International Journal of ChemTech Research
CODEN (USA): IJCRGG, ISSN: 0974-4290, ISSN(Online):2455-9555
Vol.11 No.05, pp 521-527, 2018

Characteristics of bat rest sites in buildings of Sincelejo, Sucre, Colombia

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Abstract : Bats settle in urban areas because they find there an appropriate climate for their development, food, resting places and protection in buildings of all kinds. In order to assess the physical and climatic conditions of their refuges, the largest and smallest diameters of the entrance sites were measured as well as their interior height. The temperature and relative humidity were also obtained inside and outside, both during the day and night. A total of 185 individuals of four species were captured. These belonged to three families: Phyllostomidae (*Loncophylla fornicata*), Molossidae (*Molosssus molossus* and *Eumops nanus*) and Vespertilionidae (*Myotis nigricans*). These bats may or may not live together in the same shelter. The false ceilings are made of eterboard or wood panels and above, the roof tiles are made of eternit. The narrowest access point and the highest temperature and humidity value were determined in *Molosus molossus* refuges. The temperature and the relative humidity in the interior remain relatively constant and higher than that in the exterior.
Keywords: bats, shelter, Phyllostomidae, Vespertilionidae, Molossidae.

Introduction

Bats in urban environments may have a positive impact on humans, such as their controlling capacity for insect pests (1), among others. However, there are numerous diseases associated with them, such as rabies, leptospirosis, histoplasmosis and equine encephalitis, which can be transmitted to other animals and humans (2). They can also cause considerable damage to the buildings where they live (2, 3). They take refuge mainly in the false ceiling and there, they find climatic and safety conditions for their development throughout the year (4). For this reason, it has been suggested that coexistence with these animals should be avoided.

To reduce the coexistence of man and bats without damaging their populations, researchers in the city of Cali (5) proposed making artificial shelters offering the minimum requirements to house colonies of these urban species. According to these authors, the factors that directly influence the colonization of new shelters would be the design, construction materials, coloration, sun exposure, protection against predators, space and time of installation. The present work intends to provide some information regarding the physical and climatic characteristics of bat refuges in human buildings, specifically in educational institutions of the city of Sincelejo, which could be relevant for the construction of such artificial refuges.

International Journal of ChemTech Research, 2018,11(05): 521-527.

DOI= http://dx.doi.org/10.20902/IJCTR.2018.110557.

Materials and methods

The work was carried out between May 2015 and November 2016 in four educational institutions in the urban area of Sincelejo (Fig. 1). The names of these schools are omitted at the express request of their rectors. Sincelejo is located in the north of the country in the department of Sucre, in the Caribbean region of Colombia. Its geographic coordinates are: 9 ° 18 'N; 75 ° 23 'W. It has a population of approximately 260,000 inhabitants (6), maximum altitude of 260 m. a. s. l. (7) and an urban area of 2,143 ha. The average annual rainfall is 1,150 mm, temperature 27.5 ° C and relative humidity 77%. (8) The rainy months are from April to October and the dry months from November to March.

Fig. 1. Location of sampling sites in the urban area of Sincelejo. Source: Google Earth, free version.

In the urban area of Sincelejo there are 24 official educational establishments (9). The presence of bats, was corroborated through the observation of footprints and the compilation of information on architectural structures that housed bat colonies.

For capture, nylon fog nets of 12m long x 2.5m high with a mesh eye of $36mm^2$ were used. These were located approximately 1m from the access points to the shelters. For those of difficult access, the mesh was located as close as possible to these openings. The networks were on location before 18:00, and were reviewed every 30 minutes and removed at 23:00.

Width and height inside the refuges were determined with a measuring tape, as well as the height and width of the entrance and exit openings. Measures of temperature and humidity were taken during both the day and night, inside and outside shelters, with a digital thermo-hygrometer (Control Company 4410 brand).

Species identification and sexing was done "in situ" and taxon was corroborated in the laboratory using a specialized classification key (10).

