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Edge effect on roller dung beetles (Coleoptera: Scarabaeidae: Scarabaeinae) in the moist South Western Ghats

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Abstract

Effects of habitat fragmentation and modification, leading to creation of habitat edges is studied on the species richness and abundance parameters of the roller dung beetle population of Nelliampathi in South Western Ghats. Round the year collection of dung beetles was made employing dung baited pitfall traps in three habitats- semi-evergreen forest, agriculture habitat and the ecotone between the two habitats. The rollers represented by three genera, *Paragymnopleurus sinuatus* (large roller), *Ochicanthon mussardi* (small roller), *Sisyphus araneolus* (small roller) constituted the second most abundant guild (4.07%) preceded by the tunnelers. The general low abundance of rollers compared to tunnelers is attributed to the cool, moist climate which makes dung processing a difficult and energetically less efficient behavior for rollers. Species richness of rollers did not show edge effect. Two species, each was collected from ecotone (*O. mussardi* and *S. araneolus*) and forest (*P. sinuatus* and *S. araneolus*) and none from agriculture habitat. The overall abundance of rollers was low in ecotone and high in the forest. The ecotone dung beetle assemblage was essentially a diminished sample of forest assemblage and the proximity of ecotone to forest and agriculture field did not enhance its suitability as preferred habitat for roller guild of dung beetles in Nelliampathi region.

Keywords: Nelliampathi, south western ghats, roller dung beetles, edge effect

1. Introduction

Coprophagous scarabaeinae beetles predominantly feed on mammal dung. To avoid competition for the ephemeral source of food, dung beetles employ three main strategies for dung feeding, by which they are classified into guilds called, rollers (telecoprid nesters), tunnelers (paracoprid nesters) and dwellers (endocoprid nesters). Rollers form balls from dung pads, which are rolled away considerable distance, buried in tunnels and used for feeding and breeding; tunnelers bury dung balls in underground chambers beneath the dung pad; dwellers breed and feed in the dung pad itself^[1]. Rollers are considered the most competitively superior guild as they are capable of using the resource rapidly^[2]. Dung beetles are considered excellent bioindicators of habitat quality as they are highly habitat specific^[3, 4] and are adversely affected by microclimate changes associated with habitat fragmentation and modification^[5, 6].

Creation of habitat edges through anthropogenic activity have recently stimulated interest in assessing the effects of ecotones on biodiversity^[7]. Ecotones, natural or anthropogenic, can greatly affect insect abundance and diversity^[8]; faunal movement^[9], species interactions and community structure^[10]. The intensity and direction of edge effect on population levels of organisms can be extremely variable across species. Different species respond positively, negatively or neutrally to edges^[11, 12].

Roller dung beetles require specific environmental conditions such as higher dung and soil temperature, since their mechanism of resource utilization is energetically costly. This limits their distribution in moist and cooler habitats^[2, 13]. Rollers also show sensitivity to habitat types and modifications. Studies in Africa showed significantly higher species richness of rollers in wooded habitat when compared to cultivated habitat^[14] and in the Neotropics notable reduction in roller species richness was observed in disturbed forest fragments^[15], when compared to undisturbed forest habitats^[16]. Though studies have been done to show the effects of both natural and anthropogenic edges on different population parameters of dung beetle assemblages^[15, 17], no studies have been done to show the effects of anthropogenically derived edge on specifically the roller guild of dung beetles and this is the first such study in

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the South Western Ghats.

This study is aimed to determine how habitat fragmentation and modification which leads to the creation of habitat edges affect species richness and abundance in roller dung beetles across a semi-evergreen forest-agriculture habitat ecotone in South Western Ghats. Such studies can provide knowledge about ecological factors that determine the spatial and geographical distributions of roller species, as well as on the possible effects of habitat fragmentation and modification on roller guild of dung beetles in the Western Ghats, a biodiversity hotspot.

