Chapter 3

The Bat: A Benefactor Animal Poorly Understood in Algeria

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Additional information is available at the end of the chapter

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Abstract

Bats are very interesting mammals; they are man's helpers because they fight against the proliferation of insects harmful to agriculture and public health. They play an important role in the agricultural economy too because they allow farmers to save money as they do not use pesticides and also their product is organic. Even the feces of bats serve as a fertilizer of excellent quality. With all these assets, bats remain poorly known in Algeria, and protection work is highly recommended.

Keywords: bats, interesting mammals, man's helpers, economy, public health

1. Introduction to the knowledge and the importance of bats

The last few decades have witnessed the progressive impact of humans on global biodiversity [1], not only through simple loss of habitat but also through habitat fragmentation and a reduction in the quality of the habitat that remains [2, 3]. As a result, many species, including bats, are currently threatened with extinction around the world. The 1232 species of bats are found across most of the world other Antarctica and some remote oceanic islands [4]; the number and diversity of species is highest in tropical regions and decreases as they approach the poles (French Society for the Protection and Study of Mammals, 2003). Nearly half of all bat species are listed as threatened or vulnerable by IUCN (International Union for the Conservation of Nature) [5]. The main causes of this situation are increased urbanization, the destruction of natural habitats and the fragmentation of what remains of them into relatively isolated islands of varying sizes [6, 7]. The degree of human 'improvement' of green spaces has led to a lack of 'natural' vegetation and the consequent reduction in insect fauna [8–11]. These changes in

available habitat have resulted in bats exploiting "man-made structures" such as bridges [12], abandoned warehouses and mines and the attics and eaves of houses [13]; some of these animals benefit from the concentration of prey present under electric lighting [14, 15].

Chiroptera are the only flying mammals, representing a quarter of all known mammal species. Despite being the most diverse group of mammals after rodents, there is relatively limited published information available on this group. Bats were historically divided into 2 suborders: the Microchiroptera, which have about 800 species, are relatively small in size and capable of echolocation, and the Megachiroptera, which include about 170 species of relatively large and non-echolocating Old World fruit bats [16]. However, recent molecular studies [17, 18] suggest that this classification should be reviewed, as some families previously attributed to the microchiroptera are closely related to the Old World fruit bats. These include families of temperature insectivorous bats, such as the Rhinolophids. The suggested new classification places the Old World fruit bats and their relatives in a sub-order called the Yinpterochiroptera, with the remaining species attributed to the Yangochiroptera.

Bats are thought to have appeared in a warm climate, probably at the beginning of the Eocene; the earliest known fossil, *Icaronycteris index*, dates back to about 60 million years [12]. In the world, according to phylogenetic work, all existing research support the hypothesis that they appeared during the lower Eocene (52–50 million years) coinciding with a significant global rise in temperature, suggesting that they are from Laurasia, possibly from North America, and Gondwana [18]. In 2011, Ravel et al. found the oldest occurrence of bats in Africa (5.8 to 48.6 million years) in Algeria—El Kohol, in the Brezina region of the southeast the Atlas Mountains—demonstrating that the basal group of bats had a distribution worldwide at the beginning of the Paleogene [19].

Thanks to their longevity, a fairly high position in the food web and a very wide distribution, Chiroptera are a good candidate for being a biodiversity indicator [20]. The year 2012 was declared International Year of the Bat by the United Nations Environment Program (UNEP), to acknowledge the many services provided by bats and to make people overcome some of the prejudices that persist about these harmless animals.

According to Tuttle, Honorary Ambassador for this global event, this initiative was taken in light of the essential role of bats [21]. They provide invaluable services that humans cannot afford to lose, they play a role in maintaining the health of ecosystems and they have a very important impact on the human economy. The order of Chiroptera is the richest in mammal species, nevertheless, in recent decades, populations have declined alarmingly and many species are now endangered. For example, white-nose syndrome, which affects bat populations in most parts of the United States, has killed more than 1 million bats.

Because they are only active at night and difficult to observe and understand, bats are ranked among the most misunderstood and intensely persecuted mammals on our planet. The insectivorous species (Microchiroptera for the majority and the only ones present in Algeria) are the main predators of a large number of insects that fly at night. All over the planet, bats prey on mosquitoes and consume hundreds of other species of insects that humans consider detrimental to their health or economy as they cause losses estimated at billions of dollars a year. To some extent, bats thus participate in the prophylactic means of controlling the diseases

mosquitoes carry, such as malaria or dengue fever. Whatever their geographical distribution, all authors agree that bats are one of the most powerful natural insecticides [22].