A comparison between inside and outside temperature of shelters was done through a Mann-Whitney test (11). The temperature between shelters was also compared. The same analysis was carried out for relative humidity. The data was processed through the STATISTICA 13.0 program (free internet version).

The Tropical Biodiversity Research Group and the authors of the present investigation have the Macro Permit for the collection of wildlife specimens granted by the National Association of Environmental Licenses (ANLA), according to Resolution 0391 of April 2016.

Captured individuals were released when sampling finished.

Results

The type of refuge most used by bats in schools was the false ceiling. These are generally built with eterboard or wood and the roof with eternit tiles. Where the tiles meet the walls of the buildings, openings or cracks appear due to deficiencies in the construction. These constitute the entry and exit access points for the bats, who establish their refuge or resting place in the interior (Fig. 2).

Fig. 2. Small opening that give access to the ceiling (left above), larger access point with spots due to the excreta of bats (top right) and bat in flight inside the false ceiling (below) in an educational institution in Sincelejo, Sucre. Source: A. Sampedro.

185 individuals of four species were captured, belonging to three families: Phyllostomidae (*Loncophylla fornicata*), Molossidae (*Molosssus molossus* and *Eumops nanus*) and Vespertilionidae (*Myotis nigricans*).

Lonchophylla fornicata was the best represented species (Table 1) and appeared in the most shelters.

Table 1. Proportion of individuals of each species (FC) and proportion of refuges in which each was captured (FR). Ri: number of shelters in which each species was captured; Lf: *Lonchophylla fornicata*; In: *Eumops nanus*; Mm: *Molossus molossus*; Mn: *Myotis nigricans*.

Especie	n_i	FC (%)	R_i	FR (%)
Lf	133	71.8	8	80.0
En	19	10.2	3	30.0
Mm	31	16.7	2	20.0
Mn	2	1.0	1	10.0

Most species share refuges in different proportions. However, *Lonchophyla fornicata* appears alone in five refuges (4 to 8) and *Molossus molossus* in one of them, the 10 (Fig. 3).

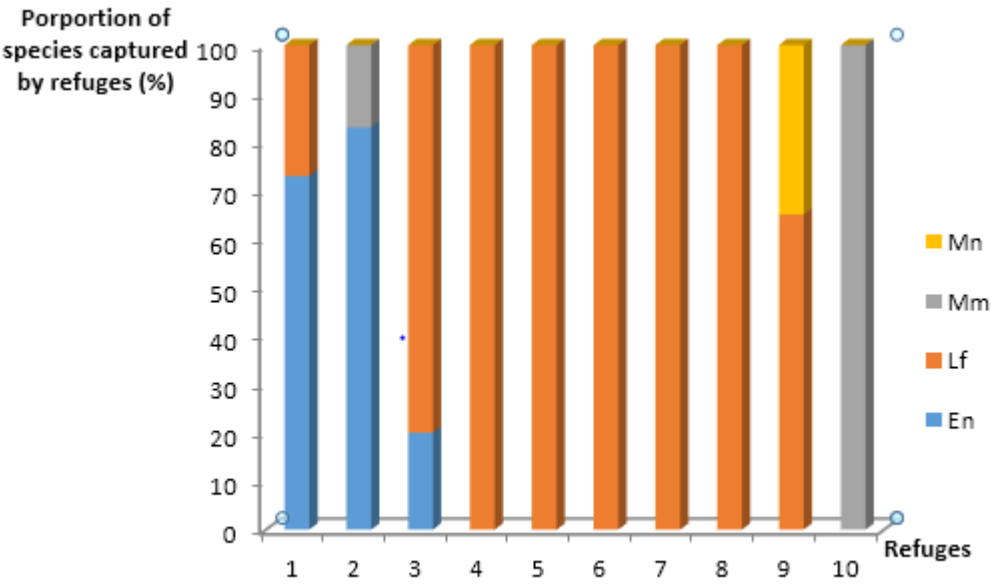

Fig. 3. Relative frequency of species captured by refuges. Mn: *Myotis nigricans*; Mm: *Molossus molossus*; Lf: *Lonchophylla fornicata*; En: *Eumops*

The temperature and relative humidity, both inside and out the refuge in the midday hours can be seen in Table 2. The measure of the largest and smallest diameter of the entrance opening and the height of the roof of the shelters is also shown.

