



# School Activity on the Theme of Bats Can Raise Awareness of Conservation

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**ABSTRACT** – Knowing about the basic ecology of less charismatic species helps strengthen conservation measures. In the present study, we evaluated primary high school students' understanding in the southwest of Goiás state, a region of Central Brazil, about bats. This paper involved two phases and analysis before and after school intervention, with lectures and practical activities. In the first phase, we recovered the basic knowledge focused on detecting whether the 170 students recognized bats as flying mammals. Then we tried to find out if they were aware of the hematophagous species estimate, and finally, we evaluated the relationship of the use of bats as bioindicators. The results showed confusion in bats' classification, with association with rodents, birds of nocturnal habit. The students believed that there were more than 10 (ten) hematophagous species regarding these animals' diet. And as expected, the concept of bioindicators of environmental quality was unclear to these animals. Finally, after school intervention, there was a significant increase in understanding all the topics covered on bats. These data reveal the importance of academic intervention in schools to reduce the social distance concerning biodiversity. We conclude that the development of school activity with the theme of bats can increase awareness of conservation.

**Keywords:** Flying mammals; chiroptera; human perception; cerrado.

## Atividade Escolar sobre o Tema dos Morcegos Pode Aumentar a Conscientização sobre a Conservação

**RESUMO** – Conhecer a ecologia básica de espécies menos carismáticas ajuda a fortalecer as medidas de conservação. No presente estudo, avaliamos a compreensão de alunos do ensino fundamental do sudoeste goiano, região do Brasil Central, sobre os morcegos. Este trabalho envolveu duas fases e análises antes e depois da intervenção escolar, com palestras e atividades práticas. Na primeira fase, recuperamos os conhecimentos básicos focados em detectar se os 170 alunos reconheciam os morcegos como mamíferos voadores. Em seguida, procuramos saber se eles tinham conhecimento da estimativa de espécies hematófagas e, por fim, avaliamos a relação do uso de morcegos como bioindicadores. Os resultados mostraram confusão na classificação dos morcegos, com associação com roedores, aves de hábito noturno. Os alunos acreditavam que existiam mais de 10 (dez) espécies hematófagas quanto à dieta desses animais. E, como esperado, o conceito de bioindicadores de qualidade ambiental não era claro para esses animais. Finalmente, após a intervenção escolar, houve um aumento significativo na compreensão de todos os tópicos abordados sobre os morcegos. Esses dados revelam a importância da intervenção acadêmica nas escolas para diminuir a distância social em relação à biodiversidade. Concluímos que o desenvolvimento de atividade escolar com a temática dos morcegos pode aumentar a conscientização para a conservação.

**Palavras-chave:** Mamíferos voadores; chiroptera; percepção humana; cerrado.



## Actividad Escolar sobre el Tema de los Murciélagos Puede Crear Conciencia sobre la Conservación

**RESUMEN** – Conocer la ecología básica de las especies menos carismáticas ayuda a fortalecer las medidas de conservación. En el presente estudio, evaluamos la comprensión sobre murciélagos de estudiantes de la enseñanza primaria en el suroeste del estado de Goiás, una región del centro de Brasil. Este trabajo implicó dos fases y análisis antes y después de la intervención escolar, con conferencias y actividades prácticas. En la primera fase recuperamos los conocimientos básicos enfocados a detectar si los 170 alumnos reconocían a los murciélagos como mamíferos voladores. Luego tratamos de averiguar si conocían la estimación de especies hematófagas y, finalmente, evaluamos la relación del uso de murciélagos como bioindicadores. Los resultados mostraron confusión en la clasificación de los murciélagos, con asociación con roedores, aves de hábitos nocturnos. Los estudiantes creían que había más de 10 (diez) especies hematófagas en relación con la dieta de estos animales. Y como era de esperar, el concepto de bioindicadores de calidad ambiental no estaba claro para estos animales. Finalmente, después de la intervención escolar, hubo un aumento significativo en la comprensión de todos los temas tratados sobre los murciélagos. Estos datos revelan la importancia de la intervención académica en las escuelas para reducir la distancia social en torno a la biodiversidad. Concluimos que el desarrollo de la actividad escolar con la temática de los murciélagos puede aumentar la conciencia sobre la conservación.

