

Cave of the Adaouste (France, Provence): a major regional roosting for the populations of Mediterranean bats. Study for a concerted management of the site

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Abstract

The *Adaouste* cave opens 15 km north of the *Sainte-Victoire* mountain. It has been known since the late 1950s as a major regional roosting for many species of Mediterranean bats. Indeed, its geographical position located on a hill 200m above the lower Durance river is ideal as a hunting area. Today, the low urbanization of the region means that the cavity is still used by populations of bats. However, the *Adaouste* cave, very well known locally and easily accessible, undergoes some human occupations which can be very harmful for the bats. As the previous studies were partial, there was an urgent need to better understand the cave uses by bats. To this end, a study was recently proposed by the *Fédération française de spéléologie*. It includes ultrasonic listening, field visits and climatic monitoring of the different areas of occupation of the cave. We present the first results of this study. At the same time, a cavity management plan is being considered. We thus hope to preserve the cavity for bats while maintaining access to the cavity for cavers during periods of low attendance. Indeed, the cavity still partially described, has a strong karstological interest.

Résumé

Grotte de l'Adaouste (France, Provence) : un gîte régional majeur pour les populations de chiroptères méditerranéens. Étude pour une gestion concertée du site.

La grotte de l'*Adaouste* s'ouvre à 15 km au nord de la montagne *Sainte-Victoire*. Elle est connue depuis la fin des années 1950 comme un gîte régional majeur pour de nombreuses espèces de chauves-souris méditerranéennes. En effet, sa position géographique située sur une colline à 200m au-dessus de la vallée de la basse Durance est idéale comme zone de chasse. Aujourd'hui, la faible urbanisation de la région fait que la cavité est toujours utilisée par les populations de chiroptères. Cependant, la grotte, très connue localement et facilement accessible, subit une fréquentation et parfois des dégradations humaines qui peuvent être préjudiciables. Les études précédentes étant partielles, il était urgent de mieux comprendre les utilisations de la cavité par les chauves-souris. À cette fin, une étude a été récemment proposée par la *Fédération française de spéléologie*. Elle comprend une écoute par ultrasons, des visites de terrain et un suivi climatique des différentes zones d'occupation de la grotte. Nous présentons ici les premiers résultats. Dans le même temps, un plan de gestion de la grotte de l'*Adaouste* est en cours de réflexion. Nous espérons ainsi préserver la cavité pour les populations de chiroptères tout en maintenant l'accès à la cavité pour les spéléologues pendant les périodes de faible fréquentation. En effet, la cavité encore partiellement décrite, présente un fort intérêt karstologique.

1. Introduction

The Adaouste cave (also called Davouste) is located in Provence, in the lower valley of the Durance, 15km north of the Sainte-Victoire mountain. It is perched on a hill 400m above sea level overlooking the Durance valley from nearly 200m. Its pedestrian access is easy and attendance to the upper room does not require any specific equipment. It has always been known locally. It has been the support for several studies on various themes: Archaeology (MAFART

et al., 2004), karstic fillings (CONRAD, ONORATINI, 1997), hypogenic speleogenesis (AUDRA et al., 2009). Concerning bats, it is mentioned as an important roost in the study conducted by Gallocher in 1959 (GALLOCHER, 1959) and by Védovini, an entomologist who in 1961 observed significant deposits of guano and the presence of specific parasites (VÉDOVINI, 1967). Since then, numerous occasional observations or net captures have been made, in particular by the

Groupe des chiroptères de Provence (GCP). But there was a lack of systematic annual observations to determine the periods of occupation and use of the cavity (transit roost, reproduction, nursery, etc.). In addition, speleologists and the owner of the cavity have noted many degradations and occupations harmful to bats (rave party, bivouacs, fires). It was therefore urgent to better understand the

dynamics of populations in order to protect this site in a reasoned manner. Thus, the *Comité départemental de spéléologie et de Canyonisme des Bouches-du-Rhône* (CDSC13, local part of FFS) has proposed a study program. It is part of the animation policy of the Natura 2000 *Montagne Sainte-Victoire* area and has been completed by the GCP with a continuous ultrasound listening program over one year.

2. Cave description and various degradations

The cavity begins with a large room with multiple entrances. The main entrance is 2x2 meters in size. At the other end of the room is a large pitch never used by cavers. Other small entrances give access to this room. A pitch gives access to the *Chauves-souris Room*, a vast sloping room where presence of bats, blackened cupolas and piles of guano are regularly observed. At the bottom of this room, a narrow opening gives access to the *Phosphates Room* also widely used by bats. It has a vertical development of around 20 meters. Subsequently, a complex network of small

connected rooms developed: the *Racines System*. Here ends the description of the upper network. The rest of the cavity develops from the *Chauves-souris Room* through a series of pitches, the presence of bats is much rarer. The upper entrance room shows numerous deteriorations and traces of various occupations, including a bivouac and campfires area (Figure 1, photo b). Very many wild inscriptions are regularly inscribed in the painting (Figure 1, photos a and c). The owner of the premises also testifies to occasional occupations for rave parties.

