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DISTRIBUTION AND EXTERNAL MORPHOMETRIC ANALYSIS OF *SCOTOPHILUS KUHLII* (LEACH, 1821) IN GOALPARA DISTRICT OF ASSAM, INDIA.

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Abstract :

In-depth research on *Scotophilus kuhlii* was conducted in the study region (Goalpara) between March and November of 2022. The number of active roosting bat populations (N = 39) in various habitat categories was computed. According to Bates and Harrison (1997), every bat was numbered, and a male and a female were taken from their individual roosts for additional taxonomic identification and comparison. External morphometric data revealed that male forearm length was 45.82 ± 0.9418 and female forearm length was 45.94 ± 0.9672. The male wingspan was 179.4 ± 6.5421 mm, whereas the female wingspan was 181.01 ± 6.3773 mm. The male and female HB measurements were 62.68 ± 1.1009 mm and 65.26 ± 0.6655 mm. Males and females differed somewhat in forearm (FA), head body length (HB), total wingspan (WSP), and other measurement acronyms (Table 2). After being measured and weighed, the caught bats were quickly released back into their natural habitat. *Scotophilus kuhlii* is a widely distributed species that roosts in holes, tree leaves, and abandoned house roofs, among other natural and man-made materials. This adapted species is found throughout much of Asia, extending from peninsular Malaysia, Singapore, Indonesia, Myanmar, Thailand, and Indochina to the Philippines from Pakistan and peninsular India. The distribution of the species within the study area varied depending on the type of roosting habitat. Roosting type has a direct effect on bat populations. The range and presence of this species in the surveyed areas indicate that there may be more nocturnal bats, which are critical for maintaining the food chain's balance.

Keywords : Morphometrics , Distribution, Vespertilionidae, Chiroptera, Assam.

Introduction :

Vespertilionidae is a family of microbats in the order Chiroptera, which includes flying, insect-eating mammals known as vesper or simple nosed bats. The vespertilionidae family is the most diversified and extensively dispersed of bat groups. Members of the family Vespertilionidae, also known as "evening bats" or "vesper bats," are the biggest family in the order Chiroptera, with 407 recognized species, 48 genera, and six subfamilies (ADW, 2023). A group of mammals that have mastered active flight are the chiropterans. Blumenbach (1779) coined the term "Chiroptera", meaning "hand wing". Chiroptera are one of the most diverse and extensive mammalian orders. Bats, or chiropterans, are one of 29 extant orders of mammals and a remarkable group in terms of evolution and zoogeography (Wilson and Reeder, 2005). Bats have existed for over 52 million years and have evolved to encompass over 1,400 species today. Bats are the second largest animals and the only mammals that can fly considerable distances. It is found worldwide except in polar regions (Arctic and Antarctic) and some oceanic islands (Simmons, 2005).

Vesper bats dwell in colonies and roost in caves, hollow trees, and other similar habitats (ADW, 2023). Although most species are tiny, their sizes can vary from 30 to 130 mm. The bulk of Vespertilionidae species share many other physical traits in spite of this size variation. Vespertilionidae are often dull-colored animals, usually brown, gray, or black with a lighter underbelly (Hill and Smith, 1992). The most common characteristic that sets them apart is a simple face lacking a true noseleaf. Vespertilionidae bats use ultrasonic echolocation to find their prey. They vibrate at high frequencies, and by locating potential prey by listening for sounds that reverberate, they are able to create a mental map of their environment. Vespertilionidae bats are classified as frequency modifying bats because they all produce pulses at different frequencies. Certain species are better adapted to the particular frequency range in which they find and track prey, even though most species can hear fairly well between 10 and 50 kHz. This varies according on the species (Harris, 1999; Simmons and Conway, 1997). Mostly bats of these types are voracious insect predators. They consume hundreds of insects every night, especially temperate species during the summer and females during peak lactation. Individual adult bats in Kansas are thought to consume roughly 2.0 g of insects per day. This equates to an annual insect consumption of more than 16 tons (Kunz, 1974; Kurta et al., 1989; Wilson, 1997).