A decline in bats may therefore induce greater demands for insecticides, raising the cost of the production of many crops such as rice, maize and cotton because without them considerable additional volumes of insecticides would be used. Foresters have also realized that bats are a valuable ally of the forest ecosystem and are increasingly involved in protective approaches, with increasingly ecological management approach [23].

Bats also play a significant economic role: They allow biological discoveries that ensure the development and exploitation of many products and raw materials. Even their feces can be exploited by agriculture or help with research [22]. While the Executive Secretariat of the Agreement on the Conservation of Bat Populations of Europe (Eurobats) had launched 2012 as the year of the bat, a study published in the journal Science made the link between the decline of bats in the United States and the financial impact for agriculture. According to researchers, the disappearance of bats could cost farmers $ 3.7 billion a year as a result of increased pesticide use. This is a "conservative estimate" of environmental services rendered by bats, warn researchers. By studying their eating habits, they have also been able to establish the positive impact of these mammals on crops. In Texas, for example, bats eat up to 8 grams of caterpillars each night, while Midwest caterpillars eat *Chrysomeles*, including corn, and pentatomidae. Services provided range from $ 12 to 174 per acre (about 40 acres), depending on the nature of production and the type of cultural practice. Scientists hope that "some will disagree with this estimate in order to open a scientific debate on the subject."

According to Tuttle, fruit bats (Megachiroptera) are just as important in maintaining entire plant life ecosystems; their contribution to seed dispersal and pollination is essential to the regeneration of tropical forests, which are the lungs of our planet [21].

Many of the plants that depend on these bats are also of great economic value; their products ranging from wood to fruit, spices, nuts and natural pesticides.

Chiroptera are useful for more than one reason and they have a very important ecological role. For 30 million years, bats have been helping entire ecosystems to live and regenerate. In island environments, endemic species often play a vital role in the survival of island ecosystems. On oceanic islands, fruit bats are often the only species capable of pollinating certain plant species or carrying fruit over great distances. Cox, an American biologist, says that 30% of trees in Samoa are directly dependent on bats. During the dry season, in these same territories, 80–100% of the seeds deposited on the ground are transported by bats. Today, this essential role of pollination and seed dispersal is known and recognized. An American study conducted in the 1990s has also shown that breeding of 300 tropical Old World plants depends totally or partially on bats [22].

In Texas, 1.5 million bats now live in crevices under the only bridge in the city center. When they started to colonize this bridge, the health authorities warned they were dangerous and could spread diseases. However, thanks to BCI's (Bat Conservation International) outreach work, there was widespread public awareness of the situation. In 30 years, not one person has been attacked or contracted an illness. The fear has been replaced by the love of these animals who eat 15 tons of nocturnal insects and which bring in 12 million dollars each summer

thanks to the tourism. Hence the deduction that it is now well-proved that people and bats can share even our cities to great mutual benefit.

It is determined that 450 products used by humans depend directly and indirectly on bats. This impressive list includes, among others, 110 foods or beverages, 72 medicines and 66 tree species used in cabinet making. Some pollinated fruits represent an important economic value for developing countries. This is the case of Durian fruit, *Durio zibhetinus* and Petai, *Parkia speciosa* and *P. javanica*, which are increasingly used as food for some Asian populations. In Africa, the Roussettes are the only species to disperse the seeds of Iroko, a rare species. In the Sonoran Desert, in the southwestern United States and in the arid areas of Mexico, the long-nosed bat plays a major role in the pollination of agaves and large cacti. An entire economy is directly dependent on them, because from these cacti are drawn Tequila and Mescal, two alcohols which represent important currency flows for the local economy [22].