Table 2. Small and large diameters of the points of access to the shelters (Acc), maximum height (Mh), internal (It) and external (Et) temperature and internal (Ihr) and external (Ehr) relative humidity in 10 shelters detected in four educational institutions of Sincelejo, Sucre. (Id: indeterminate).

Refuges	Acc (diameter major and minor) (cm)	Mh (cm)	It (°C)	Et (°C)	Ihr (%)	Ehr (%)	Ceiling construction materials
1	39x25	100	35.4	32.3	80.7	76.5	Eterboard
2	23x17	85	36.1	32.3	81.2	76.4	Eterboard
3	30x20	100	Id	32.2	Id	76.5	Eterboard
4	80x40	120	Id	31.4	Id	71.6	Eterboard
5	75x30	130	35.6	32.5	72	66.9	wood
6	23x20	130	35.9	32.5	73.3	67.3	wood
7	60x40	200	35.7	32.1	75.2	70.2	wood
8	45x20	200	36	32.1	75.8	70.2	wood
9	Id	450	Id	31.1	Id	69.1	palm roof (without ceiling)
10	8x5	75	40.9	31.5	84.1	73.7	wood

The internal temperature of shelters is higher than the external temperature and both remain relatively constant (Table 3). The same was the case for relative humidity, although no statistical significance was found. These variables do not present differences among shelters. The highest temperature and humidity was obtained in shelter 10, which has the narrowest access of all. The average height of shelters is around 159 cm, except for shelter 10 where it is lower (75 cm).

Table 3. Comparison between temperature and relative humidity inside and outside seven shelters of four educational institutions in Sincelejo, Sucre. (U: Mann-Whitney U test).

Obs(1) vs Obs(2)		N	Average range (1)	Average range (2)	U	P value
T.int (°C)	T.ext (°C)	7	11	4	0,000	0,0020
HR.int (%)	HR.ext (%)	7	9,57	5,43	10	0,064

Day and night temperatures and relative humidity remain with little variation (Figs. 4 and 5).

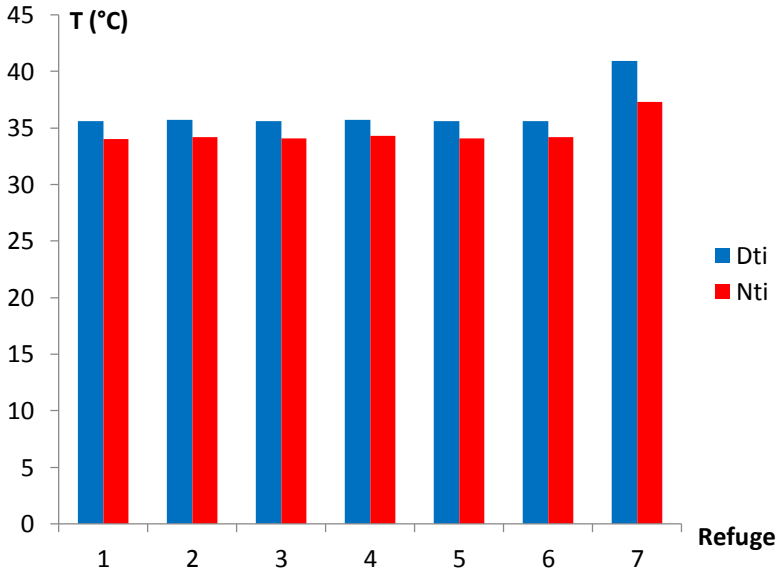

Fig. 4. Temperature variation inside seven shelters during the day (Dti) and the night (Nti).

