

## Microhabitat Preference Use and Colony Size of Three Co-existing Species of Microbats in Kut Kai Areas

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### ABSTRACT

The study was conducted at two caves, namely La Gang and Yin Ngaw caves from November 2008 to December 2009. Three species of microbats, *Ia io*, *Hipposideros armiger* and *Aselliscus stoliczkanus* co-exist in the La Gang Cave. Abrupt fall in the number of *I. io* in January 2009, while no single bat in December 2009 were encountered. Other species thrive well up till November, 2009.

The preference index D calculated for *I. io* indicated negative values for all the environmental factors, such as height of roosting site, distance from the entrance, temperature and humidity of roost places. *Hipposideros armiger* and *A. stoliczkanus* showed positive attitude towards all the factors considered.

In Yi Ngaw Cave, only two *I. io* was recorded, however not a single bat was found again during the remaining months of the study period. A small group of *H. armiger* was first encountered only in June 2009. Then increased number in September 2009, and not a single bat was found in December, 2009. *Hipposideros armiger* and *A. stoliczkanus* appeared to have propagated during the rainy season.

Shift in roost places had been recorded and it was found that humidity factor mainly played an important role in roost shift especially in *H. armiger*.

### INTRODUCTION

Bats are the only group of vertebrates that have successfully explored caves for permanent shelter. Most families and genera of bats include species that regularly or occasionally seek refuge in caves. Roost is one of the essential elements for the survival of bats because they need a place to rest and seek protection from predators (Neuweiler, 2000). In the world, almost 1000 species of bats are known to be cave-dwelling species either in limestone or in other rocks. About 70 species of insectivores and three species of frugivores are known or expected to roost in caves of Myanmar (Bates and Harrison, 1997). Roosting habits therefore play a major role in the ecology and evolution of bats (Kunz, 1982). Thus morphological, physiological and behavioural characteristics of bats are commonly regarded as adaptations for roosting. Bat may use different roosts according to different requirements for environmental conditions in different seasons, and that many factors such as microclimate, structural characteristics of the roost, such as presence of stalactites, cavities and other features of cave architecture, surrounding habitat, disturbance by human and risk of predation may influence roost selection by bats (Brigham and Fenton, 1986). Although, Myanmar is rich in living natural assets including the bat fauna there is a general decline in the population of bats owing to a number of reasons, including disturbance and loss of roosting habitats and feeding grounds, partly due to human encroachments.

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Kut Kai area has richness of limestone caves and some of these form the roosting habitats of a number of bats. As there is no previous record on the diversity and distribution of bat species from this area, the study on this aspect was undertaken and at present some bat species confined to two caves in the vicinity of the study area were studied to ascertain their micro-habitats and roost selection.

Hence the objectives of this study are

- to describe the cave structure related to location of studied bat species
- to work out their spatial and temporal distribution
- to determine the population size and habitat use of each species with respect to some parameters

### MATERIALS AND METHODS

The study was conducted from November, 2008 to December 2009. The two caves, La Gang Cave and Yi Ngaw Cave are situated about 12.8 km distance from Kut Kai, Northern Shan State. Kut Kai is located in between 99° 35'E and 98° 15' E and between 23° 15'N and 24° 35'N at 1349.95m above sea level. Caves were explored during daylight hours, Care was always taken to minimize disturbance in order to determine roost site selection. Population size estimates were made by direct count, using a manual tally counter. Bats were captured by means of a hand net and identified immediately in the field, from external characters following after Lekagul and McNeely (1977) and Bates and Harrison (1997). Microclimatic conditions were recorded by thermohygrometer during the survey trips. Determination of habitat use was evaluated only on the data collected from La Gang Cave, since complete data was collected, relevant for determining the habitat use.

Habitat use was their assessed by using Jacob's preference index D as given in Kasprzykowski (2003) and Sutherland (2004).

$$D = \frac{r - p}{r + p - 2rp}$$

Where r is the proportion use of a habitat by number of individuals of the study species, p is the proportion in the environment, which included data on the height of roof where the study species roosted, and the data on the roost distance from the entrance, the temperature and the percentage in humidity recorded. Both r and p thus have values between '0' and '1' while D has values between -1 (always ignored) and +1 (restricted to that habitat).