India, one of the 17th most bio-diverse countries in the world, is home to 7-8% of all mammal species, including bats. Of the 127bat species known in India, 74 are found in northeastern India, which is part of the Himalaya-Indo-Burma biodiversity hotspot (Saikia et al., 2021). Assam has about 39 species of bats in 16 genera, 5 species are called megabats (fruit bats) and 34 species are called microbats (Ali, 2022). The state of Meghalaya has the highest bat diversity in the country with 67 species, representing 51% of the total bat species in the country (Saikia et al., 2021). Bates and Harrison (1997), reported the presence of 28 species of bats in Assam. Some of the most important revisions to the geographical distribution and classification of Indian bats are Sinha (1999), Ghosh (2008), and Boro et al.,

2018), Brosset (1963), Sinha (1970), Pradhan (2008), Das (2003), Csorba et al., (1995), Ramakrishna et al., (2003), Srinivasulu and Srinivasulu (2001 & 2006).

The reported species richness in Assam, India, is likely underestimated due to the lack of extensive survey and field studies on the taxonomic diversity, distribution, ecology, and population status of the bat fauna. This knowledge gap is evident from the small number of scattered publications on the Chiropteran fauna of the state. Given the scattered nature of published information and ambiguity regarding bat diversity and distribution, it is predicted that more bat roosting could occur in the region. The population status of bats and their prevalence in the study area can help determine the number of species and people's attitudes towards conserving bat diversity. In western Assam, the Goalpara district is situated between Meghalaya to the south and the Brahmaputra River to the north. Except for a few tree-covered hills, the Goalpara region is almost completely flat. The present study is a pioneering effort in the study area to reports the distribution of a micro-bat (*Scotophilus kuhlii*) in various habitat types and evaluates its external morphometrics and population status.

Materials and Methods

Study area: The study area is highly forested with tall trees (Saal, Shegun, & Bamboos) and adjacent to water sources, making it ideal for expanding bat populations. The yearly temperature in the district is 27.55°C (81.59°F), which is 1.58% higher than the national average. Goalpara gets about 82.07 millimeters (3.23 inches) of rain each year and has 49.99 rainy days (13.7% of the time). The locational Map of the study area highlighting its located bat roosts is represented in Fig 1.

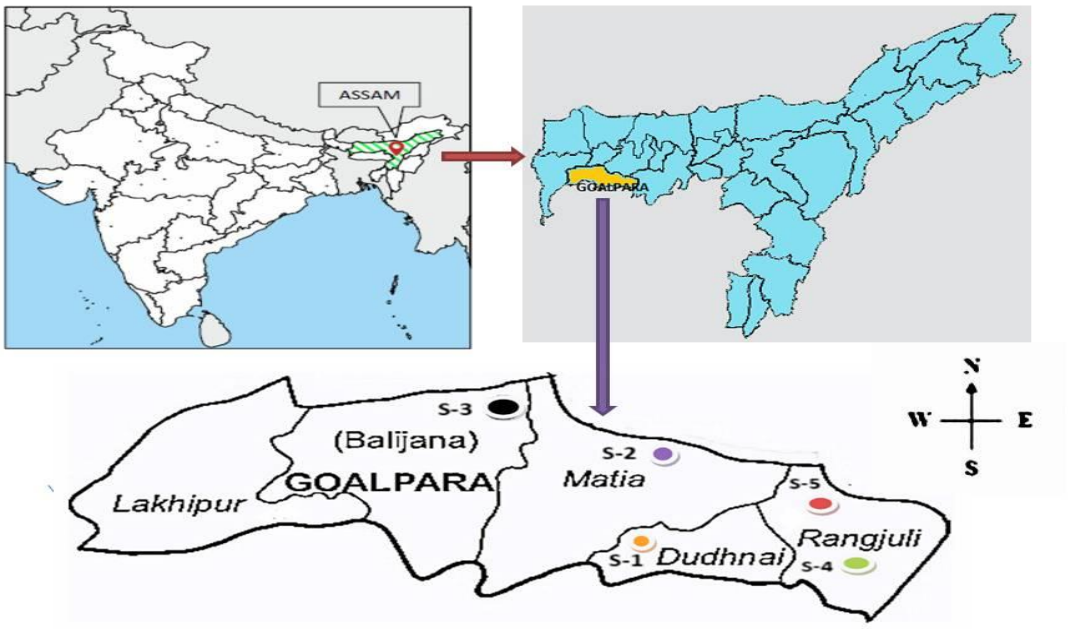

Fig 1: The Map of the study area highlighting its located bat roosts (S-1, S-2, S-3, S-4, and S-5)

Sampling and Survey: The study area was surveyed intensively for the presence of bats from 18:30 to 20:30 hrs in the evening from March –November 2022 on a weekly basis. The occurrence of the bat was informed by a key informant. Bats were found to be roosting in a hole of betel-nut tree, tree cavity, abandoned house and palm tree leaves at located roosts in five different habitats and sites from the study region (Table 1). Roost ID (S-1, S-2, S-3, S-4 and S-5) was given for further observation. The GPS coordination of the roosting site was taken by compass mobile application. Since the bats are at a reachable height so bats were captured manually using modified butterfly nets and gloves. Total numbers of bats at individual roosts were counted and only a male and female were capture for further taxonomic identification and conformation.