2. Materials and Methods

2.1 Study site

The study region Nelliampathi is located on southern “edge” of Palghat gap. It is an ecologically sensitive region at a height of 467 to 1585 m above sea level, with an area of 82 sq. kms. It encloses the Nelliampathi reserve forest and is bordered by the Parambikulam wildlife Sanctuary and Tiger reserve towards the south and southeast [18]. The Anamalais-Nelliampathis is one of India’s most important elephant conservation areas [19]. Nelliampathi forest presents a greatly fragmented habitat in the southern region of the Western Ghats, a global biodiversity hotspot. Large plantations of tea, coffee, cardamom and orange, dams, and roads intersperse the hills [18]. The annual average rainfall in the area is 47.24 mm and the temperature vary between 15 °C-30 °C [20]. The collection site Kaikatty is located at 10° 31’N longitude and 76° 40’E latitude, at an elevation of 960msl.

The vegetation in the study site is characterized by West coast semi-evergreen forest consisting of a mixture of evergreen and deciduous trees of moderate height (15-20m). About, 40% to 80% trees are evergreen. The forest presents a rich mammal fauna represented by elephant (*Elephas maximus*), gaur (*Bos gaurus*), sambar deer (*Cervus unicolor*), wild boar (*Sus scrofa*), langur (*Semnopithecus sp*), lion tailed macaque (*Macaca silenus*), Nilgiri marten (*Martes gwatkinsii*), small Travancore flying squirrel (*Petinomys fuscocapillus*), brown mongoose (*Herpestes fuscus*), Malabar civet (*Viverra megaspila*) [21]. The selected area included a multistoried semi-evergreen forest lying adjacent to an agriculture habitat separated by a distinct edge of dense shrubs.

2.2 Collection, sorting and identification

Dung beetles were collected using dung baited pitfall traps in presummer (Oct-Feb), summer (March-May), and rainy season (June-Sep) from the semi-evergreen forest, agriculture habitat and ecotone between the two habitats. A series of ten 100m transects, each transect separated by 50m, was established at the study site. Each transect ran perpendicular across the forest–agriculture field ecotone and consisted of three pitfall traps. A trap at the forest–agriculture field ecotone in the zone of dense shrubs established the midpoint of each transect. Traps were then placed 50 m away from the center trap, one in the forest and one in the agriculture field [17]. A 25 x 25 x 2 cm plastic sheet was set over each trap to protect it from rain. Traps were baited with fresh cow dung and the contents collected at 24-hour intervals. Collected specimens were identified to species level.

2.3 Statistical analysis

The data used for statistical analysis was tested for normality with Anderson-Darling test. Since the data was normally distributed, One-way ANOVA was used to test the significant

levels of variation in abundance of individual species of roller dung beetles between habitats. Statistical analysis was performed using Megastat version 10.0 [22].

3. Results

A total of 1425 beetles belonging to 10 genera and 34 species were captured during the study period in the three habitats. A total of 58 rollers represented by three genera (*Paragymnopleurus*, *Ochicanthon*, *Sisyphus*) and three species (*P. sinuatus*, *O. mussardi*, *S. araneolus*) were collected (Table 1). Rollers were the second most abundant guild (4.07%), preceded by the tunnelers (95.01%) and dwellers (0.92%) were the least abundant. Two species each were collected from ecotone (*O. mussardi* and *S. araneolus*) and forest (*P. sinuatus* and *S. araneolus*) and none from the agriculture field (Table 1). Higher roller abundance (68.96%) was recorded in the forest than in the ecotone (31.03%) (Fig. 1). While *O. mussardi* was found only in the ecotone and *P. sinuatus* in the forest, *S. araneolus* was found in both forest and ecotone with higher abundance in forest (72.22%) than in the ecotone (27.77%) but no significant difference in abundance was observed between the habitats (Table 2). Presummer season accounted for the highest collection of rollers (91.4%), followed by monsoon (5.2%) and summer seasons (3.4%).