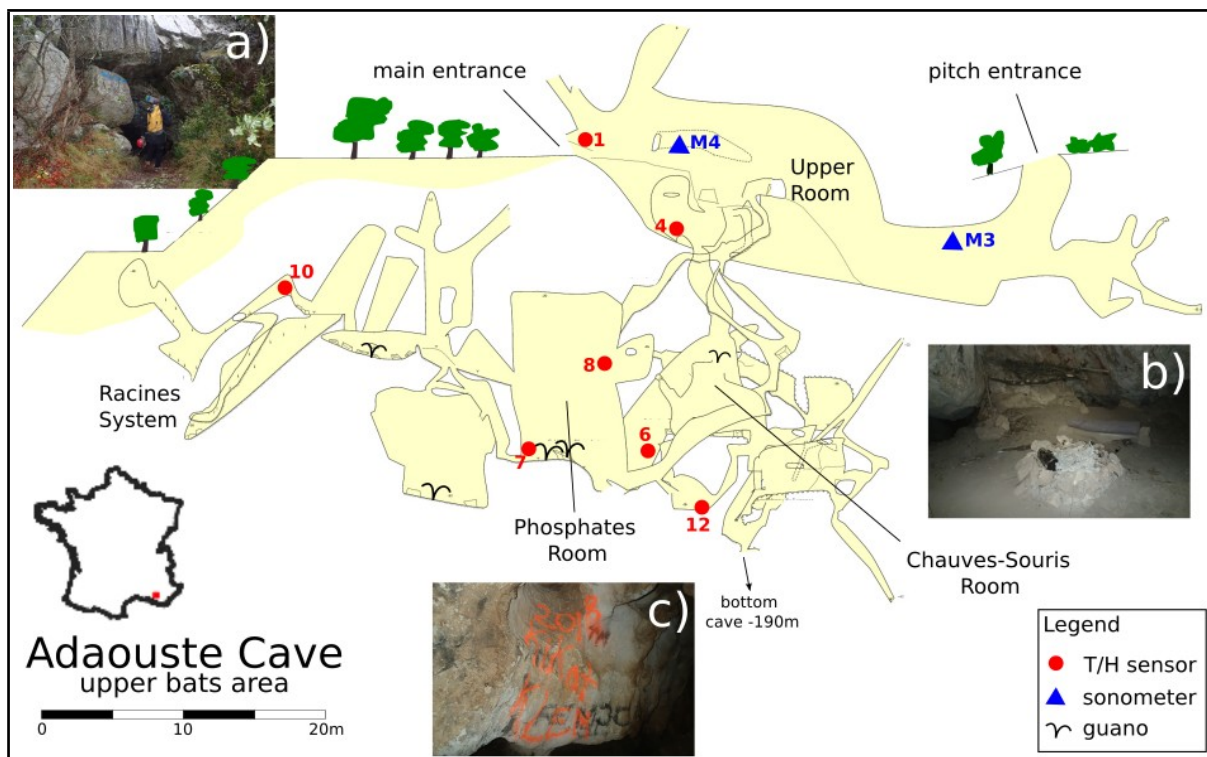


Figure 1: Topographic extended section of upper entrance area (EGELS et CORE 2020). Photos : a) Cave main entrance (L. Core). b) Upper Room, bivouac and campfire (M. Egels). c) Chauve-souris Room, one of the many paint tags (M. Egels).

3. Materials and methods

Due to its hypogenic nature, the Adaouste cave presents a complex and labyrinthine path. The old reference topography only represented the main paths of the two deep networks and of the *Thermometer* network. Since 2016, a team of speleologists from the Bouches-du-Rhône department under the leadership of the *Association Sport et Nature* speleo club has taken an exhaustive topography of the cavity. This is a fundamental element which is a prerequisite for any scientific study.

Twelve temperature and humidity probes were distributed in the cavity between August 2018 and November 2019. The acquisition step was set at one hour. A probe was deployed near the entrance as a reference for outdoor conditions. The others were placed in areas frequented by bats with the aim of measuring the thermal gradients between the low and high parts. Only

seven probes lasted a year of measurement in underground conditions. Figure 2 shows the distribution of the probes in the cavity.

The objective of this study being to acquire knowledge in order to propose a management plan for the cavity with possibly closure of the main entrance, we chose to place two ultrasound batboxes in the upper room. The first near the main entrance between the latter and the wells leading to the bat rooms. The second near the base of the access shaft to the main hall in order to check if the bats were making this entrance and could readjust if the main entrance was closed (see figure 1). The main settings of our batboxes are as follows: maximum listening time: 2 minutes, detection threshold: -50 db; gain: 0 db. The good quality sound recordings made it possible to determine the species. They have been analyzed by *Asellia Ecologie*.