Morphometric measurements: The specimens were immediately anesthetized at the spot itself. Bats are measured for its external morphometrics, and sexes were assessed. The Morphological characters such as body mass, head and body length, length of forearms and hind arms, body width, length and width of the ear, tragus width, length of second, third, fourth, and fifth metacarpals were then measured using a digital millimeter calliper (Zhart-0 300 mm) with an accuracy as close as possible to 0.01 mm. Each individual sample was measured, and the measurements were documented for comparison with the pertinent literature (Bates and Harrison, 1997). The comprehensive acronyms for the morphometric measurements are represented in Table 2. The specimens were Photographed (Fig 2 & Fig 3).

Fig.2 Distinct tragus, ear and muzzle of *S. kuhlii.*

Fig 3. Ventral view of *S. kuhlii* with brownish pelage

Statistical analysis: The mean and the standard deviation are calculated. For a number of n samples (Table 2), the mean or average value for the measurement range is first calculated, and later, the standard deviation is calculated using an online software tool (calculator.net). Error bars are constructed from the assessed data (Fig.4 & Fig.5).

Results and Discussion

In the Goalpara region, *Scotophilus kuhlii* was found at five roosting sites (Khara Medhi Para, Matia, Balijana, Simlitola, and Tiplai Pt 2). The distribution of the sites (S-1: Tree cavity, S-2: Abandoned home, S-3: Tree hole, and S-5: Tree leaves) reveals the amount of bats that reside in different habitats. The type of roost has a direct impact on bat population size. Of the 39 bats counted from five separate roosts, one pair of bats from each roost were measured for morphometrics (external) of both sexes. A statistically significant difference was found between the male and female (*S. kuhlii*) morphometric examinations. Male forearm length was 45.82 ± 0.9418 and female forearm length was 45.94 ± 0.9672. The female had a wingspan of 181.01 ± 6.3773 mm, while the male had a wingspan of 179.4 ± 6.5421 mm. The HB values for the male and female were 65.26 ± 0.6655 mm and 62.68 ± 1.1009 mm, respectively. The results showed that the measurements of total wingspan (WSP), head body length (HB), and forearm length (FA), among other acronyms, differed slightly between males and females (Table 2). The measured values of the other determining variables, such as Tail (T), Ear, and Metacarpals (2mt, 3mt, 4mt, 5mt), reveal a small range of variation among the evaluated specimens (Table 2). The majority of the measurements of the acronyms in the current investigation are in ranges when compared with conventional taxonomic literature, Bates & Harrison, 1997.

Table 1 : Distribution, types of roosting habitats with GPS location and population of *S. kuhlii* in different habitats.

Roost ID	Roosting site	GPS Coordination	No. of bat Population in the roost	Type of Roosting habitat
S-1	Khara Medhi Para	25°59`9.82"N 90°47'11.64"E	4	Tree- cavity
S-2	Matia	25.9689° N 90.9355° E	12	Abandoned house
S-3	Balijana	26.0714° N 90.5364° E	5	Tree hole
S-4	Simlitola	26.5054° N 90. 271° E	7	Abandoned house
S-5	Tiplai Pt 2	26.0470° N 90.9701° E	11	Tree leaves

The morphology of the specimens seems to be Light-yellowish on the ventral side and chestnut-brown on the dorsal pelage. It has a blunt, wide muzzle. The tragus, which has a basal notch and is crescent-shaped, is half the length of the ears and has transverse ridges. The ears are small. The coat is brief and incredibly thick (Fig. 2 & Fig 3). It has a dog-like face with a blunt muzzle and prominent, pointed ears. Its long tail is covered by the

membrane between its hind legs. The fur of this bat is light brown to yellowish in color and incredibly soft to the touch.

Table 2 . External Morphometric analysis of *Scotophilus kuhlii* and comparison of the present data with Bates and Harrison, 1997.