Table 1: Abundance of roller dung beetles (mean±SD from 30 samples) across the semi-evergreen forest, ecotone and agriculture habitat of Nelliampathi region during 2007-2008 study period

Species	Forest	Edge	Agriculture
<i>Paragymnopleurus sinuatus</i>	0.03±0.18	0	0
<i>Ochicanthon mussardi</i>	0	0.1±0.55	0
<i>Sisyphus araneolus</i>	1.3±3.42	0.5±1.53	0

Table 2: Statistical analysis of roller abundance across semi-evergreen forest, ecotone and agriculture habitat of Nelliampathi region during 2007-2008 study period

	F	df	P
Overall abundance	0.72	2	>0.05
<i>Paragymnopleurus sinuatus</i>	1	2	>0.05
<i>Ochicanthon mussardi</i>	1	2	>0.05
<i>Sisyphus araneolus</i>	2.77	2	>0.05

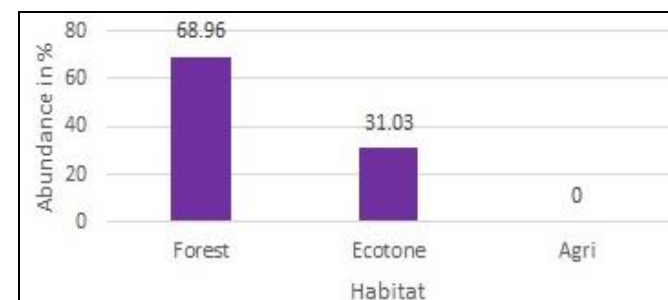


Fig 1: Roller abundance in Forest, ecotone and agriculture habitat of Nelliampathi during the 2007-2008 study period

4. Discussion

The high abundance of small roller genus, *Sisyphus* in the forest and ecotone in Nelliampathi is similar to earlier records from the Wayanad forests of Western Ghats [23, 13]. Adaptations of genus *Sisyphus* to the vegetation, trophic resource, and microclimate of the region had led to this high abundance. Presence of large roller *P. sinuatus* only in the forest could be attributed to its preference towards large dung

pads of elephant and gaur that frequent the forest habitat as opposed to the ecotone. Earlier studies had also associated large dung beetles with large dung pads [24]. Large rollers also prefer forest habitat when compared to croplands and pastures [25]. Presence of *O. mussardi* only in the ecotone might be related to its preference towards dung pellets and the presence of dung pellet producing mammals such as deer in the ecotone. Similar preference towards pelleted dung by tribe *Canthonini* was observed in the montane forest of South Western Ghats [26].

The tunneler guild dominated the assemblage in the forests of the region [23, 13]. Dung rolling is an energetically costly behavior for the thermophilic rollers and the cool, moist climate of Nelliampathi probably makes dung processing a difficult and energetically less efficient behavior. But the roller abundance in the forests of Nelliampathi was higher when compared to Wayanad forests in the region. This is because Nelliampathi forest had less understory vegetation due to anthropogenic activities which would otherwise make dung ball rolling a difficult task to perform as observed in Wayanad forests [13]. The ecotone harbored low roller abundance compared to forest habitat due to changes in vegetation cover which led to low mammal abundance, and decreased food resource [27]. The roller beetle's absence in agriculture habitat was owing to the scarcity/non-availability of fresh dung due to agricultural activities, changes in vegetation and microclimate and land use of the cultivated land which made it less suitable for rollers [28, 29].

The majority of the roller beetles was collected during the presummer season. Drying up of vegetation in summer reduces food availability and herbivores migrates to other evergreen patches in the region, this reduces the dung availability for beetles in summer [30]. Moreover, dung pads dry up rapidly in the summer months, making it unusable by beetles and also increases larval mortality [6, 31]. Similar observations were made in the forests of Wayanad in the Western Ghats region [13]. In the monsoon season, the heavy rains in the region either wash away the dung or maintains the dung in a fluid state, making dung ball rolling a difficult task to perform [30].

Hence, it could be concluded that the ecotone dung beetle assemblage was essentially a diminished sample of forest assemblage and the proximity of ecotone to forest and agriculture field did not enhance its suitability as a preferred habitat for roller guild of dung beetles in Nelliampathi region.

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