## OBSERVATIONS AND RESULTS

### Layout of La Gang Cave

La Gang cave is very long cave, running in East-West direction. The cave mouth in the East, is regarded as entrance and the further end in the west, is taken as the exit. The cave is and consisted of three elongated chambers, each connected by a short narrow channel. The first chamber is widest and approximately 32m in length and consist of two portions, the one that is adjacent to the entrance is somewhat narrower and shorter (13.1m) and the second portion that followed is larger and longer (19.0m) than the first. This chamber leads into a much narrower and more elongated second chamber through a short narrow channel. The first portion near the connecting channel is narrower, however become wider, with the two side walls almost parallel, until it becomes narrow again to form the inter connecting channel that than lead into the third chamber. This chamber appeared to be more narrower and much more elongated (65.3m) compared to the second one. From the east wall of the leading channel, a blind cavern is given off, having a length of 3.05m and a breadth of 5.5m.

### Microhabitat Selection and Colony Size of Studied Species

The first trip to La Gang cave was taken on (11.11.2008), a colony of 70 bats assumed to be composed of *Ia io* and *Hipposideros armiger*, were encountered. The colony was roosted on the wall at the height of 7.6 and 23.5 m away from the entrance. The bats were observed either in propped up or free hanging position. In addition, *Aselliscus stoliczkanus*, numbering 10 individuals were also for in the crevices in the roof approximately 3 high and 13m away from the entrance of the cave (Table 1). On second trip (1.1.2009), only three individuals of *I. io* were found roosted in the state of topper on the wall at the height of 6 and 32m from the cave entrance. During the same trip, 20 individuals of *A.stoliczkanus* were also encountered, between 6.1 and 15.2m from the cave entrance and roosted in the crevices 3m high. Not a single *H.armiger* was encountered during this trip (Table 1). On (13.4.2009) a third trip four *I. io* were encountered on the roof 15m high and was found roosted singly between 21 and 32m away from the cave entrance in free hanging position. *Aselliscu stoliczkanus* was found to be roosted in the same place, as encountered during the second trip. During this trip, a single *H. armiger* was encountered roosted on the wall at the height of 9.14 and 18.28 m away from the cave entrance (Table 1). A fourth trip was taken on (15.6.2009), three *I. io* were encountered roosted in free hanging position at the height of 3.7 and 36.6m away from the cave entrance. *Aselliscus stoliczkanus*, approximately 30 in number were found roosted in a highly dispersed manner along the roof which ranged in height from 2.4 to 15.2m that stretched 6 to 66.4m away from the entrance. On this trip a colony of 22 *H. armiger* was also recorded roosted in propped up position on the roof 15m high and 30.5m away from the cave entrance (Table 2). The fifth trip was taken on (15.8.2009), during which, two individuals of *I. io* were observed to be roosted in a free hanging manner on the wall,

at the height of 5.5 and 77.4m away from the cave entrance. *Aselliscus stoliczkanus* approximately 38 in number were found roosted in crevices along the 6m high roof; situated between 13 to 61m away from the cave entrance. During this trip, a large colony of 160 *H. armiger* were encountered in propped up position on the roof which ranged in height of 12 to 15m and 160m from the entrance of the cave, a place which is near to the cave exit at the other end (Table 2). The sixth trip in September (10.9.2009) only three *I. io* were encountered, free hanging on the wall at the height of 4.5 and 51.8m from the cave entrance, while *A.stoliczkanus* was found approximately in the same place as encountered a month before. Similarly, *H.armiger* remained almost in the same place. However, the colony seemed to have increased since the number counted was approximated to 183 individuals.