External morphometric measurements (mm)	**Male (n=5)** Mean ± S.D	**Female (n=5)** Mean ± S.D	**Bates and Harrison, (1997)** Mean (range)
HB	62.68 ± 1.1009	65.26 ± 0.6655	69.8 (60-78.0)
FA	45.82 ± 0.9418	45.94 ± 0.9672	49.0 (40.0-65.0)
Tr	1.846 ± 0.5336	1.90 ± 0.3096	NA
E	9.26 ± 0.5968	10.06 ± 0.3409	13.5 (9.0-17.0)
T	41.86 ± 0.6655	42.39 ± 0.7680	47.5 (40.0-65.0)
WSP	179.4 ± 6.5421	181.01± 6.3773	NA
5 mt	43.94 ± 1.0261	44.43 ± 0.5674	45.0 (42.1-53.9)
4 mt	43.86 ± 1.0406	44.896 ± 0.5844	48.3(43.7-57.2)
3 mt	44.68 ± 0.8700	44.896 ± **0.5856**	48.8(44.4-58.8)
2 mt	41.02 ± 0.9174	42.08 ± 0.6039	NA

Note - S.D- Standard deviation; n- number of bats measured; N- numbers of bats counted; HB- head and body length; FA- forearm length; Tr- Tragus length; E- ear; T- tail length; 5mt- fifth metacarpal; 4mt- fourth metacarpal; 3mt- third metacarpal; 2mt- second metacarpal; NA- not available.

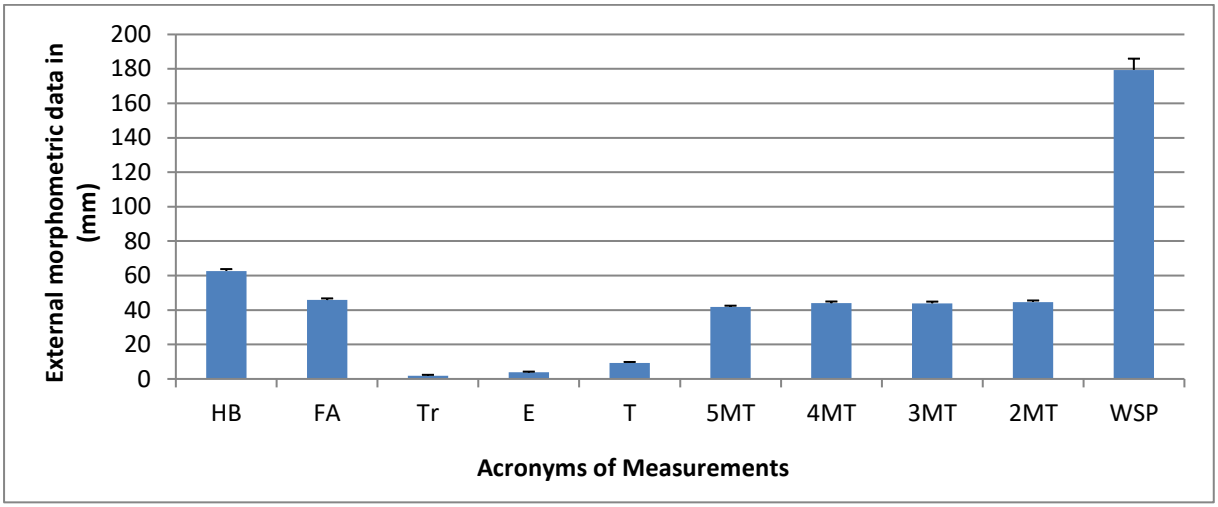

Fig.4 A graphical representation of the variability of morphometric parameters assessed in *S.kuhlii* (male) specimens.

