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Influence of Agricultural Expansion and Human Disturbance on the Encounter Rates of Nocturnal Mammals in Tropical Hill Forests in Bangladesh

Hassan Al-Razi [1], Marco Campera [2,*], Sabit Hasan [1], Marjan Maria [1], Vincent Nijman [3] and K. Anne-Isola Nekaris [3,*]

1 Department of Zoology, Faculty of Life and Earth Science, Jagannath University, Dhaka 1100, Bangladesh
2 Nocturnal Primate Research Group, Faculty of Health and Life Sciences, Oxford Brookes University, Oxford OX3 0BP, UK
3 Nocturnal Primate Research Group, Faculty of Humanities and Social Sciences, Oxford Brookes University, Oxford OX3 0BP, UK
* Correspondence: mcampera@brookes.ac.uk (M.C.); anekaris@brookes.ac.uk (K.A.-I.N.); Tel.: +44-186-548-3767 (K.A.-I.N.)

Abstract: Agricultural expansion has had a detrimental effect on tropical forests and the animal communities that depend on them. Agroforestry systems, however, with their more complex tree and plant communities, have been shown to be important habitats for a range of globally threatened species, including nocturnal animals. Here, we present novel data on the encounter rates of seven species of nocturnal mammals in relation to agroforestry systems within four national parks and associated plantations in Bangladesh to examine if encounter rates were influenced by the human population density, presence of plantations, and human access as represented by a Human Influence Index of anthropogenic disturbance. We walked 70.3 km of transects with only semi-natural forest, 26.9 km of transects with semi-natural forest and gardens, and 21.7 km of transects with semi-natural forest and monocultures over 55 nights from 2017–2019. Of the seven species of nocturnal mammals we detected, all were present in Satachari National Park, whereas six occurred in Lawachara National Park, Rajkandi Forest Range, and Rema-Kalenga Wildlife Sanctuary. Within these national parks, three species (Bengal slow loris, large Indian civet, particolored flying squirrel) were more frequently recorded in areas with human disturbance, especially agroforestry plantations. With declining forest cover in Bangladesh, we highlight here the potential of agroforestry systems as emerging important habitats for these species. We encourage long-term studies of these lesser-studied taxa to understand fully the capacity of agroforestry systems in order to support their long-term conservation.

Keywords: agroforestry; nocturnal mammal; line transect; Bangladesh; conservation

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1. Introduction

Tropical forests are among the most ancient, diverse, and ecologically complex of terrestrial habitats and support about two thirds of all known species [1]. At the same time, around 1.2–1.5 billion people rely directly on tropical forests for food, timber, medicines, and other ecosystem services [2]. This dependency on tropical forests is increasing anthropogenic disturbance and causing their destruction [3]. Deforestation is recognized as one of the most serious environmental and economic problems for many countries in the tropical and subtropical regions of the world [4]. In tropical areas, around 5–10 million hectares of natural forests are disappearing every year [5,6].

Habitat shift to agriculture is the main threat for tropical forests and is predicted to be even more impacting in the future [7,8]. Human disturbance plays an important ecological role in natural environments and can affect species diversity, promote alterations in system structures, reduce species competition, and change resource availability [9,10]. Agricultural expansion into forested areas increases the risk of diseases and pests as well as the rate of wildlife trading of protected animals [11–13]. Nevertheless, several species have been shown to thrive in agricultural areas, especially if they are in the form of agroforestry systems with crops and trees [14–17].

Here, we provide baseline data on the response of a nocturnal mammal community (squirrels, primates, carnivores) to agricultural expansion and human disturbance in tropical hill forests in eastern Bangladesh. Bangladesh is one of the most densely human populated countries in the world, and only 14.5% of its natural forests remain [18]. While the mangrove littoral forest of the Sundarbans especially has gained significant attention from the conservation community [19–22], in terms of land cover the hill forests that are mostly found in the eastern and northern part of Bangladesh are equally important [18]. Ecologically, these hill forests, comprising of moist tropical evergreen and semi-evergreen forests, constitute a transition between the Indian subcontinent floristic region and the Indo-China floristic region [23]. The forests are generally uneven-aged and multi-storied. The majority of smaller understory trees are evergreen and most of the larger trees are deciduous. In terms of light pollution, only 5.3% of Bangladesh is not affected, but this percentage is higher in eastern Bangladesh where large areas remain relatively unaffected by artificial lighting [24].

