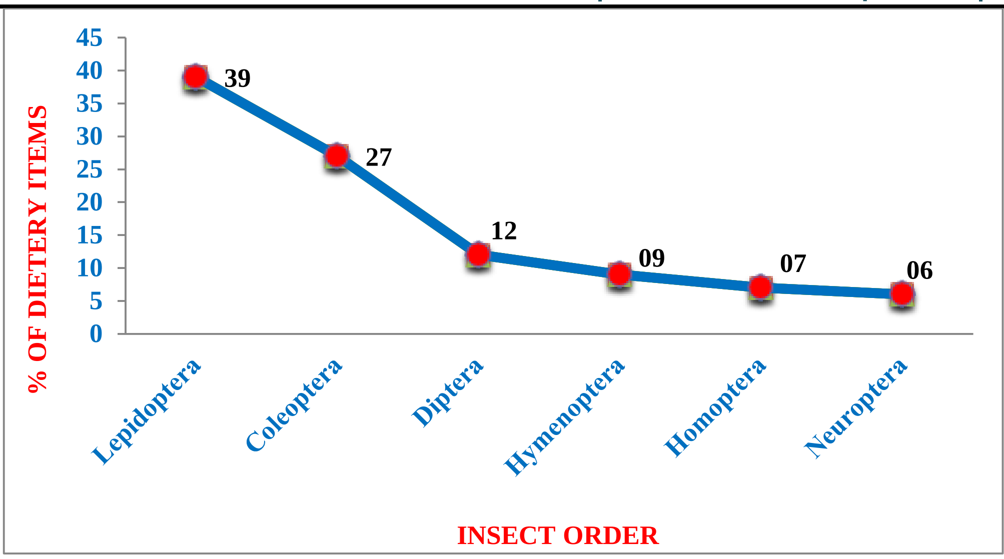

Figure 4: Percentage frequency of insect consumption in the dietary components

IV. CONSERVATION MEASURES

Tropical forests are known to be more species-rich than other terrestrial ecosystems but these are also the most threatened ecosystems of the world. The major threats to *Rhinolophus beddomei* are roost disturbance by tourism, high vulnerability to extinction and degradation of high-altitude forest. The baseline ecological data collected during the tenure of this project is really helpful in understanding the distribution, abundance, habitat preferences and designing necessary conservation measures for *R. beddomei* as this endemic species needs immediate protection. Table 3 shows the Roost location of *R. beddomei* in KMTR

Table 3: Roost location and characters of study species (Endemic and Endangered)

NAME OF THE BAT SPECIES	Location of the roost	Type of Roost	Name of roost	COLONY SIZE (APPROXIMATE)
RHINOLOPHUS BEDDOMEI	Shengaltheri (Kalakad hills) Ele: 3103 ft, N: 8°31.932' E: 77°26.932'	Man-made structure	Abandoned bungalow	2
	Muthaliruppan parai (Kalakad hills) Ele: 1350 ft, N: 8°32.129' E: 77°28.539'	Cave	Muthaliruppan parai cave	1
	Kuthiraivetti (Kodayar hills) Ele : 3609 ft, N: 8°41.567' E: 77°44.208'	Cave	Kuthiraivetti Cave	2
	Kannikatti (Pothigai hills) Ele : 2634 ft, N: 8°37.922', E: 77°16.411'	Cave	Kuravankuzhi cave	2

Due to disturbance of bats' traditional roosts in caves and tree hollows, abandoned and inactive underground mines, many bat species are found to be threatened throughout the world. As thousands of abandoned mines are being reclaimed, available evidence suggests that millions of bats have been inadvertently buried or have lost crucial habitats. Closure of abandoned mines without first evaluating their importance to bats is perhaps the single greatest threat to many bat populations. Roost protection is the major conservation measure to protect these valuable species. It is our duty to protect and conserve these bat species from endangering.

V. CONCLUSION

Forest insect outbreaks cause economic damage to forests which in turn affect the wealth of the country. The present impact study shows that there is availability of certain harmful insect pests throughout the year. The role of the studied rhinophid is of great importance in the forest ecosystem as pest manager. The present study so far has evaluated the importance of these species and their value of pest suppression. The bat conservation will not only replenish forest ecosystem but also helps to assess the habitat quality which is really essential for the species recovery, survival and biodiversity augmentation.

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