Even the excrement of bats is important, like that of birds. The guano of bats represents a significant source of income for low-income countries. Natural and of very good quality, this fertilizer can, moreover, be exploited on the spot at very low costs [22]. As long as the bats remain present and the environment allows them to feed, this commodity will also be renewable. The guano harvest offers economic benefits to developing countries as it prevents them from importing phosphate fertilizers, often bought in hard currency, which increases their external debt. But bat droppings also have other interests. Millions of unknown bacteria live in the guano and contribute to its degradation. Discovered in the enormous piles of excrement in the southern caves of the United States, bacteria have been isolated and subjected to research programs [22]. The use of these new organisms could make it possible to optimize landfill waste disposal, to partially abandon certain fossil fuels and to produce even more efficient detergents. Only a small part of the microorganisms contained in bat guano has been studied so far and new applications may be discovered in the coming years. The destruction of a colony of bats may eliminate these millions of organisms at the same time even before they have been studied [22].

Pure guano is a good fertilizer for plants, it has a composition of 10-3-1 in NPK and it is also a soil conditioner because it improves its texture and richness. In addition, it contributes to the detoxification of the soil because it is a bio-corrector favoring the proliferation of micro-organisms that eliminate toxic residues and it plays at the same time the role of fungicide by eliminating phytopathogenic fungi and nematocide by promoting the development of decomposing micro-organisms that contribute to the control of nematodes, and it is also an activator of compost: decomposer micro-organisms accelerate the composting process [24, 25].

Bats are also given special attention due to some of their characteristics, which are either unique or important. One can quote their surprising morphology, with their aptitude to flight, as well as their echolocation system. The ecological value of the bats justifies that all their species be considered as "species of fauna strictly protected" by the Bern Convention, 1979, relative to the Conservation of the Wild Life and the Natural Environment. Bats are also listed in Appendix II of the Bonn Convention, 1979, on the Conservation of Migratory Species of Wildlife. Bats are studied and monitored by many international and national organizations, including BCI (Bat Conservation International), Batcon (Bats conservation) and Eurobats (European bats), and in 2013, Africa saw its organization created after the Naivasha summit

in Kenya on February 15, 2013. This had the participation of 19 African countries, Algeria not having been present; the organization was created to contribute to the preservation of the bats of Africa and the Western Indian Ocean Islands and is known as BCA (Bat Conservation Africa). The causes of the reduction in the density of bats are many; the image of the bat in the popular culture can be beneficial or evil, according to culture. Because of their "strange" appearance and their nightlife and, as a result, the mystery surrounding their way of life, they are often victims of popular beliefs and have long been persecuted by humans [17, 18].

In addition to the concerns for its survival, a health warning has come in recent years threatening their rehabilitation with the general public, leaving the threat of zoonosis to be the most feared such as rabies and the fear of bats being the origin of emerging viruses in the Old and New World such as the Ebola virus. The causes of the disappearance of Chiroptera are multiple; it seems to be explained also by the strict ecological requirements of the species in terms of habitats. In fact, a population of bats can only sustainably live in a region if it offers a coherent network of hunting grounds rich in prey and wintering, breeding and transition sites connected by functional circulation corridors, that is to say without any physical interruption. The reproduction and wintering roosts, free from any pollution, are at most 20 km distant from each other [26], within a rich bocage landscape in diversified environments: mainly grazed meadows, wooded areas, wetlands and orchards [27–31]. The animals also hunt large insects, mainly Lepidoptera, Coleoptera (Aphodius, Melolontha, Geotrupes) and Diptera (Tipulidae), which are key prey for some species [27, 28, 32, 33].

2. Presentation of Algeria and its Chiroptera

Algeria is the largest country bordering the Mediterranean (2,381,741 km^2) and the largest country in Africa, and it offers a wide variety of biotopes that make the existence of a great diversity of species of bats possible. There are Mediterranean and desert regions, mountainous regions, highland areas and ancient volcanic regions. Each of these areas can host a particular bat fauna. Chiroptera are represented by 26 species in 7 families; most of these are considered vulnerable in many countries of the world and are listed on the IUCN Red List of Threatened Species (International Union for the Conservation of Nature).

Although much work has been done on mammal fauna, very little work has been done on the bats of Algeria, despite their major ecological role in the maintenance of ecosystems [34]. Indeed, the valuable ecological services provided by bats are still ignored by the majority of the population and even by the authorities in charge of the management of fauna and flora [35]. The main consequence of this state of affairs is that bats are not taken into account in the conservation and management projects of the fauna and flora of ecosystems in many countries where they are threatened or in decline [35].