We here aim to estimate the encounter rates of nocturnal mammals and determine the influence of anthropogenic disturbance and presence of plantations on their encounter rates. The tolerance of species to anthropogenic disturbance varies [25], and several animals are able to adapt to human-modified habitats [26]. We discuss the potential of agroforestry systems as emerging and important habitats for these species to conserve small-to-medium-sized nocturnal mammals.

2. Materials and Methods

2.1. Study Area

We conducted the survey in the Satchari and Lawachara National Parks, Rema-Kalenga Wildlife Sanctuary, and Rajkandhi Reserved Forest. These are four of the few natural forest areas remaining in the northeastern region of Bangladesh, situated in the Moulovibazar and Habigonj Districts (Figure 1).

Satchari is a National Park with an area of 242.91 ha that lies within the Raghunandan Hill Reserve Forest (24°12′713″ N 91°44′436″ E). The area occupies the higher ridges of the northernmost extension of Dupitila, Tipam, and Surma sedimentary rocks extending from the Chittagong Hill Tracts through the Tripura State of India. Although this forest classically belongs to the evergreen type, the large-scale conversion of the indigenous forest cover to plantations has changed its forest type [27]. Currently, among 1760 ha of total reserve area, old-growth forest comprises 120.3 ha (6.84%), whereas secondary forest comprises 89.9 ha (5.11%), followed by old plantation 63.9 ha (3.63%) and oil palm plantation 24.7 ha (1.40%) [28]. The climate is mainly tropical, with high rainfall concentrated during the monsoon from June to September and generally having a 4-to-5-month dry period. The total annual average rainfall is 4162 mm. A number of small, sandy-bedded streams drain the forest during the rainy season. The maximum and minimum temperature of the area is 32 °C and 12 °C, respectively. The relative humidity fluctuates between 74% to 90%. Eighty percent of the local people around this forest are largely illiterate and are dependent on the forest for their livelihoods [28].