**Palabras clave:** Mamíferos voladores; chiroptera; percepción humana; cerrado.

### Introduction

Bats are found almost everywhere in the world. Urbanization, livestock, agriculture, mining, and road construction result in the loss of natural habitat for many species. These changes in the natural landscape, significant for man, resulted in bats approaching humans (Lim & Wilson, 2019), which are not enormously appreciated due to their non-aesthetic characteristics (Bhattacharjee et al., 2018) and by the hematophagous habit, even though this diet is exclusive to three species. Unfortunately, their bad reputation as to their potential to transmit diseases makes these animals seen as medical, urban, and agricultural pests, which causes a significant obstacle to their conservation, as it creates fear and hostility (Rego et al., 2015). However, bats provide essential ecosystem services, including seed dispersal, pollination, and insect predation (Lim & Wilson, 2019; Souza et al., 2020). Thus, understanding this lousy reputation and studying the interactions between these animals and humans has shown promise in creating strategies to forge a non-antagonistic coexistence between both parties and promote bat conservation (Rego et al., 2015; Castilla et al., 2020).

Bats are well studied as to the benefits for natural ecosystems, and given that, scientists of the future need to use this accumulated knowledge in environmental education activities to generate positive attitudes and conservation measures.

Recognizing their importance in pest control, chiropterans from some parts of the world are considered partners of farmers since the action of preying on insects potentiate for the optimization and reduction of expenses with pesticides, consequently favoring environmental and food security (Whitaker, 1995; Boyles et al. 2011; Wanger et al., 2014), through increasingly natural products. On the other hand, since the 1970s, these animals have been victims of the action of pesticides, heavy metals, and trace elements, where the drastic reduction in populations due to the bioaccumulation of chemical contaminants in their food has also been emphasized (Bayat et al., 2014). Given this sensitivity to pollution, many species can be used as bioindicators of environmental quality (Souza et al., 2020), reinforcing the need for scientific dissemination of this intimate relationship with the environments.

Therefore, based on the premise that current high school students are the conservationists of the future, the extent of support for the conservation of bats for this and future generations depends on their attitude towards these animals (Bhattacharjee et al., 2018). Lim and Wilson (2019) stress that understanding public perceptions and knowledge about bats and their answers is necessary to develop appropriate educational programs to support their conservation. Thus, this study's objective was to evaluate the first time in Goiás, Brazil, the perception of high school students from two state schools about the basic knowledge of these

organisms in order to strengthen a conservation conscience.

## Material and Methods

### Study region

The municipality of Rio Verde in Goiás is in the Southwest of Goiás (Figure 1), 232 km from the capital Goiânia. This city was chosen due to its prominence in Brazilian agribusiness (Pignati et al., 2017) and has 24 state and municipal schools and

five higher education centers. Two of these teaching centers, the University of Rio Verde (UniRV) and Instituto Federal Goiano (IFGoiano), receive the highest demand for high school students in the region and neighboring cities in other Brazilian states. In recent years, teachers linked to these two institutions' zoology and ecotoxicology have made significant efforts to understand bats' fauna in the region (see Benvindo-Souza et al., 2019a, b), as well as the effects of environmental quality on wild fauna.