### **Layout of Yi Ngaw Cave**

This is peculiar shaped cave, located 11.9 km, north of Kut Kai and is situated close to an orange orchard. Somewhat resemble an Chinese artichoke (Chinese bean Pepodi). It runs from south to north and 31.3 m long. The cave mouth is situated to the east and regarded as the entrance. This lead into the very long first chamber, running 17 m south-west and 10 m, north-south. There is also a cave on the far western end of this chamber, however, this cave mouth is now totally blocked by cave-in, so that no entry or exit could be taken. Occupying a place adjacent to this end is an elevated miniature hillock-like structure which partly obscured the blocked eastern cave mouth. The height of the roof in this section ranged from 7.62 to 12.19 m. In the midsection of the northern part of this cave is elevated and lead into the second chamber which is much smaller than the first. It is somewhat square shaped, running 6 m south to north and the same length east west. The roof is approximately 5.18 m high. This lead into a smaller third section, a chamber running 4.8 m south to north and approximately 6 m, east to west. The roof in this section is only 1.82 to 2.74 m high. The last section of the cave is narrow and elongated and composed of three small chambers, somewhat in a beaded manner. The fifth section of this cave has the approximate length and breadth of the third section and opens through the cave mouth at the far northern end.

### **Microhabitat Selection and Colony Size of Studied Species**

The first trip to Yi Ngaw cave was taken on the 15.11.2008. Only two *I. io* were roosted in free hanging manner in the second section of the cave 15 m away from the entrance. The two were found roosted in the roof 5.18 m high, adjacent to the eastern wall of this cave. Not a single bat was found again during the second trip, On the 3.1.2009, so also the result was the same during the third trip, taken on 14.4.2009 (Table 3). During the fourth trip taken on the 16.6.2009, a small colony of approximately 23 individuals of *H. armiger* were found roosted at a height of approximately 7.62m in the roof and situated 8 m away from the cave entrance. The individual bats were spaced and roosted in propped up position. Similarly during the

fifth trip and sixth trip taken on the 15.8.2009 and 10.9.2009, the same colony was encountered again, however not a single *I. io* was found again since their first encounter during the first trip in November, 2008 (Table 4). During the December trip not a single bat was encountered again in the whole cave.

Determination of habitat (microhabitat) use by the respective species of bat under study revealed that, the result of preference index D calculated for *I. io* indicated negative values for all the environmental factors, such as height of roost places, distance from the entrance, and the temperature and humidity of roost places. On the other hand, *H. armiger*, showed positive attitude towards all the factors considered. Similarly, *A.stoliczkanus* revealed positive results towards microhabitat use. (Table 5, Fig.1).