This lack of basic data on the chiropterofauna of Algeria is a barrier to knowledge and understanding of their role in maintaining the stability of natural ecosystems [34, 36]. Bats do indeed present systematic interests [37] including ecological [34, 38–40], veterinarian [41, 42], medical [43], economic and pharmacological [39, 44] (**Table 1**).

Family	Number of species	Species
Rhinopomatidae	01	*Rhinopoma cystops* Thomas,1903
Emballonuridae	01	*Taphozous nudiventris* Cretzschmar, 1830
Rhinolophidae	06	*Rhinolophus blasii* Peters, 1866
		Rhinolophus clivosus Cretzschmar, 1828
		Rhinolophus euryale Blasius, 1853
		Rhinolophus ferrumequinum Schreber, 1774
		Rhinolophus hipposideros (Bechstein, 1800)
		Rhinolophus mehelyi (Matschie, 1901)
Vespertilionidae	13	*Eptesicus isabellinus*
		Myotis punicus (Felten, Spitzenberger and Storch, 1977)
		Myotis capaccinii (Bonaparte, 1837)
		Myotis emarginatus (É. Geoffroy, 1806)
		Myotis nattereri (Kuhl, 1817)
		Nyctalus leisleri (Kuhl, 1817)
		Nyctalus noctula (Schreber, 1774)
		*Otonycteris hemprichii (*Peters, 1859)
		Pipistrellus kuhlii (Kuhl, 1817)
		Pipistrellus pipistrellus (Schreber, 1774)
		Pipistrellus rueppellii (Fischer, 1829)
		Hypsugo savii (Bonaparte, 1837)
		Plecotus gaisleri (Benda, Kiefer, Hanak et Veith, 2004)
Molossidae	02	*Tadarida aegyptiaca* (É. Geoffroy, 1818)
		Tadarida teniotis (Rafinesque, 1814)
Miniopteridae	01	*Miniopterus schreibersii* (Kuhl, 1817)
Hipposideridae	01	*Asellia tridens* (É. Geoffroy, 1813)

Table 1. Algerian bat species.

To get a general idea about the distribution of bats in Algeria, Kowalski and Rzebick Kowalska established a division of the territory according to large biogeographic sets [45].

The country is divided into five distinct areas, on a North-South axis, characterized by their climate:

The Tell: Large area from 80 to 190 km the Tell includes the plains and the richest territories of the country. The climate is Mediterranean. Sometimes the sirocco brings the heat and sand of the Sahara to the cities of the coast. The eastern part formed by the mountains of Kabylie and Constantine has the most water.

The chains of the Tellian Atlas are located between the sea and the high plains and extend over almost 7000 km (highest point: Mount Lala Khadija: 2308 m). They have forests of olive trees and oaks on their slopes. These regions are very populated.