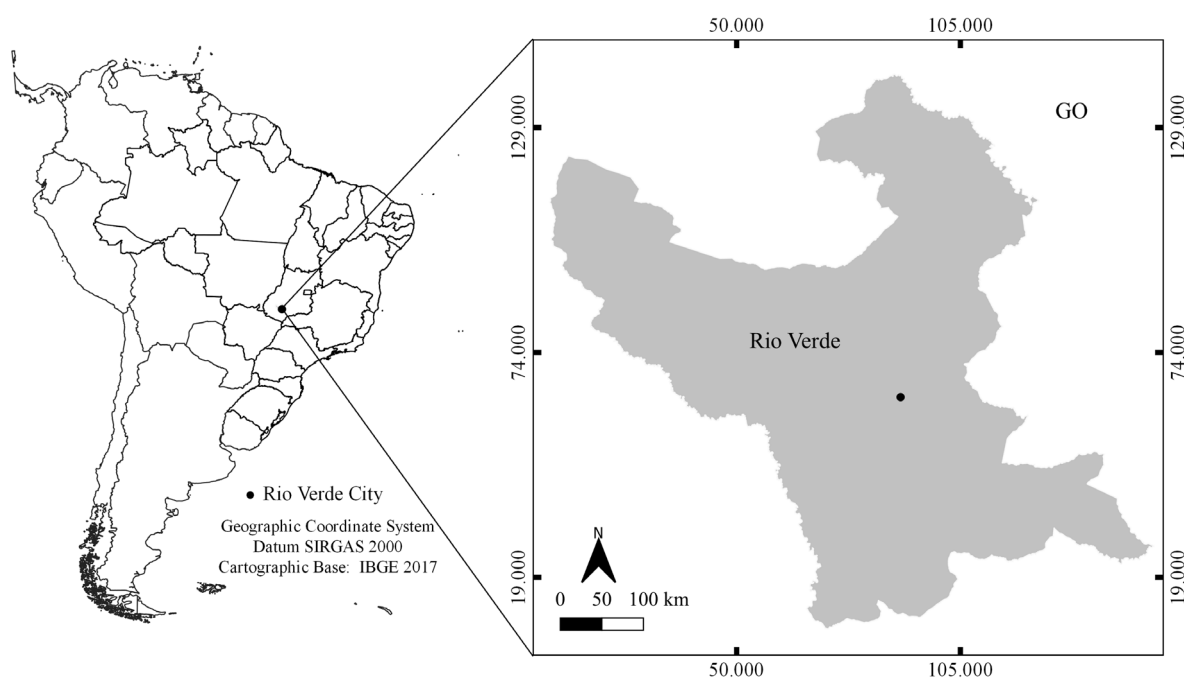


Figure 1 – Study point in the municipality of Rio Verde, Goiás, Brazil.

### The target audience of the investigation

Between February to August 2018, the work took place with students of primary high school, first, second and third year-grades, who were randomly selected in two public schools in the municipality of Rio Verde. A total of 170 students participated in activities on knowledge of the Chiropteran order. In general, the age range of students ranged from 15 years in the 1st grade of high school and 16 years in the 2<sup>a</sup> and 3<sup>a</sup> years. The qualitative and quantitative research was applied through a semi-structured questionnaire composed of three multiple-choice questions, in which students could choose only one alternative. We carried out this investigation in two moments,

before and after an academic intervention, where a lecture was held with the classes, followed by practical activities.

The questions were focused on knowledge about (i) classification of bats (in this item, there was the intention of knowing if students know who the bats are); (ii) number of hematophagous species (here he sought to know if students know approximately the number of species that feed on blood, to discuss other eating habits of the other species finally). In addition, vampire bats (*Desmodus rotundus*) are closely associated with diseases such as rabies, thus being considered an important topic to be addressed; and whether (iii) bats are used to assess environmental quality

(here investigated whether students know of the possibility of using bats as bioindicators). This bioindicator theme was a provocation, considering that Universidade de Rio Verde (UniRV) and Instituto Federal Goiano (IFGoiano) have been developing research and academic training with bats. v) Finally, we evaluated an open questionnaire on the perception of the importance of bats. For practical activities, it is essential to show that these institutions provided fixed animals and ecotoxicological resources. The practical material used in the activities had a federal and local license (SISBIO: 54101-1; CEUA /IF Goiano: 8436060516). Note that the study was part of the PROEXT extension project (n° 03/2017), entitled: Toads and Bats in School: ecological and economic importance of wildlife at the University of Rio Verde.

### Data analysis

Normality and homoscedasticity were verified with the Shapiro-Wilk and Levene tests, respectively. As it has a normal distribution,

the Student's t-test was performed (Dependent variables (number of students' responses) and grouping variable (category of responses)). The data are presented as mean  $\pm$  standard error. A  $p < 0.05$  was established for statistical significance. All statistical tests were performed using Statistica v. 7.0.

## Result

Knowledge about bats was addressed to 170 high school students in Rio Verde Goiás, Brazil. Research on bats classification as flying mammals indicated that students initially confused these animals with birds for nocturnal habit and even rats with flying capacity. Thus, 42% of the students revealed that they did not answer the chiropterans' true identity ( $p = 0.218$ ; Figure 2A). After the intervention with a lecture and practical activities about this group of animals with the same students, there were 76% positive responses resulting in a significant increase in knowledge ( $p = 0.0006$ ; Figure 2B).