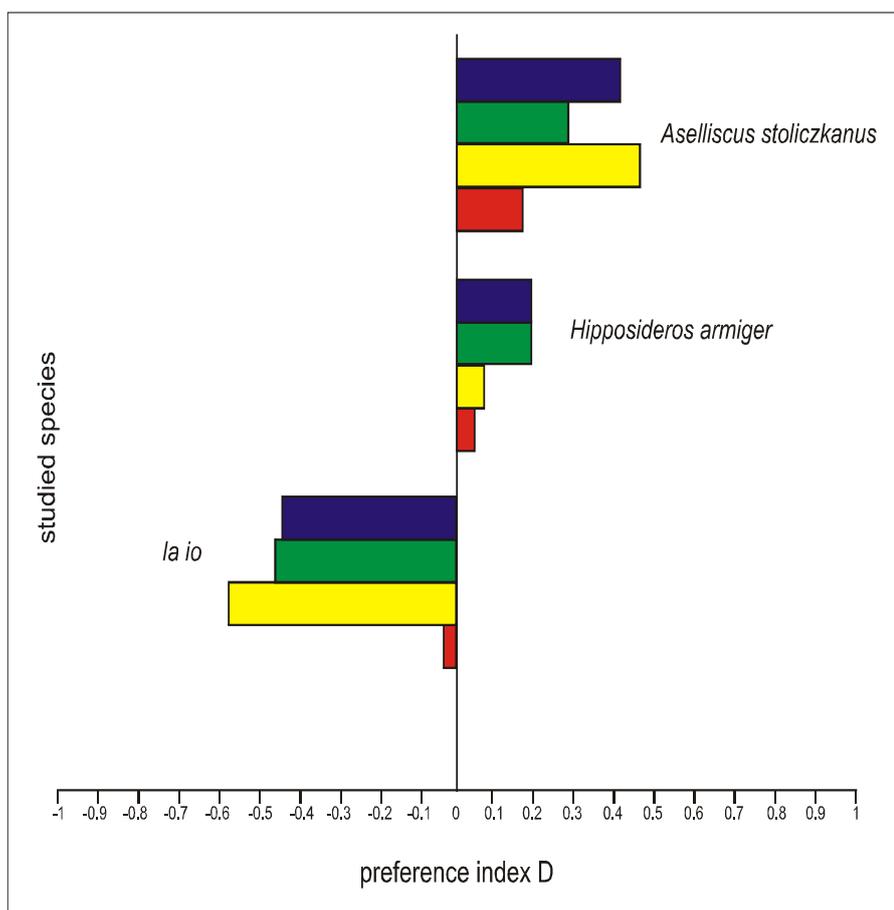


**Table 4 Colony size of studied bat species with respective parameters in Yi Ngaw Cave during 4<sup>th</sup>, 5<sup>th</sup> and 6<sup>th</sup> Trips**

| Species                     | 4 <sup>th</sup> Trip (16.6.2009) |              |        |           |            | 5 <sup>th</sup> Trip (15.8.2009) |              |        |           |            | 6 <sup>th</sup> Trip (10.9.2009) |              |        |           |            |
|-----------------------------|----------------------------------|--------------|--------|-----------|------------|----------------------------------|--------------|--------|-----------|------------|----------------------------------|--------------|--------|-----------|------------|
|                             | Height (m)                       | Distance (m) | Number | Tem: (°C) | Humid: (%) | Height (m)                       | Distance (m) | Number | Tem: (°C) | Humid: (%) | Height (m)                       | Distance (m) | Number | Tem: (°C) | Humid: (%) |
| <i>Ia io</i>                | -                                | -            | -      | -         | -          | -                                | -            | -      | -         | -          | -                                | -            | -      | -         | 57.8       |
| <i>Hipposideras armiger</i> | 7.62                             | 8            | 23     | 24.0      | 81.3       | 7.62                             | 8            | 28     | 24.6      | 69.3       | 7.62                             | 8            | 33     | 21.2      | 96.0       |

**Table 5 Preference index of three studied species with respect to recorded parametric and environmental factors**

| Species                        | Height |       |       |     |       |      | Distance |       |      |      |       |       | Temperature |      |      |      |       |      | Humidity |      |      |      |      |      |
|--------------------------------|--------|-------|-------|-----|-------|------|----------|-------|------|------|-------|-------|-------------|------|------|------|-------|------|----------|------|------|------|------|------|
|                                | 1      | 2     | 3     | 4   | 5     | 6    | 1        | 2     | 3    | 4    | 5     | 6     | 1           | 2    | 3    | 4    | 5     | 6    | 1        | 2    | 3    | 4    | 5    | 6    |
| <i>Ia io</i>                   | 0.73   | -0.86 | -0.76 | -   | 0.5   | 0.82 | 0.8      | -0.95 | -    | -0.7 | -0.97 | -0.95 | 0.8         | -0.6 | -0.6 | -0.6 | -0.95 | -0.9 | 0.8      | -0.6 | -0.5 | -0.6 | -0.9 | -0.9 |
|                                |        |       |       | 0.5 |       |      |          |       |      | 0.8  |       |       |             |      |      |      |       |      |          |      |      |      |      |      |
| <i>Hipposideros armiger</i>    | -      | -     | -0.9  | 0.4 | 0.3   | 0.45 | -        | -     | -0.9 | 0.13 | 0.6   | 0.5   | -           | -    | -0.9 | 0.13 | -0.8  | 0.76 | -        | -    | -0.9 | 0.13 | 0.76 | 0.8  |
| <i>Aselliscus stoliczkanus</i> | -0.75  | 0.85  | 0.92  | -   | -0.32 | 0.9  | -0.58    | 0.9   | 0.9  | 0.52 | 0.2   | 0.9   | -0.74       | 0.73 | 0.84 | 0.4  | -0.4  | 0.89 | -0.74    | 0.72 | 0.84 | 0.39 | 0.37 | 0.89 |
|                                |        |       |       | 0.5 |       |      |          |       |      |      |       |       |             |      |      |      |       |      |          |      |      |      |      |      |