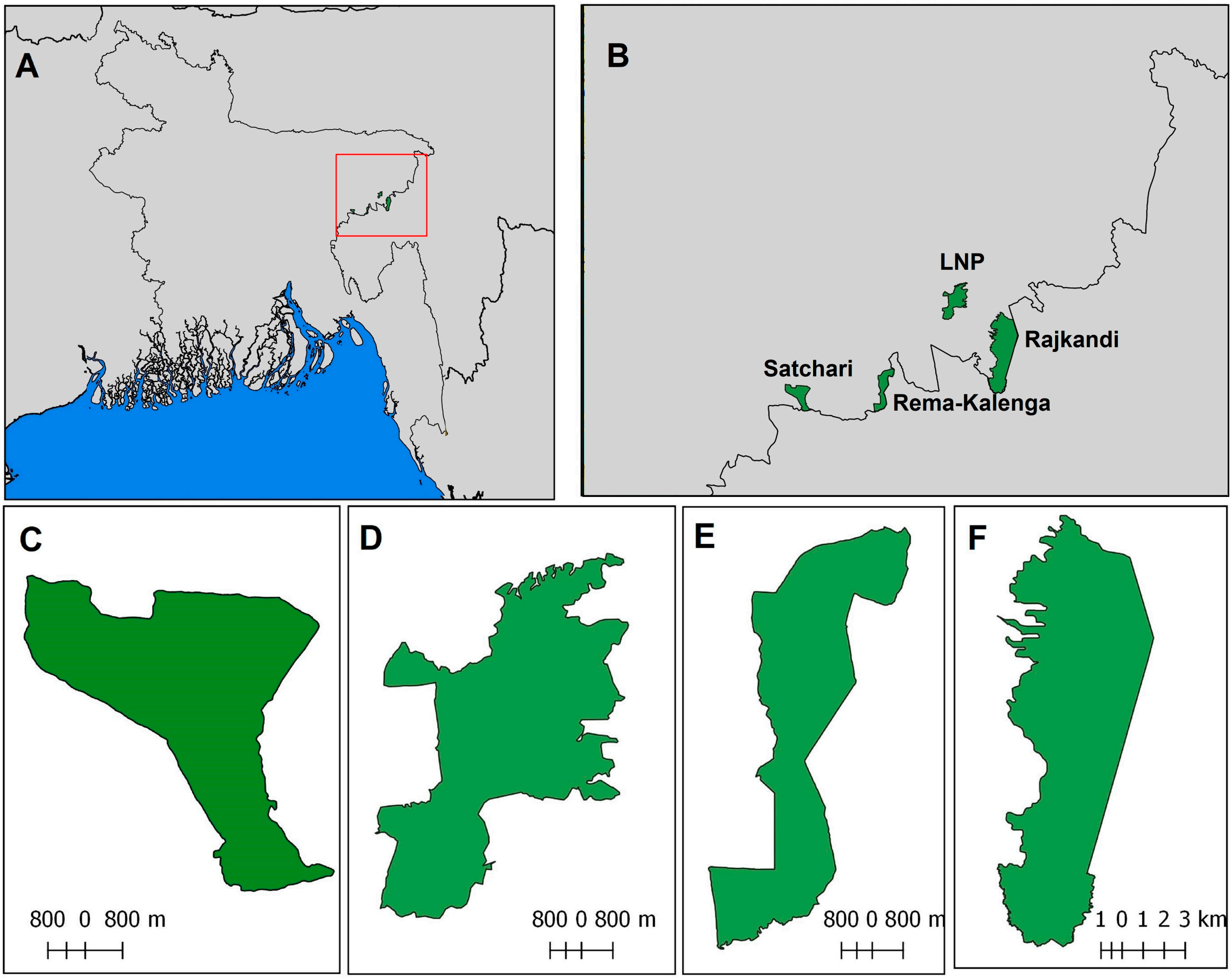

Figure 1. Map of Bangladesh; (**A**,**B**) The red square shows the area of the study sites in Bangladesh, whilst the small green patches show the position of the study sites in Bangladesh, and the size of the study sights is represented in (**C**) Satchari, (**D**) Lawachara National Park, (**E**) Rema-kalenga, and (**F**) Rajkandi.

Lawachara National Park is a 1250 ha mixed evergreen forest characterized by an undulating landscape, with slopes and hillocks at an elevational range of 10–80 m above sea level. Several streams and small water bodies are distributed evenly throughout the park. The region has a tropical monsoon climate, with an average annual rainfall of approximately 4000 mm. The annual mean temperature ranges from 32.9 °C (April) to 9.5 °C (January) [29]. About 30 villages are situated in and around the LNP, where villagers are involved in different forest practices, labor intensive works, small businesses, eco-tour guides and other services. Khasia and Garo indigenous communities utilize betel leaf, pineapple, and lemon-based agroforestry systems [30].

Rema-Kalenga Wildlife Sanctuary is a tropical evergreen and semi-evergreen forest with an area of 1795.54 hectares, lying between 24°06′–24°14′ N latitude and 91°34′–91°41′ E longitude [31]. Bio-ecologically, it falls under the Sylhet Hills zones as part of the Tarap Hill Reserve Forest. Annual average rainfall is approximately 4000 mm [32]. The temperature varies from a minimum of 27 °C in February to 37 °C in June on average. The humidity is high in the Wildlife Sanctuary throughout the year, with the monthly average humidity varying from 74% in March to 89% in July. A total of 36 villages are situated inside and on the periphery of the forest; all households are dependent on the forest resources [32].

Rajkandi Forest Range is situated (24°24′392″ N 91°90′582″ E) in the southeast of the Lawachara NP. It is in Kamalganj thana of the Maulvibazar district. A stream is running through the forest and some plantations occur within its boundaries. This tropical forest comprises an area of 5293 hectares, with the Dhalai River flowing through it. Numerous hillocks with water streams form part of the topography of Rajkandi. The average rainfall is about 275 cm a year, and the average humidity is 82%. The average maximum temperature is 30.7 °C during May to July, whereas the average minimum temperature is 30.7 °C during November to March. Rajkandi Forest Range is rich in floristic diversity and besides angiosperms, it is an ideal habitat for bryophytes and pteridophytes flora [30]. Fifty-two families belonging to the Khasi tribe live inside the forest, and they are entirely dependent on betel leaf cultivation inside the forest for their livelihoods.

All the four study areas are continuous with forest areas generally to the north in Bangladesh. Importantly, they are also continuous with forest in the neighboring state of Tripura in India, thus greatly reducing the level of isolation.