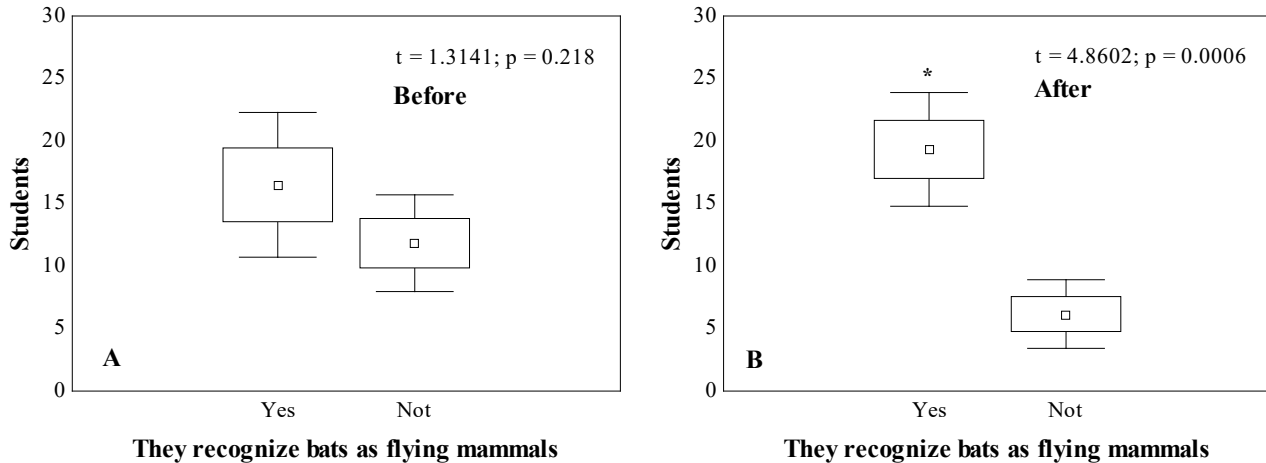


Figure 2 – Classification of bats as flying mammals, an analysis before (A) and after (B) of the intervention. Analysis based on the number of correct or incorrect responses. The mean is indicated by the central square and the standard error by the vertical bars. The asterisk (\*) indicates significant differences between the groups (Student's t-test).

In the diagnosis of students 'understanding of bats' eating habits, initially, 72% believed that there were more than three animals with a blood-sucking habit ( $p = 0.001$ ; Figure 3A), a response that is contrary to reality, indicating a

lack of biological information about the group. After the activities, the students recognized that only three species feed on blood (84%;  $p = 0.00002$ ; Figure 3B) and the others, more than 1440 feed mainly on fruits, pollen, nectar, and

insects. This view on the ecological importance of bats indicated that 41% of the students related the chiropterans for insect control, 30% for seed dispersal, and 28% referred to the importance of bats for pollination. In assessing the perception of bats' use as bioindicators, as expected, students did not have prior knowledge on this topic ( $p = 1.00$ ; Figure 4 A). However, after didactic-

pedagogical activities, this theme started to become clearer (61%) for students ( $p = 0.03$ ; Figure 4B). Finally, after the intervention, the students were able to report the importance of bats (Figure 5), whose descriptions were directed mainly to these animals' diet, indicating a new understanding of these mammals' interactions in natural ecosystems.