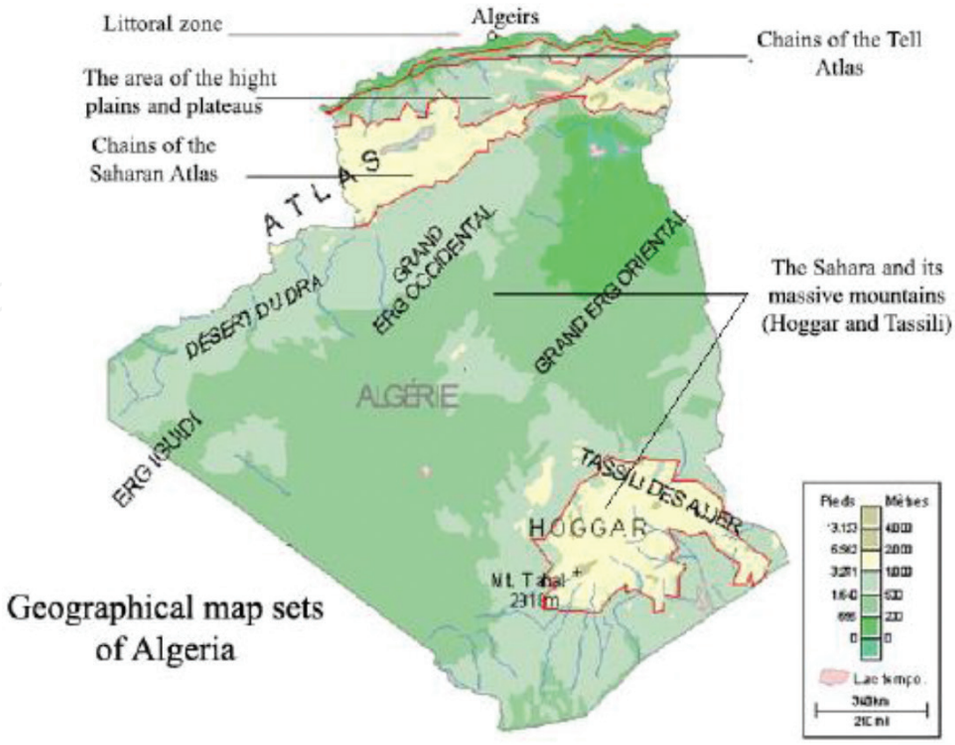

Figure 1. Geographical map sets of Algeria.

The High Plains and Highlands Domain: These immense steppe plateaus stretch from East to West, from 1000 to 600 m. The climate is semi-arid, allowing a cereal crop without irrigation thanks to certain depressions (called chott). Of semi-desert aspect, for a long time, these zones constituted places of Saharan transhumance.

The Saharan Atlas: The south of this succession of mountains marks the limit of the arid climate and limits of the Northern region with the Sahara. Mount Chelia in the Aurès rises to 2328 m.

The Sahara and its massifs (Hoggar and Tassili): covering a large part of southern Algeria, the vastness of the Algerian Sahara includes, with its 2 million km^2, a quarter of the entire desert. It is a dry and arid desert with varied landscapes: great ergs, dry valleys, arid plains and sand dunes. There are volcanic mountain massifs including the massif of Hoggar, which culminates in the highest mountain of Algeria, the Tahat, at 2918 m above sea level, and the Tassili massif. Temperatures range from an average of 36°C during the day to 5°C at night. Riches are found beneath the soil: not only oil and natural gas but also precious metals found during the recent survey of the Hoggar massif. This territory represents 97% of the country's exports (**Figure 1**).

3. History and data on the knowledge of Algerian bats

The first work done on bats in Algeria is represented by that of Dobson who received some bat specimens collected by Lataste [16]; they were individuals of eight species which are *Otonycteris hemprichii*, *Vesperugo* (Vesperus) *serotinus* sub-species *isabellinus*, *Vesperugo pipistrellus*, *Vesperugo kuhli*, *Vespertilio murinus*, *Vespertilio capaccinii*, *Miniopterus schreibersi* and *Rhinolophus euryale*.

In 1912, Weber undertook chiropterological exploration in different parts of the Algiers region and found individuals of *Rhinolophus euryale* and *Myotis murinus* (*M. punicus*) and in 1911 *Miniopterus schreibersii* in Birkhadem [46]. It was not until nearly 20 years later that Laurent cited a Saharan form of the genus *Plecotus*, a rare species of which only one individual was reported by Loche in 1867 in Blida [47]; he studied an individual collected in El Golea by Doctor Foley of the Pasteur Institute of Algiers and he came to the conclusion that there are two *Plecotus* species in the sub-Saharan regions of North Africa *Plecotus austriacus* and a new species *Plecotus auritus saharae*. He was followed by Heim de Balsac in 1936 who questioned the statement of Laurent concerning the genus *Plecotus* [47, 48] he stipulated that the Algerian species is none other than *Plecotus auritus christiei* of which there was another capture at Oumeche near of Biskra by Rotschild and Hartert [49]. In 1944, Laurent first banded bats in Algeria and North Africa in 1942 in a cave around Algiers [50].

In 1976, Anciaux de Favaux established the first complete study of Algerian bats [51]. He cites the presence of 23 species belonging to 5 families, many of which are rare and 2 remain problematic. Javrujan (1980) investigated Algerian bats, as well as border areas with Tunisia and Morocco, found 20 species and 660 individuals. In 1984, Hanak and Gaisler reported for the first time the presence of *Nyctalus leisleri* as a new species for the African continent, from Yakourene region to Tizi Ouzou [52], and they captured an individual of *Myotis nattereri* reported for the second time for Algeria [52]. In 1983 Gaisler completed this list [53], he worked with his collaborators mainly in the northeastern part of the country with the town of Setif as the central point, and it was he who for the first time signaled the presence of *Myotis nattereri* for Algeria, as well as the reappearance after a century-long absence of *Pipistrellus pipistrellus* and *Myotis capaccinii* [54]. They also report the presence of *Hypsugosavii* in three regions of the country at altitudes ranging between 1050 and 2004 m; they gave very important details about its ecology and he studied the distribution of 10 species namely *Rhinolophus ferrumequinum*, *R. hipposideros*, *R. euryale*, *R. mehelyi*, *R. blasii*, *Myotis blythii*, *M. emarginatus*, *Pipistrellus kuhlii*, *Plecotus austriacus* and *Miniopterus schreibersii*. Other work was done by Gaisler et al. [54] and Kowalski et al. [45].

