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Temporal Variation in the Activity of Echolocating Bat Community in Amurum Reserve North Central Nigeria

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ABSTRACT

The effect of temporal variation on activity of the echolocating bat community was determined in four habitat types in and around Amurum Forest Reserve: (i) gallery forest, (ii) savannah, (iii) rocky outcrop, and (iv) farmland. Using transect-based acoustic surveys in the various habitats, bat activity was estimated based on the recorded number of bat passes per minute of echolocation recordings from the field survey grouped into hours after dusk (19:00-23:00) and hours before dawn (02:00-06:00). Bat activity was significantly higher in hours after sunset than hours before sunrise. Activities did not vary significantly in the farmland between hours after sunset and hours before sunrise. In the gallery forest both times of the night had significant impact on bat activity, while in savannah and rocky outcrop habitats only hours after sunset did have significant effect on bat activity. The farmland showed a different trend by hours before sunset having a significant impact on bat activity. Echolocating bat communities in Amurum Reserve are more active during the hours after sunset than hours before sunrise. We recommend hours after sunset as more suitable period for surveying echolocating bat species through acoustic methods. The managements of reserves may do well in avoiding human activities in the protected areas during hours after sunset for maximum performance of the echolocating bat communities in the reserves.

Keywords: bat community, echolocation, Amurum Reserve, temporal variation, bat activity

Introduction

Bats constitute 20% of all known mammalian species [1]. They provide outstanding ecosystem services due to the ample trophic niches they occupy. Typical ecosystem services they provide include seed dispersal, pollination and insect pest control among many other roles they play which contribute immensely to the sustainability and stability of the ecosystem. Additionally, bats also provide information on the status of the environment as bioindicators [2], as they respond noticeably to human alteration of the habitats where they occur. Bat species differ considerably in their forage flight timing and the information on the foraging time of wildlife is vital for the conservation and management planning [3]. This is considered to be mediated by the availability of the different categories of insect preys in space and time [4]. The significance for bat survey need not to be over emphasized as they provide quality information required for the determination of conservation and development plans for protected areas [5].

The aim of this research was to assess the temporal variation in echolocating bat species activities in Amurum Reserve, north central Nigeria. This study specifically tested the effects of time of night on bat activity across the habitats. The null hypothesis was that time of night does not affect bat activity across the four habitat types. We predicted that bat activity will be higher within hours after sunset relative to hours before sunrise. The selected site for the present study provided a suitable habitat landscape of four different types at high altitude typical of Jos Plateau. This study provides insight into the variation in activities of echolocating bat communities in Amurum at a spatiotemporal scale.

Material and method

The study was carried out in Amurum Forest Reserve (9°53'N, 8°59'E), comprised of patches of gallery forest, scrub savannah, grassland and rocky outcrops habitat types (Figure 1). A detailed description of the reserve can be found in [6]. These habitat types host such plant species as *Parkia biglobosa*, *Acacia seyal*, *Dichrostachis cinerea*, *Anogeissus leiocarpus*, *Albizia lebbeck*, and *Khaya senegalensis* and many more [7]. The agricultural practice in the surrounding farmlands were dominantly monoculture and less of polyculture. Some the crops cultivated in these farmlands were *Cucumis sativus*, *Citrullus lanatus*, *Arachis hypogaea*, *Zea mays*, *Abelmoschus esculentus* and *Manihot esculenta*.

We recorded the echolocations of the bat community using an Anabat II bat detector (Titley Electronics, Ballina, New South Wales, Australia), linked to the Anabat ZCAIM (zero crossings analysis interface module) to store the recordings on the Compact Flash card. Transect-based acoustic surveys were used to record bat activity in the various habitats by actively walking along the transect at the pace of 0.27m/s with the detector tilted at 45^{o} and adjusted to its maximum usable sensitivity and its division ratio set to 8 for field recordings. The surveys were partitioned into two survey periods: hours after dusk (19:00-23:00) and hours before dawn (02:00-06:00) to determine temporal variation in habitat use.

The stored data on the compact flash (CF) card were read into a personal computer using CFCread software. The CF card was erased prior to every survey period. Call files were identified with date and locality information before been stored in the hard drive of a computer. Bat calls were visualized in frequency vs time graph for analysis using AnalookW software. Generalized linear model (GLM) with a Poisson error distribution was used to analyse the relationships between bat activity and habitat types and time of the night. Poisson error distribution was chosen as we estimated bat activity by counting bat passes recorded per minute during the survey. We corrected for over-dispersion using the *quasipoisson* function.

Results

The temporal variation in bat activity was significant (glm, $F = 4416.865$, $df=1$, $p<0.00001$; Table 1; Figure 1) with high activity at hours after dusk (65%, 15,285) relative to hours before dawn (35%, 8,258). High level of significance in the interaction term between habitat types and time of the night ($F = 30.282$, $df=3$, $p<0.0001$; Tables 1) reveals that temporal variation in bat activity depends on the habitat types (Figure 2). This is such that bat activity does not vary equally on temporal scale across the different habitat types.

