

# Invertebrate cave fauna in three protected areas in Catalonia: an excellent team-building exercise

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## Abstract

Although of great scientific interest, studies of hypogean fauna are still not undertaken by many of the government bodies in charge of protected areas. This deficiency is usually attributed to the lack of teams of speleologists that have at their disposal trained entomologists who can collect, sort and identify specimens and/or document and preserve collected specimens. In addition, adequate funding for conducting studies of cave-dwelling fauna and for transferring acquired knowledge is required. To help solve this problem, we began collaborating with four entities whose combined efforts constitute a whole that is greater than the sum of its parts: two public bodies, the Barcelona Provincial Council (DIBA) and the Natural Science Museum of Barcelona (MCNB), a naturalist association, the Catalan Biospeleological Association (BIOSP), and a sports federation, the Catalan Speleological Federation (FCE). In 2016–2020, we studied 18 caves in three protected areas in Catalonia. The most outstanding results include a new species of *Dicranophragma* (Diptera: Limoniidae) and new records for Catalonia of *Troglobisium racovitzai* (Ellingsen, 1912) (Pseudoscorpiones: Bochicidae), *Linderia armata* (Schaufuss, 1863) (Coleoptera: Staphylinidae), *Dactylobasis sexmaculata* (Macquart, 1826) and *Elliptera hungarica* Madarassy, 1881 (Diptera: Limoniidae).

## Résumé

**Le tout est plus grand que la somme de ses parties.** Bien que d'un grand intérêt scientifique, les études de la faune hypogée restent un problème non résolu pour des nombreux organismes gouvernementaux en charge des zones protégées. Cette carence est généralement attribuée au manque d'équipes de biospéléologues avec des entomologistes qualifiés pouvant collecter, trier, identifier et / ou documenter ainsi que conserver les spécimens collectés. De même, un budget adéquat pour réaliser une étude appropriée de la faune troglodyte et pour transférer les connaissances acquises est également essentiel. Pour mener à bien ce projet ambitieux quatre organismes complémentaires ont mutualisé leurs efforts: deux organismes publics, le Conseil provincial de Barcelone (DIBA) et le Musée de sciences naturelles de Barcelone (MCNB), une association culturelle, l'Association catalane de biospéléologie (BIOSP) et une fédération sportive, la Fédération Catalane de Spéléologie (FCE). En 2016-2020, nous avons étudié 18 grottes dans trois parcs naturels de Catalogne. Parmi les découvertes marquantes figurent une nouvelle espèce de *Dicranophragma* (Diptera: Limoniidae) et de nouveaux enregistrements pour la Catalogne de *Troglobisium racovitzai* (Ellingsen, 1912) (Pseudoscorpiones: Bochicidae), *Linderia armata* (Schaufuss, 1863) (Coleoptera: Staphylinidae), *Dactylobasis sexmaculata* (Macquart, 1826) et *Elliptera hungarica* Madarassy, 1881 (Diptera: Limoniidae).

## 1. Introduction

Caves are home to highly specialized faunas harbouring species with very small ranges that are often endemic or relict (GALÁN & HERRERA, 1998; JUBERTHIE & DECU, 1994). These faunas are very sensitive to environmental changes and so can be used as bioindicators of the conservation status of threatened subterranean habitats (TERCAFS, 1992; WATSON *et al.*, 1997; GALÁN & HERRERA, 1998; CAMACHO, 2011; ELLIOTT, 2012; NIEMILLER & TAYLOR, 2019). These environments are particularly at risk from anthropogenic disturbance and several types of impact have been identified for the habitats and organisms they

contain (TERCAFS, 1992; WATSON *et al.*, 1997; GALÁN, 2006). At the request of Barcelona Provincial Council (DIBA), the Arthropod Department of the Natural Science Museum of Barcelona (MCNB), and with support of the Catalan Biospeleological Association (BIOSP) and the Catalan Speleological Federation (FCE), we performed a study of the invertebrate cave fauna in three protected areas in Catalonia (Spain). The main objective of the project was to evaluate the presence of key troglotic arthropods, all of which are endemic and included in protection proposals (VERDÚ *et al.*, 2011).