Kowalski et al. and Gaisler and Kowalski studied the dynamics of bat populations in the caves of northern Algeria between 1978 and 1983 and worked on the annual cycle of cave-dwelling species in 26 localities of the country [54, 55], including the Ain Nouissy Cave near Mostaganem (35° 48′N, 0° 2′E), the Yebdar Cave located near Ain Fezza in the Tlemcen Mountains (34° 53′N, 1° 18′W), Cave of Mersa Agla in Honaine (35° 10′N, 1° 39′W), Sig (35° 32′N, 0° 12′W, the mountains of BeniChougrane, the hills of Mourdjadjo at 6 km S from the village of Misserghin near Oran (35° 38′N, 0° 43′W), At the seaside at Madagh (35° 40′N, 1° 0′W), the cave of Aokas (36°) 38′N, 5° 14′E), the cave of Tichy, the valley of Chabet lakhra (36° 39′N, 5° 17′E) there are several artificial galleries of 50–800 m of length carved in the rocks, cave at the foot of Mount Chelia in the Aurès (35° 19′N, 6° 40′E), Hot Cave near Tiddis (36 22′N, 6° 39′E), in the Saharan Atlas considered as the southern limit of the Mediterranean species, in the cave El Rhar in Ain Ouarka (32° 44′N, 0° 10′W) located in semi-desert and rocky, consisting of a single gallery about 800 m long [56], Brezina (33° 6′N, 1° 16′E) and several caves located between the desert. They noted that the hibernation period in Algeria is shorter than in Europe, but that the reproductive cycle was similar and copulation took place in autumn

and fertilization in spring. Parturition was also seen taking place earlier than in Europe for the same species and they noted a tendency to form harems during the breeding season.

The above observations show that bats found in the caves of northern Algeria remain there throughout the year and are not migratory toward Europe as presumed by Heim de Balsac [48]. In 1912 Weber examined and studied the hibernation of bats in Algeria and found specimens belonging to several species in the state of torpor in winter [46]. When the weather is favorable, bats are observed to be active during the winter in northern Algeria [56]; previously, there was no information concerning the winter activity of cave-dwelling bats from Algeria. The caves of Algeria contain more bats in summer than in winter. The same observation has also been made in other areas of the Mediterranean, for example in Dalmatia [57], Provence [58], Sardinia [59] and Corsica [60]. This distinguishes them from Central European caves, which are used primarily as hibernacula while breeding and maternity colonies are exceptionally held in summer.

The hibernation period in northern Algeria is shorter than in European countries. In March in the cave of Misserghin fresh droppings began to accumulate under the bat colony, proving that they had started foraging for food, bat movements inside and between the bats' winter roosts seem to occur especially in Algeria; this was indicated by changes in the composition, number and distribution of bats during consecutive visits to the caves of Algeria. These movements between hibernacula have also been documented in Europe [61].

In the book Mammals of Algeria in 1991, Kowalski and Rzebick Kowalska reported the existence of 26 bat species, confirming the data of Gaisler in 1983 who undertook a variety of work on bats in 1979 and in 1984, and Kowalski and his collaborators had to analyze and study cave-dwelling bats of Algeria [45, 62].

4. Zoogeography of Algerian bats

The bats reported for Algeria belong to the Palearctic region, whose boundaries were delineated by Corbet [63]. This region is described as beginning in the north with the Spitsbergen Islands; the Azores, Madeira and the Canary Islands are included, unlike the Cape Verde Islands which are excluded. In Africa, the western boundaries start at 21°30'N (Between Western Sahara and Mauretania), and the countries that are included are Algeria, Libya and Egypt and excluded are Niger, Chad and Sudan. The Hoggar Mountains are included in contrast to Tibesti. The entire Arabian Peninsula is included. The Asian boundary begins between Pakistan and Iran and continues in Afghanistan to central China.