- Height
- Distance
- Temperature
- Humidity

Fig. 1 Preference index of three studied species with respect to recorded parametric

## DISCUSSION

Survey were done on 37 limestone caves situated around Kut Kai area, commenced from November 2008 till December 2009. Only two caves, La Gaung and Yi Ngaw Caves were chosen for detailed study since they are quite readily accessible and convenient to conduct the study. During the study period, the caves were visited seven times. The shift from one roosting place to another was recorded at each trip, so also the temperature and humidity at the respective places of roost were recorded for evaluation as to the microhabitat and roost selection of the different species.

**La Gang Cave** Three microbat species, namely *Ia io*, *Hipposideros armiger*, and *Aselliscus stoliczkanus* co-existed in this cave. With respect to *Ia io* it was rather surprising to find an abrupt fall in the number from 70 to only 3 individuals of this bat during the second visit in January 2009. Information gathered revealed that, some people go after these bats, because of their large size and easy harvesting, since this species has the nature of staying calm to human approach and especially went into torpor when the temperature falls. Thus it is envisaged that these bats appeared to have become the victims of human onslaught. This may be one of the reasons why only 3 specimens were encountered up till the 6<sup>th</sup> trip and in December 2009, not a single individual was found in the cave. With respect to the shift in roosting places from the place near the main entrance toward the more northern (inner) part of the cave appeared to have been caused by human transgression (Table 1 and 2)

*Hipposideros armiger* was not encountered during the first and second trips, a single specimen was encountered during the third visit in April 2009. The bat was found to be roosted at the distance of 18.28 m from the eastern main entrance. The number rose to 22 individuals in June and was found to have changed their roost place, since they were found in a place 30.5m away from the main entrance. By August 2008 the colony have grown to 160 individuals and have shifted to a place deeper into the cave (103.6m) towards the more western part of the cave. The individuals in the colony rose to 183 in September and occupied the same roosting place. This species is rather aggressive and very active, so that even the sounds of human encroachment make them flee from the places of roost. This makes them rather difficult to catch and pursue. Aye Aye Khaing (2007) disclosed that this species roosted in an active manner as some bats often fly within the cave and respond immediately to disturbance.

The number of bats was recorded to rise month by month. However, it is rather surprising to observe that, the number arose abruptly from 22 individuals in June to 160 in August. The additional specimens might be new arrivals from other places. Food supply during lactation and weaning is the single most important factor in timing of reproductive cycle on bats from both temperate and tropical regions, young are produced at a time when the rainfall is highest and food supply abundant (Kunz, 1982). Thus, it is assumed that some bats in the original group of *H. armiger* must have parturited during the onset of rainy season in April or May and by August those pups might have attained juvenility and grown almost to the adult size, so that they were counted as individual grown-up bats in the colony. With respect to

micro-habitat selection, it appeared that, *H. armiger* prefer to roost in a place where the humidity is high, the colony was found to be roosted in the same place, 103.6 m away from the main entrance, both in the August and September, where the humidity recorded ranged between 73 and 96%.

*Aselliscus stoliczkanus* was encountered in the cave since the very first visit in November 2008. A group of 10 individuals was recorded to be roosted 13m away from the main entrance. During the second visit in January 2009, their number was found to have increased to 20 individuals, and have shifted their roost place to 15.2m away from the entrance. Their number rose month by month until 48 individuals were accounted on the 6<sup>th</sup> trip in September 2009. However, it was interesting to observe that since the third trip in April, individual bats were highly dispersed manner roosted in different places, No relationship could be drawn with the temperature factor, since it fluctuated monthly, however, a sort of relationship was seen with the humidity factor, since these bats were found to be highly scattered when the humidity in the cave rose and ranged between 73-94% (Table 2). It is well established that, caves provided not only the temperature but also the relative humidity, which is so necessary especially in the tropics, since there is always the danger that the fragile-wing membranes might be dried out. So for this reason, it is assumed that many species seek out places of high humidity. With respect to the increase in the number of *A. stoliczkanus*, it is assumed that propagation must have taken place in some individuals like most tropical microchiropterans during the rainy season of May through August, thus adding new individuals to the original number. Moreover, it must be added that, because of their small size, they are not vulnerable to the human predation, so that the colony of these bats was found to be intact during the study period.