2.2. Survey Methods

The study covered 55 nights between April 2017 and May 2019. We used pre-established trails to record every visible nocturnal mammal from 18:00 to 23.30, only surveying during dry periods. We walked each trail once and took note of the presence of crop plantations in the transects, categorizing them into monocultures and gardens (i.e., polycultures including trees). The length of each trail varied from 1.00 km to 4.73 km, and a total of 118.9 km was covered (70.3 km of transects with only semi-natural forest, 26.9 km of transects with gardens and semi-natural forest, and 21.7 km of transects with monocultures and semi-natural forest) (Table 1). We used the reconnaissance (recce) survey method [33] in conjunction with the line transect method [34] for field surveys. A group of two to four observers walked on the trails at a speed of ~0.5–1.5 km/hour each night and searched for nocturnal mammals in the forest canopy as well as the lower forest levels and on the ground. Each observer used a 300-lumen headlamp covered with a red filter to minimize disturbance to animals [35–37]. Upon encountering a mammal, we recorded the GPS coordinates and time of detection. All detections were of single individuals.

Table 1. Total length of transects, total representation of the three habitats, and mean Human Influence Index in the four sites.

Site	Total Transect Length (km)	Monoculture with Semi-Natural Forest (km)	Semi-Natural Forest (km)	Gardens with Semi-Natural Forest (km)	Human Influence Index
Satchari	21.54	7.92	4.92	8.70	18.0
Lawachara	36.05	10.10	14.32	11.63	22.0
Rajkandi	36.86	3.64	28.74	4.48	10.2
Rema-Kalenga	24.46	0.00	22.35	2.11	14.6

Using the geographic coordinates of the transects, we extracted the Human Influence Index (HII; proxy of anthropogenic disturbance; [38]). We extracted a value from the HII for each transect considering the middlemost coordinate of the transect. The HII is a composite variable with a resolution of 30 arc seconds (~1 km) that integrates human population density, human land use and infrastructure, and human access [39].

2.3. Analysis

We ran generalized linear models to determine whether the encounter rates of nocturnal mammals were different between sites. We then ran generalized linear mixed models via the glmmTMB function to determine whether the encounter rates were dependent on the HII and the presence of plantations in the transect (dividing between gardens and monocultures). For all models, we used animal counts as a response variable (fitted to a Poisson, nbinom1, nbinom2, genpois, or compois distribution), site as a random effect, and transect length as an offset [39]. We selected the fit family and included/excluded a zero-inflated term based on model residual diagnostics using the DHARMa package. We performed the tests via R v 4.1.0 considering $p < 0.05$ as level of significance.

3. Results

We encountered seven nocturnal mammals in the four sites, i.e., Bengal slow loris (Primates: *Nycticebus bengalensis*) (n = 75), particolored flying squirrel (Rodentia: *Hylopetes alboniger*) (n = 27), common palm civet (Carnivora: *Paradoxurus hermaphroditus*) (n = 21), masked palm civet (Carnivora: *Paguma larvata*) (n = 15), large Indian civet (Carnivora: *Viverra zibetha*) (n = 12), jungle cat (Carnivora: *Felis chaus*) (n = 4), and leopard cat (Carnivora: *Prionailurus bengalensis*) (n = 2). Two of the smaller species (particolored flying squirrel and Bengal slow loris) had the highest number of encounters and two of the larger species (large Indian civet and jungle cat) had a low number of encounters. Despite these trends, there was no statistically significant relationship between body mass and encounter rate (log-transformed data, Pearson Correlation Coefficient R = −0.606, n = 7, p = 0.179). Given the low number of encounters with jungle cats and leopard cats, we excluded these species from any further analysis.

The encounter rates with Bengal slow lorises were different between sites (Wald χ^2 = 74.3, p < 0.001), with higher encounter rates in Satchari than in the other sites (Sequential Bonferroni post hoc: p < 0.001 for all comparisons) and significantly higher in Lawachara than in Rajkandi (p < 0.001) and Rema-Kalenga (p = 0.001) (Table 2). The encounter rates of common palm civets were different between sites (Wald χ^2 = 11.2, p = 0.011), with only a significant difference between Satchari and Rema-Kalenga (p = 0.008). The encounter rates of masked palm civets were different between sites (Wald χ^2 = 11.2, p < 0.001), with Satchari having higher encounter rates than Rajkandi (p = 0.045) and Rema-Kalenga (p = 0.045). The encounter rates of large Indian civets were different between sites (Wald χ^2 = 13.8, p = 0.003), with only a significant difference between Satchari and Rema-Kalenga (p = 0.011). The encounter rates of particolored flying squirrels were not different between sites (Wald χ^2 = 1.8, p = 0.627).

Table 2. Encounter rates (individuals km^{-1}; mean and standard error) of nocturnal animals in four sites in Bangladesh. The number of transects for each site is given between brackets. Superscripts indicate significant differences following Sequential Bonferroni post hoc tests.