To assess the possible presence of key species and identify the sites in which these species had previously been recorded, we reviewed both the literature and the

historical collections in the MCNB pertaining to these three protected areas.

## 2. Material and methods

The study was carried out in 18 caves in three protected areas in Catalonia (NE Iberian Peninsula): El Garraf Natural Park, Sant Llorenç del Munt i l'Obac Natural Park and El Montseny Natural Park (Fig. 1).

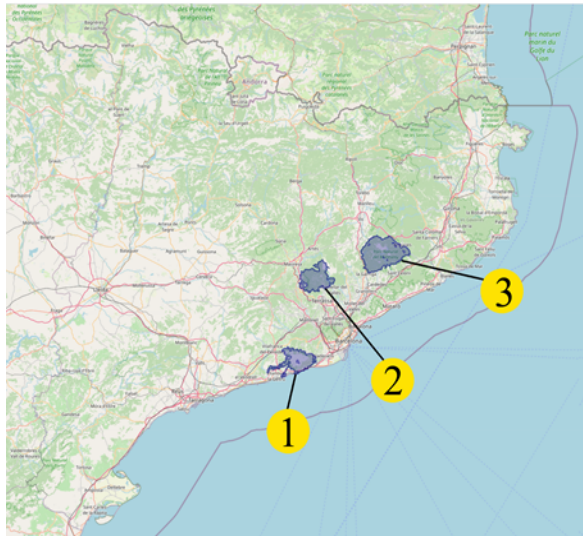


Figure 1. Map of Catalonia showing the location of the three studied protected areas: El Garraf (1), St. Llorenç del Munt i l'Obac (2) and El Montseny (3).

In 2016, we visited five caves in El Garraf: Avenc de la Pepi (Gavà), Avenc Morgan i Comas (Sitges), Avenc de Sant Roc, Avenc del Corral Nou and Avenc Serrano-Arbonés (Begues). The target species in Garraf were the Leiodidae beetle *Troglocharinus ferrerii ferrerii* (Reitter, 1908), and the pseudoscorpion *Troglobisium racovitzai* (Ellingsen 1912).

In 2019, we visited six caves in Sant Llorenç del Munt i l'Obac: Coves d'en Carner (Castellar del Vallès), Avenc de la Canal de Mura (Vacarisses), Avenc de la Codoleda (Matadepera), and Cova Simanya, Cova Simanya Petita and Avenc del Daví (Sant Llorenç Savall). The target species here were *Troglocharinus kiesenwetteri sanllorensi* (Zariquiey, 1924), and the isopod *Stenasellus virei* Dollfus, 1897.

Finally, in 2020, we visited seven caves in El Montseny: Cova Trencada (Tagamanent), Avenc de les Pedreres, Forat nº. 1 i ½ de les Pedreres and Forat nº. 2 de les Pedreres (Gualba) and Cova del Moro, Cova de l'Ermitta and Cova de l'Infern (Aiguafreda). The target species in El Montseny were two *Parvospeonomus* (Leiodidae, Coleoptera), *P. canyellesi* (Lagar, 1974) and *P. urgellesi* (Espanol, 1964).

In each cave, we established three sampling points in different sectors ranging from the entrance zone, to the twilight zone and finally to the profound dark zone, in parts

of the cave that we were able to access (Fig. 2A). At each sampling point, we measured the humidity and temperature with a GEO Fennel FHT60 meter to an accuracy, respectively, of  $\pm 3.5\%$  HR and  $\pm 2^\circ\text{C}$  (Fig. 2B). The arthropod community was sampled by direct sampling (Fig. 2C) and by using pitfall traps with bait (Fig. 2D) following standardized protocols.