Discussion

Bats were most active in the few hours after dusk, and less active in the hours before dawn (Figure 2). Reference [8] also reported that activity varied markedly temporally as activity peaked between 6 and 7 h post-sunset and decreased gradually up to dawn. This may be attributed to insect abundance being higher at hours after dusk relative to hours before dawn [9], as bats have been observed to be opportunistic foragers [10]. The unequal temporal variation in bat activity across the habitat types may be attributed to the variation in insect activity across the habitat types (Figure 3). This implies that changes in environmental factors may not affect bat activity at the same degree across habitat types. The farmland showing a slightly different trend in the temporal pattern of bat activity from other habitats may be due to the impact of human activity on the farmland. There were roads linking communities across the farms of which taking into consideration the noise generated by vehicles, human voices and light from vehicle head lamps being relatively higher during the hours after dusk than hours before dawn, may have influenced the activities of the echolocating bat community in the farmlands.

This study therefore quantified the effect of time of night on bat activity in different habitat types; it rejected the hypothesis that bat activity was not affected by time of the night; and it supported the prediction that bat activity would be higher within hours after sunset relative to hours before sunrise.

Conclusion

Echolocating bat communities in Amurum prefer hours after dusk to hours before dawn for their activities. This pattern being consistent across habitat types in the Amurum Reserve provides insight into

the positive impact of protection of the habitats within the reserve. We therefor recommend hours after dusk as the most appropriate time for survey of echolocating bat species as greater bat activity will be recorded relative to hours before dawn. This also encourages the reserve management to desist from higher human activities within the reserve at hours after dusk as this may interfere with optimal activities of the bat communities in the reserve.

Research Ethics:
The study was designed, approved and supervised by The A. P. Leventis Ornithological Research Institute (APLORI), Laminga.

Animal ethics:
This section does not apply to our study as no animal was handled during the study.

Permission to carry out fieldwork:
Permission for the study was approved by The A. P. Leventis Ornithological Research Institute, Laminga. Amurum Reserve is under the management of APLORI.

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(Figures & Tables)

Figure 1: Map of Amurum Forest Reserve showing distribution of major habitat types.

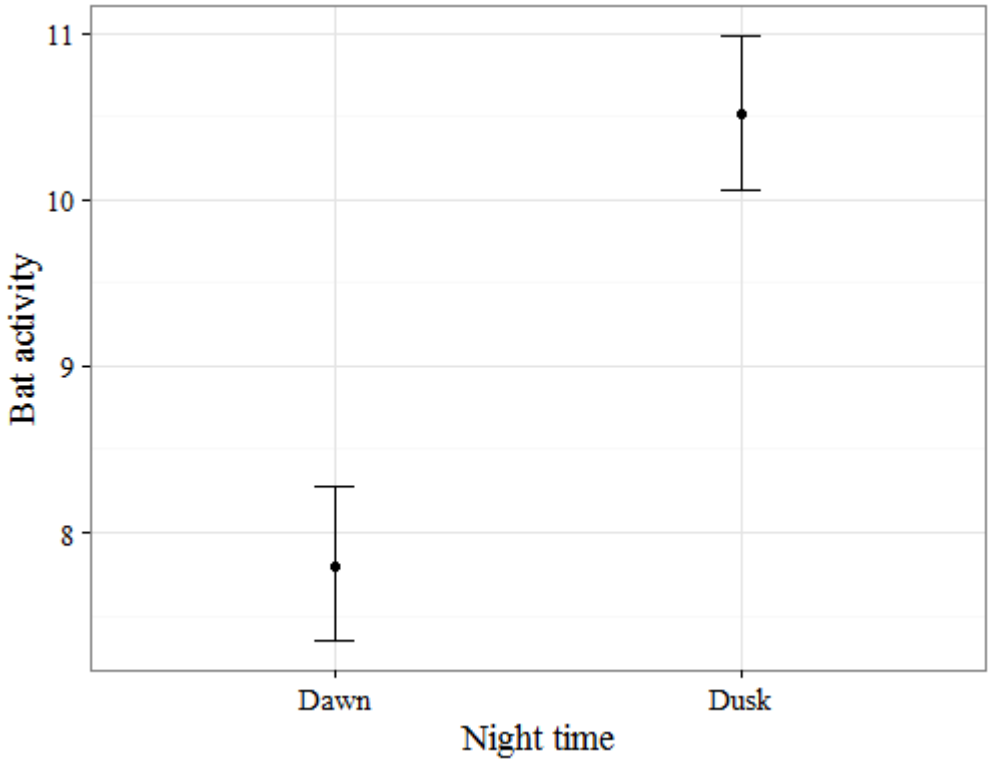

Figure 2: Effect of time of night on bat activity (mean ± 95% Confidence Intervals)