Species	Satchari (n = 13)	Lawachara (n = 18)	Rajkandi (n = 15)	Rema-Kalenga (n = 9)
Bengal slow loris	1.53 (0.16) ^{a}	0.74 (0.11) ^{b}	0.16 (0.06) ^{c}	0.34 (0.12) ^{c}
Particolored flying squirrel	0.46 (0.14)	0.19 (0.07)	0.23 (0.09)	0.20 (0.09)
Common palm civet	0.38 (0.11) ^{a}	0.19 (0.07)	0.18 (0.08)	0.07 (0.05) ^{b}
Masked palm civet	0.33 (0.10) ^{a}	0.11 (0.07)	0.06 (0.04) ^{b}	0.05 (0.05) ^{b}
Large Indian civet	0.27 (0.12) ^{a}	0.09 (0.05)	0.10 (0.07)	0.04 (0.04) ^{b}
Jungle cat	0.04 (0.04)	0.00 (0.00)	0.05 (0.03)	0.05 (0.05)
Leopard cat	0.04 (0.04)	0.03 (0.03)	0.00 (0.00)	0.00 (0.00)

The encounter rates of Bengal slow loris were positively influenced by the Human Influence Index, meaning they were more recorded in conditions of anthropogenic disturbance (Table 3). The encounter rates of large Indian civets and particolored flying squirrels were higher in the mixed habitat category of gardens with semi-natural forests than in semi-natural forests (Figure 2). There was also a trend towards higher encounter rates of common palm civets in the mixed habitat category of gardens with semi-natural forests than in semi-natural forests.

Table 3. Results of the generalized linear mixed models with the encounter rates of nocturnal species as the response variable and habitat type and the Human Influence Index (HII) as predictors.

Response Variable	Predictor [a]	Estimate	Std. Error	Z Value	*p* Value
Bengal slow loris	Intercept	−2.71	1.12	−2.42 *	0.016
	Habitat: Garden	−0.16	0.30	−0.53	0.599
	Habitat: Monoculture	−0.02	0.31	−0.07	0.944
	HII	0.13	0.06	1.97 *	0.048
Common palm civet	Intercept	−1.93	0.77	−2.51 *	0.012
	Habitat: Garden	0.86	0.52	1.68	0.093
	Habitat: Monoculture	0.41	0.64	0.63	0.527
	HII	−0.01	0.05	−0.18	0.861
Large Indian civet	Intercept	−3.24	1.35	−2.41 *	0.016
	Habitat: Garden	2.40	0.84	2.85 **	0.004
	Habitat: Monoculture	1.23	1.05	1.17	0.241
	HII	−0.01	0.07	−0.19	0.850
Masked palm civet	Intercept	−4.45	1.84	−2.41 *	0.016
	Habitat: Garden	0.80	0.67	1.21	0.228
	Habitat: Monoculture	0.10	0.81	0.12	0.901
	HII	0.12	0.11	1.10	0.273
Particolored flying squirrel	Intercept	−1.62	0.68	−2.39 *	0.017
	Habitat: Garden	0.93	0.47	1.99 *	0.047
	Habitat: Monoculture	0.65	0.54	1.19	0.235
	HII	−0.02	0.04	−0.39	0.698

[a] reference category for habitat: semi-natural forest; garden indicates mixed garden and semi-natural forest; monoculture indicates mixed monoculture and semi-natural forest. * $p < 0.05$; ** $p < 0.01$.