**Yi Ngaw Caves** This is also peculiarly shaped, somewhat elongated cave, where two species of bats namely *Ia io* and *Hipposideros armiger* were encountered. *Ia io* was encountered during the first visit to the cave in November 2008. Two bats were found roosted in a place just 14 m from the main entrance. However, the two bats were not found again during the remaining months of the study period. Therefore, it is rather difficult to comprehend what fate had be fallen to the two (Table 3).

During the first three months (November, January and April) of study period, not a single *H. armiger* was observed in the cave. Only during the fourth trip in June 2009 that 23 bats were first encountered. They were roosted just 8m from the main entrance of the cave. The number increase to 28 during the fifth trip in August. The number of bats was again found to have increased to 33 and roosted in the same place, during the sixth trip in September, it appeared that *H. armiger* have preference in a place of high humidity, since the humidity of their roost place (microhabitat) ranged between 69 to 96% (Table 4). With respect to the cave-dwelling habit of the bats, it is seen that bats are the only group of vertebrates to have exploited caves for permanent shelter. Bats without any effective protective coverings will be at the mercy of the

untamed nature, so it is assumed that to avoid from being predated and to conserve moisture bats become nocturnal and took refuge in the caves.

It must be emphasized that not a single bat was found again in both the La Gang and Yi Ngaw caves during the seventh or the last trip taken in December 2009. This phenomenon is rather interesting since in the La Gang Cave, both *I. io* and *A. stoliczkanus* were encountered during the cold season of November 2008 and January 2009, the first and second trip to the cave. However, with *H. armiger* it is a different case, since this species was first encountered in both caves only during the third trip in April. The disappearance of all the bats from the two caves in December, 2009 may be taken as an indication that these bats have migrated to a more favourable place during the cold seasons to avoid the subfreezing temperatures of the Kut Kai area and returned to the studied caves only in March or April, when the weather conditions are favourable again. Similar incidence of disappearance of bats during the cold season from their places of confinements and then returned when the weather became favourable in March had been reported on *Hipposideros larvatus* (Aye Aye Nwe, 2005, Khin Min Min Htun, 2007).

Thus, it appeared that suitability and availability of roost may influence the distribution, survival and reproduction of bats. But, why then, Kut Kai a mountainous place with a large number of caves which are very suitable for the bats to dwell and thrive, harboured only a few species of bats and almost in small numbers is rather of interest, since out of the 37 caves exploited, only a few are found to be inhabited. With respect to determination of the habitat use by individual bat species, it was revealed that the result on *I. io* indicated negative preference index. The result may be so, since only four/three bats were encountered in the cave, moreover monthly shift in roost places was recorded during the study period. It appeared that shift in roost places could not be eluded to the preference of roost places but because of human transgression, changing roost places further away from the cave entrance to avoid victimized by human misdemeanours. However, it appeared that the environmental factors were not totally ignored since the index D value did not go down to the level (-1), so as to be ignored. When *H. armiger* is taken into consideration, it revealed that this species showed positive attitude towards all the four environmental factors being considered. However, the preference indices were not high enough to assume that *H. armiger* is restricted to only one particular roosting place, though it appeared to have preference to roost places where temperature and humidity are higher.

*Aselliscus stoliczkanus* revealed similar results, however, when compared with *H. armiger*, the preference index for roost distance was high (approximately 0.5). Although, it cannot be taken as totally restricted to that microhabitat since the value did not come to (+1). However, this species appeared to have definite roost preference, since the colony was found dispersed along the same area, almost throughout the study period. Moreover, the results also reflected the preference of this species to places of higher temperature and humidity.

The overall results of the present study clearly indicated that, the risk factors imposing upon the bats fauna in Kut Kai area is no other than the anthropogenic factor. Thus, there is a need for further detailed study to assess the damage that had already been done, and to outline conservation measures to safeguard the sustainability of the bat fauna in Kut Kai area.

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