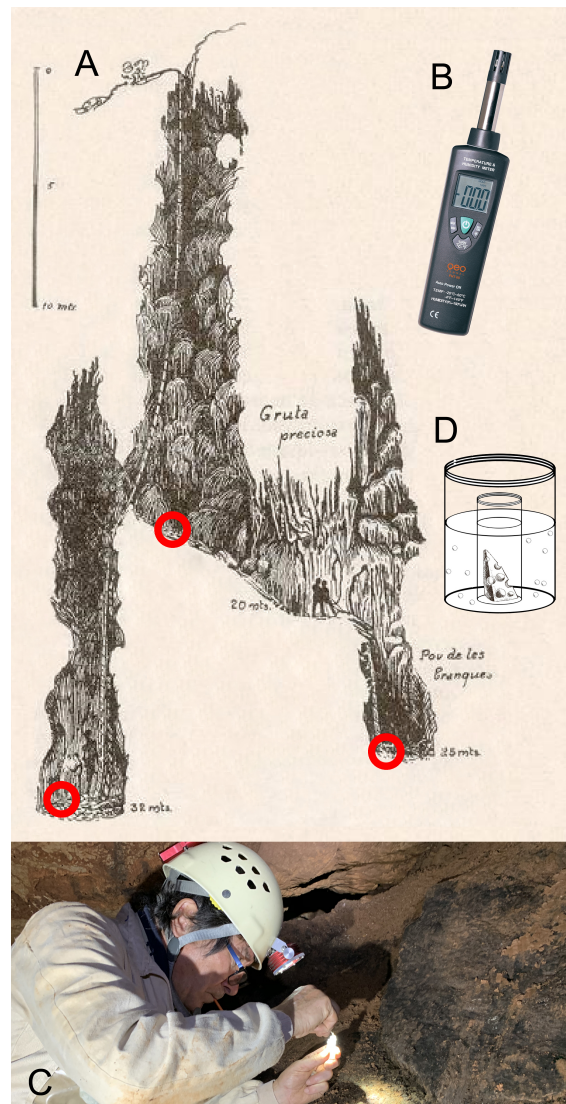


Figure 2. A: Topography of Avenc de Sant Roc (after MIÑARRO & RUBINAT, 2020) with sampling points marked by red circles; B: Humidity and temperature meter GEO Fennel FHT60; C: Floren Fadrique collecting specimens (Image: J. Mederos); D: Illustration of a baited pitfall trap.

When collecting actively, we moved around and searched for the focal taxa, combining visual observation and the use of brushes, soft tweezers and pooters (Fig. 2C).

The standard protocol for active collection is to set a standard capture time period that considers the number of collectors and the area to be prospected.

The baited pitfall traps (Fig. 2D) consist of cylindrical plastic jars (6.5 cm in height x 4 cm in diameter) with an inner tube attached using silicon; the bait consists of a mixture of cheese and bacon designed to attract predatory and/or saprophagous fauna. Pure propylene glycol, which is non-toxic and non-volatile in the temperature and humidity conditions of the caves, is used as a preservative liquid in the traps. Propylene glycol it is also suitable for preserving the DNA of the samples whilst in traps before they are transferred to ethanol. Traps were hidden under stones. A minimum of three fall traps were placed in each cave. The areas that are most sheltered from external environmental fluctuations are particularly sensitive to any alteration in the optimal conditions of humidity and temperature that favour the presence of hypogean fauna.

### 3. Results

The six-target species are well documented (FRESNEDA & SALGADO, 2016) and a large number of specimens exist in collections (Fig. 3). In total, the MCNB collection contains 4682 specimens of these six-key species, collected from 105 caves by 80 different collectors, all of who unwittingly contributed greatly to this study.

The populations of four Leiodidae species (*T. ferreri ferreri*, *T. kiesenwetteri sanllorensi*, *P. canyellesi*, *P. urgellesi*) seem to be stable since they were present in most of the studied caves, which are all fairly well preserved. Conversely, we failed to find any specimen of *Troglobisium racovitzai* or *Stenasellus virei* in two of the caves in which they had previously been reported. In the 18 caves we collected a

Two visits were made to each of the 18 caves, in April–August in El Garraf and St. Llorenç and September–November in El Montseny. A one- or two-month period elapsed between the two visits, during which time the traps were active.