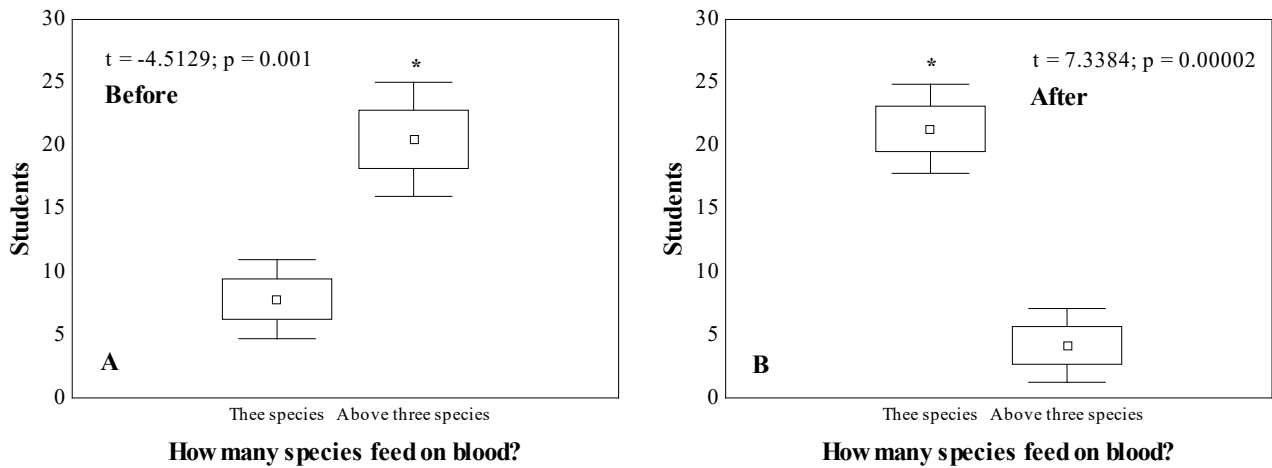


Figure 3 – Perception about bat species' feeding habits, before (A) and after (B) the intervention. The mean is indicated by the central square and the standard error by the vertical bars. The asterisk (\*) indicates significant differences between the groups (Student's t-test).

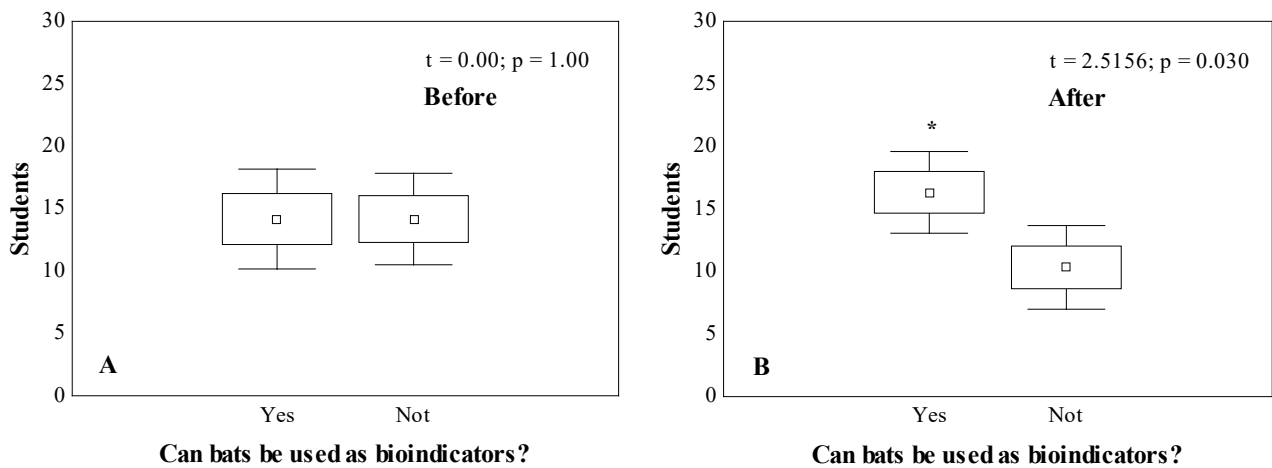


Figure 4 – School perception of bats as environmental quality indicators, before (A) and after (B) the intervention. Analysis based on the number of correct or incorrect responses. The mean is indicated by the central square and the standard error by the vertical bars. The asterisk (\*) indicates significant differences between the groups (Student's t-test).



Figure 5 – Perception of the importance of bats for high school students. Word cloud created in <https://wordart.com/create>.

## Discussion

Bats represent an ecologically and taxonomically diverse group responsible for about one-fifth of mammals' diversity worldwide (Frick et al., 2020). They are primary consumers of nocturnal insects, disperse nutrients across landscapes, and are excellent bioindicators of an ecosystem's health (Ware et al., 2020; Souza et al., 2020). This study seeks to discuss basic knowledge about bats in a school community in Central Cerrado based on this premise. Perceptions about bats' biological characteristics were assessed, where they were poorly understood before academic intervention in the school environment. For the classification of these animals as flying mammals, it was initially observed that students had difficulties in biological characterization. Among the main confusions are its association with rodents, insects, or night birds. However, after school activities with lectures on these animals' basic ecology and practical exercises, there was a significant increase in these animals' understanding. The association of bats with rats is mainly due to the Molossidae Family (Nogueira et al., 2014), also known as free-tailed bats, which consequently shelters on roofs in residences in the urban environment and are confused with rats.