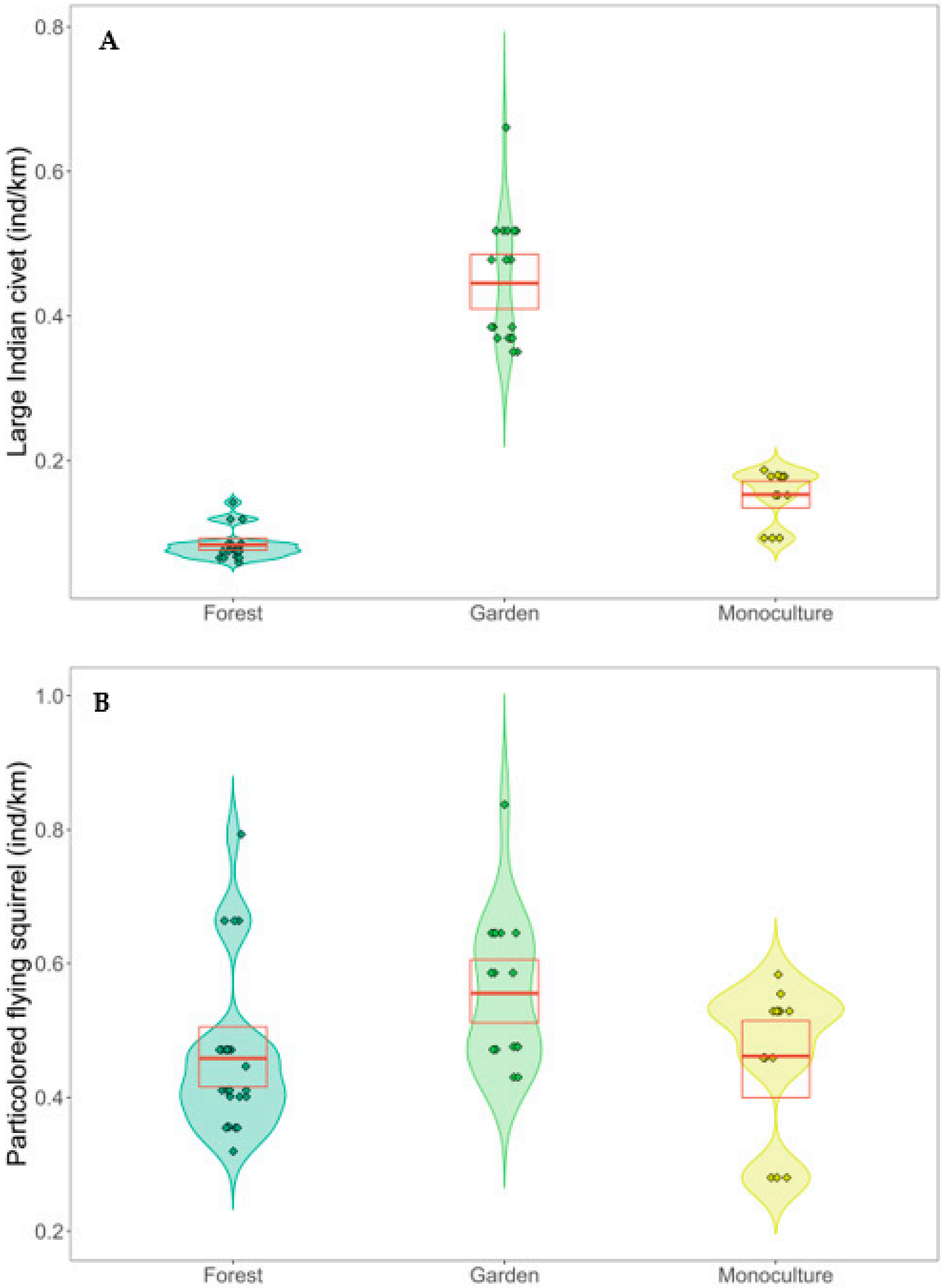

Figure 2. Significant results based on generalized linear mixed models showing the difference in encounter rates of large Indian civets (**A**) and particolored flying squirrels (**B**) between forest, gardens, and monocultures. Garden indicates mixed garden and semi-natural forest; monoculture indicates mixed monoculture and semi-natural forest. Data are predicted response values based on the model outcome; crossbars indicate means and 95% confidence intervals.

4. Discussion

We provide novel data on the presence of seven species of nocturnal mammals in Bangladesh in different habitat types. Of the seven species we encountered in our study, three of them (Bengal slow loris, large Indian civets, particolored flying squirrels) were detected more commonly in areas characterized by anthropogenic disturbance, with common palm civets also showing a trend to occur more often in such habitats. We acknowledge that the probability of detection differs to some degree in these habitats and for that reason we cannot provide a comparable estimate of abundance. Furthermore, variation between habitats in detectability can dwarf the effects of variation in animal density on encounter rates. Still, we felt that our search effort provided an appropriate description of the presence of the various taxa, and our subsequent research efforts in these areas has further strengthened these initial observations. The masked palm civet showed no difference in encounter rates, and the two wild cats were not seen frequently enough to assess their variation in encounter rates. Several researchers have reported on the occurrence and status of mammals in Bangladesh [40–44], but most of the focus is on the larger, often diurnal species, and surprisingly little information is available on the country's smaller, nocturnal mammals. These studies also focus on the interiors of national parks, where tall secondary growth forest might not provide a suitable habitat for these species (but need to consider that visibility and thus the probability of detection in natural forests is lower than in plantations and agroforestry systems [45]). For instance, Gittins and Akonda [41] walked 450 km (the total distance walked in diurnal vs. nocturnal transects is not specified) of transects in 21 forest areas throughout Bangladesh and did not encounter a single slow loris, and at only one site did they record a civet (species not specified). Likewise, Aziz [44] surveyed Lawachara National Park over a two-year period (total distance walked is not specified) and reported direct observations of masked and common palm civets, and the only evidence of the presence of slow lorises and large Indian civets came from interviews with people from local communities. Nocturnal species, however, are often not the focus of studies and interpretation of the few/no records found has been cursory.