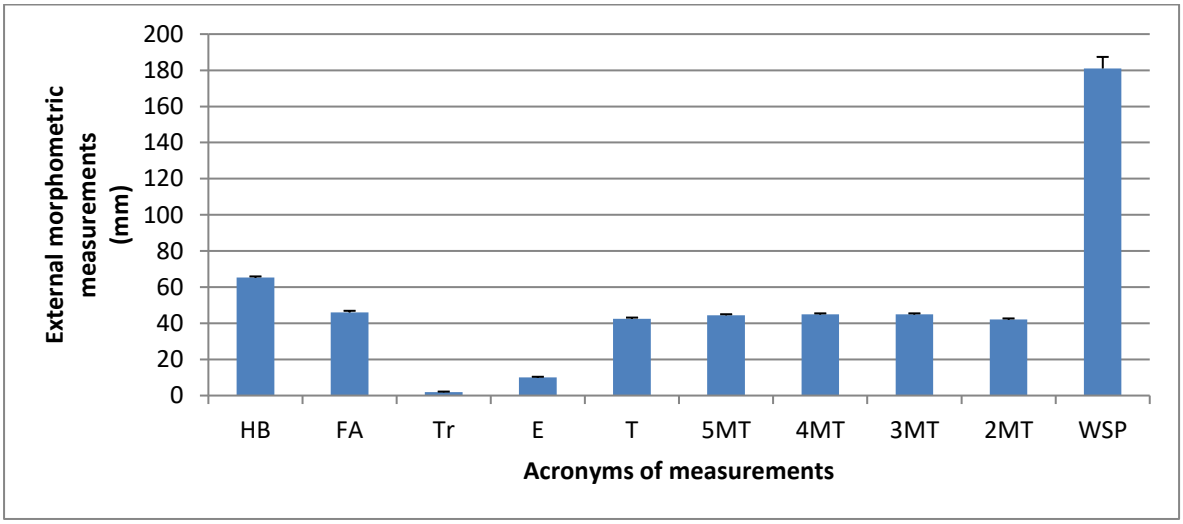

Fig 5. A graphical representation of the variability of morphometric parameters assessed in *S.kuhlii* (female) specimens.

The Asiatic Lesser Yellow Bat, also known as the Yellow House Bat, typically roosts together in hollow trees in its natural habitat. However, this species has successfully adapted to urban environments and can often be found roosting in attics or abandoned buildings in large numbers. Lesser Asiatic Yellow House bats belong to the *Scotophilus* genus, which includes 15 species worldwide. Because of its reduced forearm weight and length, the bat is nearly identical to *Scotophilus heathii*, making taxonomic identification difficult. This species distinguishes itself from the smaller, short-nosed fruit bat by having a blunt nose rather than a slightly pointed one. An aerial insectivore is likely to consume beetles, termites, moths, and other flying insects (Simmons and Conway, 1997). Across its range, *Scotophilus kuhlii* shares roosts with other bat species, but it prefers to rest in the hollows of sturdy dead trees. They are a highly adaptable species that can inhabit various environments, including woodland, suburban areas, and urban areas. They typically perch in building fissures. When these bats return from feeding locations in the early evening, they prefer to rest in another roost in the same area, even if it is several kilometers distant (Yalden and Morris, 1975; ADW, 2023). They are very social bat species, with colonies changing in size based on available roosting space and season. Smaller groups or lone bats usually perch in tight crevices, eaves, or bat

boxes, whereas bigger colonies prefer wider roosting areas like rooftops, clusters of dead leaves in fan palm trees, or beneath the leaves of coconut trees. The size of a colony can vary from a few to thousands of individuals. Presumably aerial insectivore and consumes beetles, termites, moths, and other flying insects. They forage early in the evening and can fly low to the ground. They perform a wide range of airborne movements, occasionally foraging near streetlights and sports field floodlights. With a diverse diet that varies seasonally, they primarily hunt for prey while in flight. Due to their fast speed and limited agility, they do not use the sweeping or netting technique employed by other bat species to catch small insects from the orders Diptera and Lepidoptera. Instead, they target larger insects from orders such as Coleoptera, Hemiptera, Lepidoptera, and Orthoptera, which offer *S. kuhlii* bats a higher energy content.

Under the Wildlife Protection Act of 1972, this species is not included as a scheduled species. According to Schmitz and Suttle (2001), predation by bats can affect herbivore communities directly and plant communities indirectly through interactions mediated by trait (behavioral) and density (consumption). It can also have an impact on biodiversity balance.

Conclusion

Based on the type of roosting location, the current study demonstrated that different biological spot sites had varying bat colony counts. Diverse species and attitudes toward conservation can be influenced by the status and prevalence of bat populations in a research area. The presence of the species in the research region (Goalpara) suggests the possibility of more nocturnal bats. This study expands the scope of future research by revealing previously unknown facts about the *S.kuhlii* bat species' condition and ecological connections with the environment. *S.kuhlii*, an insectivorous bat, provides essential ecosystem services. This study is the first of its kind on bats in the study area and attempt to fill a knowledge gap in the field of chiropteran studies by focusing on morphometrics, habitat distribution, population status, and ecological importance. It is imperative that this species (*S.kuhlii*) be conserved, and thorough surveying and closer observation can help identify other Vespertilionidae bats. Similar research should be done to precisely identify every species of bat and programs, conferences, and campaigns pertaining to bat conservation should be organized.

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Competing interest

Both the authors shows no competing interest.

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