Regarding the feeding habits of bat species, it is important to highlight their ecological and economic role. These animals can increase the monetary gain of farmers, as already observed in

the relation of insect control in rice crops (Puig-Montserrat et al., 2015; 2020; Toffoli & Rughetti, 2017), cotton (Kolkert et al., 2020), vineyards (Rodríguez-San Pedro et al., 2020) and cactus pollination by nectarivores (Tremlett et al., 2019). In addition to this economic bias, this study noted that students believed that blood-sucking bats were a group with a great wealth of species. In contrast, only three feed on blood out of more than 1440 globally (MDD, 2022), restricted in the Americas. Reid (2016) noted a problem of collateral damage in southern Costa Rica, where people seeking to control vampire bats (*Desmodus rotundus*) indiscriminately killed non-target sympatric species (for example, by baiting bats with poisoned bananas), possibly as a result of a lack of knowledge about the diversity of species in this group. In Rio Verde, reports of this attitude have already been observed in rural properties in settlements in the municipality. According to Ribeiro and Magalhães Júnior (2015), in a survey of children aged 4 to 12 years, 23.3% of these students schematically represented bats with red teeth or blood in their mouths, which refers to the blood-sucking habit distorted by myths. Thus, the social need for radiation of knowledge of less charismatic species such as these animals is justified.

The activities carried out in the two schools in Rio Verde provided, in the second moment, a good association on the relationship between bats

and insect control, followed by seed dispersal, these being the ecological functions most indicated by the students. This study was also in agreement with Lopez-del-Toro et al. (2016), where they found the knowledge of coffee growers in Mexico about ecological functions of bats such as seed dispersal and pollination. During the school intervention, this importance was emphasized in the biological control of pest populations, whose presence of the chiropterans population associated with agricultural systems could reduce the damage to crops and directly impact human health due to the natural control of insects (Puig-Montserrat et al., 2020).

Bats are sensitive to contaminants generated by agricultural activities, mining, and urbanization (Souza et al., 2020). The quality of the environment directly influences individuals' animals, wealth, abundance, and health status. Therefore, it is an essential topic in the school discussion, given that healthy species reflect the quality and sustainability of ecosystems. Besides, some species can be used as indicators of environmental health and safety. A priori, we found that this theme was not widespread among students. However, the intervention enhanced a greater understanding of the subject. Two research institutions in Rio Verde (the University of Rio Verde and Instituto Federal Goiano) have been addressing this issue in recent years in the region, adding to efforts to understand the relationship between environmental pollutants and wildlife health (Benvindo-Souza et al., 2019a,b; Borges et al., 2019a,b; Franco-Belussi et al., 2020). In addition to these institutions, other research groups have encouraged work on this same theme in Goiás to select bioindicator species or warn about pollutants' effects (Gonçalves et al., 2015; de Oliveira et al., 2020; Motta et al., 2020).

Finally, from the data obtained in this work, it is worth mentioning that mammals' theme worked in Biology is focused on the second to third two months of the second year of high school. These school investigations took place in the first and second months; however, apparently, this topic had not yet been addressed at the research time. On the other hand, mammals are also worked in the seventh year of elementary school, making little novelty in school; however, it can be little explored. Thus, these data provide evidence of the need for further discussion of this issue in schools. To reach the radiation of these animals' knowledge and others less charismatic, the realization of projects

promoted by higher education institutions aimed at the school community comes to add; and these efforts are recommended. Educational programs that emphasize bat biology and ecology should be conducted in primary and secondary schools to raise awareness of bats among children who could share this knowledge about bats with their families (Lim & Wilson, 2019). Future activities on environmental education involving the theme "bats" can be carried out in a practical way outside the school environment, involving more members of the school community from the perspective of observing the habitats of these animals. Increased awareness in bat habitat areas can lead to the discovery of new shelters (Trehwella et al., 2005), which can favor species monitoring in an ecological and public health sense.

## Conclusion

In summary, this study sought to assess the perception of bats in primary high school students. After the school environment's academic intervention, students showed a better understanding of animals' fauna, from the aspect of classification, feeding habits of species, and their relationship with ecosystems as indicators of environmental quality. Bats can be considered valuable bioindicators of ecosystems, and people can help protect them when they recognize these values. Such values attributed to ecosystem services (insect control, seed dispersal, and pollination) favor sustainability between human relationships and bat populations. Finally, in the face of the current Sars-Cov-2 crisis, research involving this group of animals with the public is strongly encouraged to elucidate these animals' benefits to nature and reduce prejudice against these animals. We also emphasize that the development of school activities with the theme of bats can increase awareness of conservation.

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