The encounter rate for Bengal slow lorises was between 0.16 and 1.53 individuals km^{-1}, with an overall encounter rate of 0.63 individuals km^{-1} (75 encounters along 119 km of transects). This was comparable to a study on Javan slow lorises, *N. javanicus* (0.40 individuals km^{-1}) and greater slow lorises, *N. coucang* (0.66 to 0.74 individuals km^{-1}), but higher than other studies on Bengal slow lorises (0.10 to 0.13 individuals km^{-1}), Philippine slow lorises, *N. menagensis* (0.12 individuals km^{-1}) and pygmy lorises, *Xanthonycticebus pygmaeus* (0.05 to 0.08 individuals km^{-1}) [46,47]. Slow lorises are threatened throughout their habitat, used as pets and for traditional medicines, as well as subject to electrocutions, road kills, and inappropriate translocations, and these occurrences are also carried out in Bangladesh [48–50]. Al-Razi and Maria [36] reported on the particolored flying squirrel from the same general area but for a shorter sampling period, where they encountered them at a higher rate in Satchari National Park (0.60/km) but at a lower rate in Rajkandi Forest Range (0.13/km). In India, particolored flying squirrels have been recorded as present, but no abundance has been given [49,51,52]. Both studies report the hunting and ritual killing of this species as threats, and report that local communities see them rarely.

The large Indian civet and the particolored flying squirrel were all at higher encounter rates in transects with the presence of gardens than in transects with only natural forest. These edge habitats, in fact, usually have a high abundance of insects and small pests that are included in the diet of these animals [53,54]. Civets and the particolored flying squirrel can be also attracted by the presence of fruits (including seeds) from trees. The Bengal slow loris had an increase in encounter rates in areas of higher anthropogenic disturbance, indicating the adaptation of this species to human-modified habitats [50]. Other previous studies found slow lorises more in agroforestry areas than in natural forests (Table 4). Jungle cats were only found in transects with natural forests at similar encounter rates to other natural forests (Table 3), while leopard cats were found in transects with gardens in our field site, although they were found in natural forests elsewhere [55,56]. Based on our limited data we cannot draw conclusions on habitat preference of wild cats but hope an understanding of their presence can influence further studies.

Table 4. Encounter rates of the species surveyed in Bangladesh and comparison with other sites where the species is present. This table is for general comparison only since variance at each site is unknown or not comparable.

Species	Encounter Rate	Location	Habitat Type	References
Bengal Slow Loris	0.04–0.10	Meghalaya, India	Forest	[57]
	0.05–0.33	Assam, India	Forest	[58,59]
	0.20–0.26	Arunachal Pradesh, India	Forest	[59,60]
	0.04–0.65	Central Laos	Forest	[61,62]
	0.40–0.87	South Laos	Forest	[62]
	0.34	Thailand	Forest	[63]
	0.45–1.02	Thailand	Garden	[63]
	0.38–0.50	Cambodia	Forest	[64]
	0.47	Bangladesh	Forest	This study
	0.78	Bangladesh	Garden	This study
	0.97	Bangladesh	Monoculture	This study
Common palm civet	0.35–0.39	Cambodia	Forest	[55]
	0.34	Java, Indonesia	Forest	[54]
	0.18	Java, Indonesia	Garden	[54]
	0.20	Arunachal Pradesh, India	Forest	[56]
	0.00–0.10	Karnakata, India	Forest	[65]
	0.13	Bangladesh	Forest	This study
	0.30	Bangladesh	Garden	This study
	0.18	Bangladesh	Monoculture	This study
Masked Palm Civet	0.20	Arunachal Pradesh, India	Forest	[56]
	0.07	Bangladesh	Forest	This study
	0.26	Bangladesh	Garden	This study
	0.14	Bangladesh	Monoculture	This study
Large Indian Civet	0.03	Bangladesh	Forest	This study
	0.30	Bangladesh	Garden	This study
	0.09	Bangladesh	Monoculture	This study
Jungle cat	0.00–0.05	Karnakata, India	Forest	[65]
	0.03	Jammu and Kashmir, India	Forest	[66]
	0.06	Bangladesh	Forest	This study
	0.00	Bangladesh	Garden	This study
	0.00	Bangladesh	Monoculture	This study
Leopard cat	0.00–0.07	Karnataka, India	Forest	[65,67]
	0.00	Bangladesh	Forest	This study
	0.07	Bangladesh	Garden	This study
	0.00	Bangladesh	Monoculture	This study