4. Results and discussion

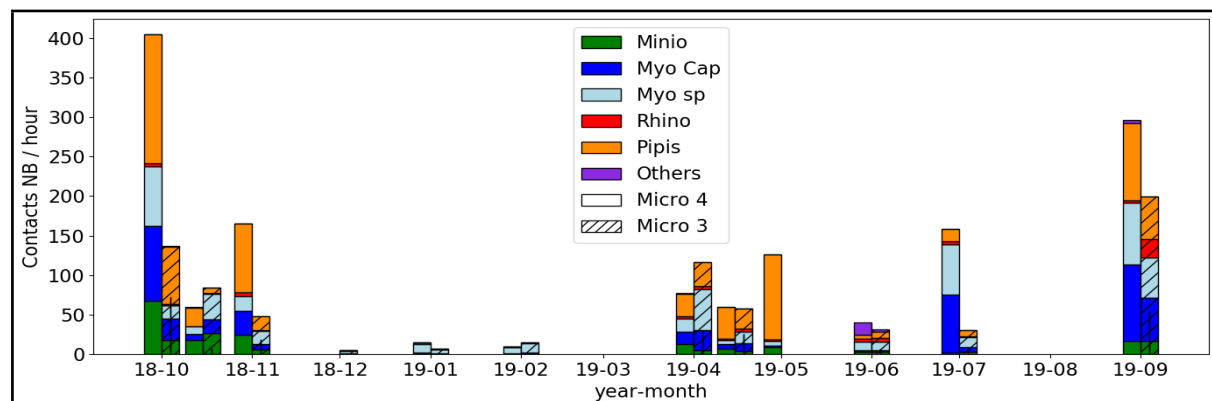


Figure 2: Cumulative bars plot of bats species or groups of species. Unit is number of contacts per hours.

The annual average temperature measured outside is 12.3° C. The top of the Phosphate room is a remarkable hot spot in the cavity (14.3° C on average) with very low variations in temperature and humidity. Figure 2 shows the cumulative species (or groups of species) histograms of the number of ultrasound contacts per hour for each listening campaign. Each listening includes between 2 and 4 nights. The empty bars show the recordings of batbox 4, the hatched bars those of batbox 3. The green bars represent the *Miniopterus schreibersii*, the dark blue the *Myotis capaccinii*, the light blue the other *Myotis* species (*nattereri*, *daubentonii*, *myotis*, *myotis* sp.), red *Rhinolophus* (*hipposideros* and *ferrumequinum*), yellow *Pipistrellus* (*pipistrellus* and *pygmaeus*) and violets all other species detected (*Plecotus* sp., *Eptesicus serotinus*, *Hypsugo savii*). Consider

all species. The maximum peak in attendance at the cave is very concentrated in the summer-autumn period. The period of lowest attendance is in winter. Spring also shows strong activity although weaker than in autumn. In the remainder of the analysis, we will focus on two species: *Miniopterus schreibersii* (*Min. Sch.*) and *Myotis capaccinii* (*Myo. Cap.*). Indeed, they are targeted as species with a very high conservation stake for the PACA region (DENTZ et al 2018), the preservation of underground deposits for these two cave-dwelling is therefore a major regional concern. The *Min. sch.* is very present in late summer / early fall, little present in spring and absent in winter and mid-summer. The catch data made by the GCP show the joint presence of males and females in autumn. This is a strong indication for the use of the cave as a breeding

ground. Spring attendance may be associated with transit. Is the cavity used as a nursery place? Although pregnant females were identified during the June 2001 captures and the temperatures measured are compatible, the low attendance observed in June/July would tend towards a negative response. For *Myo. Cap.*, We note a strong autumn activity with the presence of males and females during the captures suggesting a phase of reproduction. The species is also present in the spring for a transit occupation. Finally, the heavy occupation of July 2019 could mean the presence of a nursery. As pointed out, the climatic conditions in the Phosphate Room are favorable, moreover it is the

area where the most important piles of guano are located. Based on our results, the cavity is not used for hibernation in winter. The temperatures measured between 12 and 14.5° C on average in the different parts of the cave support this finding (DODELIN 2012). The high fall attendance and the diversity of species present (males and females) could be the sign of a swarming cavity. Bats populations can exhibit significant annual variability and occupy various caves of the Durance area. The preservation of a single roost cave is necessary but will remain insufficient. Larger environmental actions will also be necessary (pesticides, urbanization, preservation of rivers, etc.).

5. Conclusions

The *Adaouste* site cave is an important cave for the preservation of bats. Its geographical position, its speleological development and its climatology make it a roost very frequented by many species of which the *Min. sch.* and the *Myo. cap.* both identified as endangered. The features associated with the cave are autumn and spring transit, most likely reproduction, potentially a nursery for the *Myo. Cap.* Given the human

pressure on this site, it is urgent to put in place protective measures. A collective action associating the *Grand site Sainte-Victoire*, the GCP, the CDSC13 and the owner is in progress and will make it possible to finance a reasoned closure of the cavity. Access for speleological and scientific activity will be possible during periods of less crowds of bats.

Acknowledgments

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