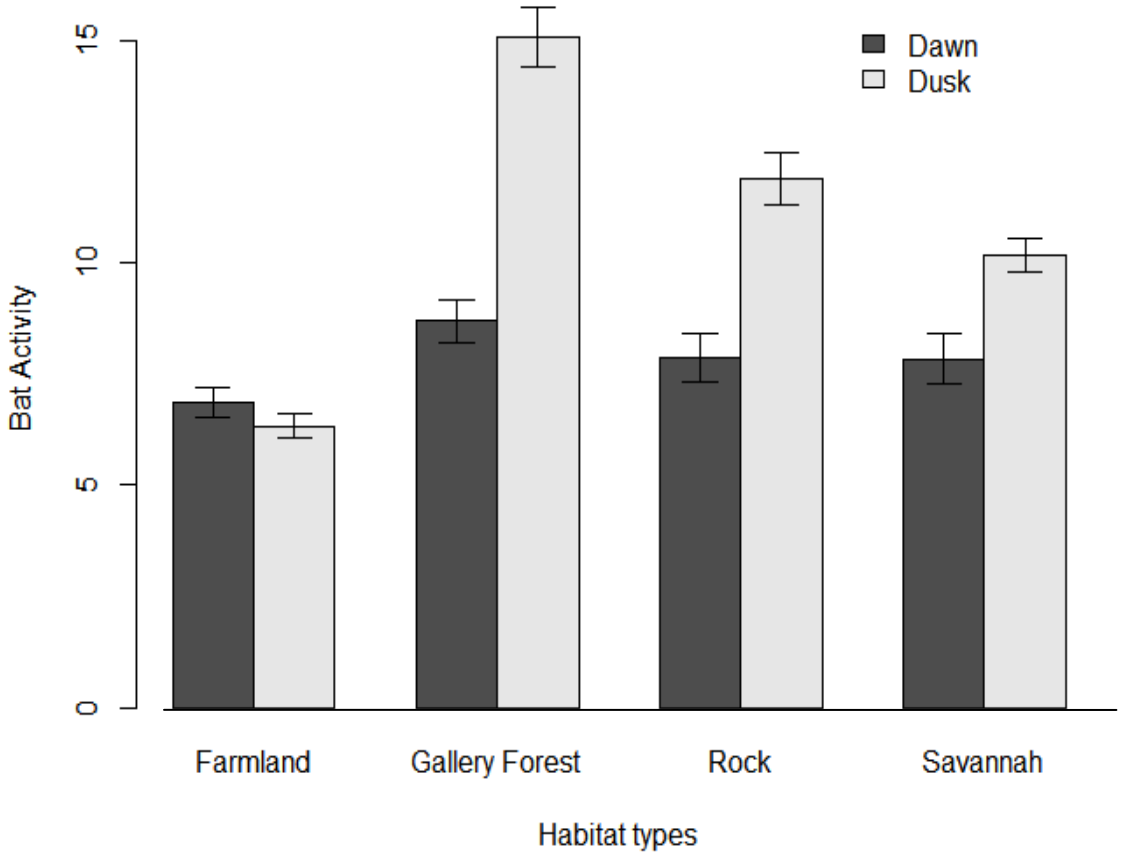

Figure 3: Temporal variation in bat activity (mean number of bat passes ± 95% confidence interval) across four habitat types.

Table 1: The relationship between bat activity and explanatory variables of bat species in Amurum Forest Reserve and its surrounding habitats.

Coefficients	**Estimate**	**Std. Error**	**t value**	**Pr(>|t|)**
Night.time(Dawn)	1.9238	0.0599	32.118	< **0.00001**
Night.time(Dusk)	1.84407	0.05633	32.736	< **0.00001**
Night.time(Dawn):Habitat(Gallery Forest)	0.23936	0.08082	2.962	**0.00309**
Night.time(Dusk):Habitat(Gallery Forest)	0.86849	0.06989	12.426	< **0.00001**
Night.time(Dawn):Habitat(Rock)	0.13828	0.08548	1.618	0.10584
Night.time(Dusk):Habitat(Rock)	0.63205	0.07186	8.796	< **0.00001**
Night.time(Dawn):Habitat(Savannah)	0.13531	0.08655	1.563	0.11811
Night.time(Dusk):Habitat(Savannah)	0.47453	0.06762	7.018	< **0.00001**
Night.time(Dawn):Habitat(Farmland)	6.8469	0.3235	21.168	< **0.00001**
Night.time(Dusk):Habitat(Farmland)	-0.5247	0.4284	-1.225	0.221

Significant p values in **bold**.

*glm(formula = Bat_Passes ~ 0 + Night.time + Night.time:Habitat, family = quasipoisson, data = Batact)