Increasingly, data as we have shown here are recorded by camera traps, including innovative arboreal camera trapping [65,66]. We would like to point out however that in low-income countries such as Bangladesh, where access to funds for camera traps, climbing equipment, and climbing safety courses are low to non-existent, line transect surveys remain a vital field method to provide data for the conservation of little-known species such as those reported here. Camera traps are even more commonly used for small carnivores (e.g., [67–71]), while estimates via line transects are becoming rare. Jennings et al. [72] confirmed via camera traps the presence of common palm civets and leopard cats in palm oil plantations in Sumatra, Indonesia. Bali et al. [73] reported the presence of 28 mammal species in coffee plantations in India, including the common palm civet, jungle cat, and leopard cat. Azhar et al. [74] reported the presence of 20 mammal species, including leopard cats and civets, in palm oil plantations via interviews with farmers and kills in palm oil plantations in Malaysia. Common palm civets have been reported in plantations also in other studies (e.g., [17,53]). It is thus possible that agroforestry environments may also play an increasingly important role for small carnivores in Bangladesh as well, and future studies should not exclude these habitats.

Gaston [75] noted that far from being a minor component of biodiversity, a high proportion of animal species, and especially mammals, are active at night, and that fundamental questions about differences and connections between the ecology of the daytime and the nighttime remain largely unanswered. He noted that already some 70 years ago the importance of studying nighttime ecology was recognized [76], but that it had failed to materialize. Gaston [75] listed several possible reasons for this, including (1) the fact that humans themselves are diurnal and therefore found it easier to focus on this part of the day; (2) it is a misunderstanding that in most ecosystems diurnal species are ecologically more important; and (3) the technological challenges of studying animals and plants during the night, including the possible adverse effect of using artificial light at night. We note that these misconceptions and challenges are even greater in tropical forest environments as problems of access, stable electricity (to charge batteries for instance), safety (large mammals, dangerous terrain), and lack of baseline knowledge of the animals are even more prevalent at night compared to during the day. As indicated by Gaston [75], now is a perfect time to revisit the nocturnal components of biodiversity. Recent research has shown that rather than nocturnality being the exception in many animal taxa, it is either the norm or is at least as common as diurnality. Hölker et al. [77] estimated that ~30% of all vertebrates are nocturnal, but this is significantly higher in mammals (~60%).

5. Conclusions

Bangladesh is currently facing one of the highest levels of deforestation in Asia [78]. With its rich biodiversity and importance as a country connecting the Indo-Himalayan and Indo-Chinese subregions, finding approaches that can reduce biodiversity loss whilst promoting the survival of a growing population are vital [26,78]. Currently in Bangladesh, large-bodied species remain the most studied and are typically at the heart of decision making regarding protected area management, with agroforestry systems less subject to any kind of conservation management [79]. With the decline of these species, considering the habitat needs, including the capacity for agroforestry systems as a viable habitat, for smaller but ecologically important species is becoming vital [80]. Furthermore, with a growing human population, understanding the importance of agroforestry systems as an integral part or as a buffer to protected areas, which can serve a vital function to both humans and animal communities, is more urgent than ever before [26]. Our short study shows the potential importance of such systems for seven small but charismatic species of seven mammalian orders that are largely data-deficient. When surveys are conducted in areas that are small relative to the range requirements of the species that are surveyed, context on the surrounding matrix habitat is important in understanding what is there, why it might be there, and what might be needed for it to persist. By providing these baseline data, we encourage further detailed studies, including abundance studies using detection probabilities, of nocturnal mammals. We also encourage longitudinal studies of the species currently relying on agroforestry systems to understand the role such habitats might play in the future of Bangladesh's threatened wildlife.

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