By working on five large areas resulting from a climatological division of the Algerian territory made by Ochando [64], In 1986 Gaisler and his collaborators stipulated that seven species are characteristic of northern Algeria [54], of which the first and second zones represent the Mediterranean zone, or the climate varies from sub-humid to semi-arid. The third and fourth zone or medulla zone corresponds to the zone with an arid climate, except for some mountainous regions where the climate is semi-arid and possibly the highlands and the Saharan Atlas. The fifth zone is the Sahara with its desert climate and the Saharan mountains.

Family	Number of species		Districts				
			The littoral zone	Chains of the Tell Atlas	Height plains and plateaus	Chains of the Saharan Atlas	Sahara and massive mountains
Rhinopomatidae	1	*Rhinopoma cystops*				X	X
Emballonuridae	1	*Taphozous nudiventris*					X
Rhinolophidae	6	*Rhinolophus blasii*	X	X	X	X	X
		Rhinolophus clivosus	X	X	X	X	X
		Rhinolophus euryale	X	X	X	X	
		Rhinolophus ferrumequinum	X	X		X	
		Rhinolophus hipposideros	X				
		Rhinolophus mehelyi					
Vespertilionidae	13	*Eptesicus isabellinus*	X	X	X	X	X
Miniopteridae		*Myotis punicus*	X	X	X	X	X
		Myotis capaccinii	X	X	X	X	X
		Myotis emarginatus	X	X	X	X	x
		Myotis nattereri	X	X	X	X	X
		Nyctalus leisleri	X	X	X		
		Nyctalus noctula	X	X			
		Otonycteris hemprichii	X	X			
		Pipistrellus kuhlii	X	X			
		Pipistrellus pipistrellus					
		Pipistrellus rueppellii					
		Hypsugo savii					
		Plecotus gaisleri					
Miniopteridae	01	*Miniopterus schreibersii*	x	x	X	x	
Molossidae	2	*Tadarida aegyptiaca*	X			X	X
		Tadarida teniotis					
Hipposideridae	1	*Asellia tridens*				X	X
			16	14	10	13	11

Table 2. Presence–absence of bat species according to the five Algerian geographical sets.

The principal species of northern Algeria, according to this division, are *Pipistrellus pipistrellus*, *Myotis punicus*, *Myotis schreibersii* and more-rarely *Myotis capaccinii*, *Myotis emarginatus*, *Myotis nattereri* and *Nyctalus leisleri*.

The results of this table are derived from the data of Gaisler [53], Hanak and Gaisler [52], Gaisler [56], Gaisler-Kowalski [54] and Kowalski and Rzebick Kowalska [45], and we have provided any necessary updates.

Table 2 shows that 16 of the 26 species (61.53%) of Algerian bats live in the littoral zone, which represents less than 10% of the total land area. This is followed by the two Atlas mountain ranges—the Sahara Atlas and the Tell Atlas which both have 56% of Algerian bat species. The areas with the least diversity of bats are in the high plains and plateaus and the Sahara and massif mountains respectively with 40 and 48%. These last two areas account for more than 70% of the land area of Algeria. These results may reflect the fact that the sampling effort is very biased, because according to the literature, the majority of studies and surveys have been carried out in the northern part of the country: the littoral zone and the Tell Atlas.

5. Habitat and distribution

According to Anciaux de Faveaux (1976) and some of our observations, the bats of Algeria can be divided, according to the habitat they occupy, into four main groups [51]. We found species that fit in two or more groups: troglophilic species, lithophilic species, phytophilic species and synanthropic species.

5.1. The troglophilic species

These are species that overwinter underground in caves and artificial cavities. During the summer breeding season, they seek warmer shelters such as attics, roofs of houses and mosques, ruins and rock crevices. They are represented by 14 species belonging to six families (**Table 3**).