All samples were preserved in 70% ethanol. Catches were quantified as the total number of individuals (adults and immature stages); with only a few exceptions, most arthropods were identified to genus or family level. Due to taxonomic difficulties, some taxa were only identified to order level (e.g. Acari and Opiliones). All specimens collected were labelled, registered and documented in *MuseumPlus*, the official database of the MCNB, which is regularly uploaded to the Global Biodiversity Information Facility (GBIF).

total of 1,374 specimens belonging to seven Classes (Arachnida, Chilopoda, Crustacea, Diplopoda, Entognatha, Gastropoda and Insecta) and 24 Orders and, overall, were able to identify 86 species and morphospecies.

It is also important to highlight that the discovery of a new species of Limoniidae *Dicranophragma relictum* Mederos, 2020 and the new records for Catalonia of species such as *Dolichopoda linderii* (Dufour, 1861), a rare endemic cave-cricket, *Troglobisium racovitzai* (Ellingsen, 1912) (Pseudoscorpiones: Bochicidae), *Linderia armata* (Schaufuss, 1863) (Coleoptera: Staphylinidae), *Dactylolabis sexmaculata* (Macquart, 1826) and *Elliptera hungarica* Madarassy, 1881 (Diptera: Limoniidae).

Protected areas and caves	Previous records & collections	Current samplings	Previous records & collections	Current samplings
<b>EL GARRAF</b>	<i>Troglobisium racovitzai</i>		<i>Troglocharinus ferreri ferreri</i>	
Av. Sant Roc	-	-	X	X
Av. de la Pepi	X	-	X	X
Av. Corral Nou	X	-	X	X
Av. Morgan i Comas	-	X	X	X
Av. Serrano-Arbonés	-	X	-	X
<b>SANT LLORENÇ</b>	<i>Stenasellus virei</i>		<i>Troglocharinus kiesenwetteri sanllorensi</i>	
Coves d'en Carner	X	X	-	-
Cova Simanya	X	-	X	X
Cova Simanya Petita	-	-	X	X
Av. Canal de la Mura	X	-	X	X
Av. de la Codoleda	-	-	X	X
Av. del Daví	-	-	X	X
<b>EL MONTSENY</b>	<i>Parvospeonomus canyellesi</i>		<i>Parvospeonomus urgellesi</i>	
Av. de les Pedreres	X	X	-	-
Forat Núm. 1½ Pedreres	-	X	-	-
Forat Núm. 2 Pedreres	X	X	-	-
Cova de l'Ermita	-	-	X	X
Cova de l'Infern	-	-	-	X
Cova del Moro	-	-	X	X
Cova Trencada	-	-	X	-

Figure 3. Brief summary of the results for the six key species assessed in the three protected areas.

## 4. Discussions and Conclusion

Our findings represent the most up-to-date information for these six strictly troglotic arthropods, which, along with the information from the studied collections, will help improve future management of these hypogean habitats.

We achieved a quite high percentage of positive findings. Although our results are not conclusive, it seems that the relative abundances we observed did not differ greatly from those reported in the bibliography or from the study of the collections that represent over a century of sampling efforts.

Our results from the biological point of view are modest since more visits would give rise to many more captures. However, the aim of this project was to highlight that the whole is greater than the sum of its parts, which is true in the current context and also from an historical standpoint. Today, to carry out this kind of study one needs a highly

qualified team that possesses the skills required to enter caves, collect and identify specimens, document specimens properly, and export data – given that museums are no longer opaque institutions – to international databases.

From a historical perspective, as a museum staff we are incredibly fortunate to have at our disposal wonderful collections from the past century that were built up by hundreds of amateur speleologists who establish the foundations on which much of our current work is based.

To conclude, the title of this communication refers to a formula that depends on the combined efforts of four separate institutions, all of which have highly qualified and skilled staff. This type of collaboration may help to improve the conservation of the subterranean habitats of these protected areas.

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