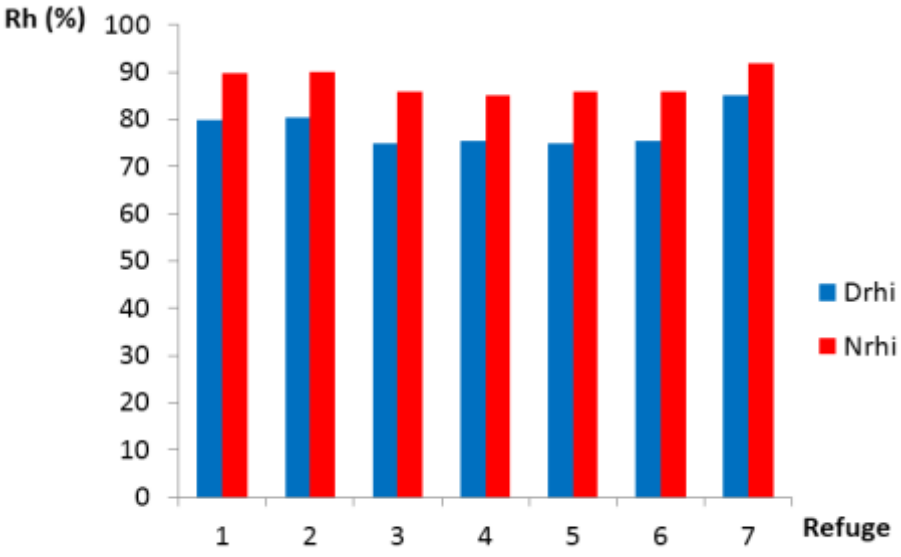

Fig. 5. Relative humidity variation inside seven refuges during the day (Drhi) and the night (Nrhi).

Discussion

Bats find many alternative shelters in the human constructions of the municipality of Sincelejo. The majority of captured specimens (92.5%) were located on the roofs of these constructions. Some species share refuge, which allows them to reduce the cost of thermoregulation and breeding in species with different reproductive conditions (12**).**

The architectural design of homes in hot and humid climates, which maintain cool environments inside the rooms isolating heat from ceilings through lofts where air flow is reduced and temperature and relative humidity are maintained constant and above the outside levels, provides favorable resting sites for bats in accordance with their physiological and safety requirements (13). The majority of the species showed preference for high and ample eterboard or wood false ceilings with external eternit roof tiles supported by wooden slats. Apparently, it is important for bats that the temperature inside the shelters is constant and superior to the external temperature, both during the day and night (1). The temperature range observed in the present work is within the range previously registered in urban bat refuges (30-50°C) (5). The refuge of *Molussus molossus* showed the highest temperature and relative humidity. This is possible due to its low height (75 cm) and reduced entrance dimension (8 x 5 cm on average), which further reduces the ventilation of these spaces. This strategy minimizes the cost of thermoregulation, necessary in the reproductive females because the low temperatures delay prenatal development (14). This type of refuge provides greater security to the species and is particularly important for *Molossus molossus,* a species that do not bear their flight-less young during their brief periods of nocturnal feeding(1).

Conclusions

The physiognomy of the municipality of Sincelejo, with its profusion of plants and large number of luminaries, as well as high temperature and humidity, have allowed bats from different food guilds to find resources throughout the year. Buildings with designs adapted to tropical climates provide the bats with different habitats, specifically those buildings that have ceilings with poor ventilation and high temperature and relative humidity.

Some species seem to tolerate variable conditions of temperature, humidity and physical characteristics of the shelters, but others require specific conditions. Thus, the construction of new shelters to avoid coexistence with humans is recommended after studying which species share such requirements and which do not.

Acknowledgments

This work was possible because of the collaboration provided by the rectors of the visited schools.

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