Family	Species	Habitat
Hipposideridae	*Asellia tridens*	In man-made tunnels
Rhinolophidae	*Rhinolophus blasii*	In caves
	Rhinolophus clivosus	In caves
	Rhinolophus euryale	In caves
	Rhinolophus ferrumequinum	In caves
	Rhinolophus hipposideros	In caves
	Rhinolophus mehelyi	In caves
Rhinopomatidae	*Rhinopoma cystops*	In caves, basements of mosques
Vespertilionidae	*Myotis punicus*	In caves
	Myotis capaccinii	In caves, cracks in the pillars of bridges
	Myotis emarginatus	In caves
	Plecotus gaisleri	Winter in caves and was in attics of houses, cracks in trees and minarets
Emballonuridae	*Taphozous nudiventris*	In dry caves
Miniopteridae	*Miniopterus schreibersii*	Old aqueducts, caves

Table 3. Troglophilic species of bats.

5.2. The lithophilic species

These are species that usually roost in rocky crevices and cracks in walls. There are four species belonging to two families (**Table 4**).

5.3. The phytophilous species

These roost in the foliage of trees and under tree bark. All five species belong to the family Vespertilionidae (**Table 5**).

5.4. The synanthropic species

These species roost under the roofs and against the internal walls of human dwellings, under bridges in towns or cities, and hunt around electric street lights in the city (**Table 6**).

5.5. Distribution by roost type

Table 7, a same species can belong to one, two or more groups. The most represented family is Vespertilionidae because its 14 species occupy four roost types. It is also apparent that troglophilic species are the most numerous (14 species), belonging to six families with all the six species of the Rhinolophidae. One family (the Molossidae) has no troglophilic species. There are four lithophilic species, belonging to two families (Vespertilionidae and Molossidae). The latter family only contains lithophilic species. Four species of Vespertilionidae are phytophilic in Algeria, and two other species of this family are synanthropic. In conclusion, we note that

Family	Species	Habitat
Molossidae	*Tadarida aegyptiaca*	Unknown
	Tadarida teniotis	In old bridges, aqueducts, cracks of rocks
Vespertilionidae	*Otonycteris hemprichii*	Wall cracks in underground cavities especially in the Saharan oases
	Hypsugo savii	In rocks crevices and hollow trees in mountainous region

Table 4. Lithophilic species of bats.

Family	Species	Habitat
Vespertilionidae	*Eptesicus isabellinus*	In trees and between leaves and branches of trees
	Nyctalus noctula	In trees, hibernating in cracks of rocks
	Nyctalus leisleri	In Oases
	Myotis nattereri	Near water and trees
	Pipistrellus rueppellii	In Oases

Table 5. Phytophilous species of bats.

Family	Species	Habitat
Vespertilionidae	*Pipistrellus kuhlii*	Cracks, bridges and houses
	Pipistrellus pipistrellus	Cracks and houses

Table 6. Synanthropic species of bats.

Family/habitat	Troglophilic species	Lithophilic species	Phytophilous species	Synanthropic species
Vespertilionidae	4	2	5	2
Molossidae		2		
Rhinopomatidae	1			
Hipposideridae	1			
Emballonuridae	1			
Rhinolophidae	6			
Miniopteridae	1			
Total	14	4	5	2

Table 7. Distribution of the bats by roost type.

the family whose species occupy the four biotopes is the family Vespertilionidae. One family (Molossidae) is lithophilic and the rest of the other families (Rhinopomatidae, Hipposideridae, Emballonuridae, Miniopteridae and Rhinolophidae) are all troglophilic.

6. Biology of conservation

In terms of conservation biology, all species in our study area are protected in Algeria and have a heritage status on the IUCN Red List. The major threats to which they are subjected are mainly of an anthropogenic nature, all the roosts have been more or less affected, the caves are overcrowded in summer and they are subject to disturbance by the activities of the public works services and the widening of roadways. Some old cellars have been restored without taking into consideration the presence of bats and sometimes even demolished. Others are obstructed by buildings, the other roosts, the majority of which are forested, are spared by the direct action of man, but are threatened by repeated fires.

On the basis of this observation, we propose protection measures for sites of interest and, lastly, we propose a succinct action plan for Chiroptera that can be used as a management tool for the managers of the various departments concerned with the conservation of sites of interest and the environment. This action plan will have as a first action, the census of bat houses at a national level, then a follow-up of an inventory of the species, which will give us an overview of the Algerian chiropterological inheritance and will allow us to take adequate measures of protection. For this, a non-governmental organization was created to work on the

protection of bats, its name is ALGERIAN BAT GROUP, and it works on the promotion of the knowledge of the beneficence of this species of mammal.

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