

## Cavernicolous Invertebrates from Serra Geral Speleological Province, SP, Brazil

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### Abstract

In order to contribute to the knowledge of cave fauna in sandstone regions, this study presents the results of terrestrial invertebrates survey of five caves in Serra Geral Speleological Province, Rio Claro - São Carlos sandstone district, in São Paulo state, Brazil. Eighteen expeditions were made to caves on the period of April to June on 2000. The results were compared with previous surveys done in some of these caves, and in some of other sandstones districts (Altinópolis, São Paulo state, and Altamira-Itaituba, Pará state), and even with the results of some survey in karst landscape. Qualitatively, cave fauna from these province shares several taxa with other known cavernicolous communities, even in limestone caves. Quantitatively, sandstone caves are distinguished only for the representative biomass, which could be explained by the numerous bat populations, providing a larger guano accumulation, and, therefore, more energy.

### Introduction: The Study of Sandstone Caves

The development of caves depends so much on the lithology. Carbonate rocks present high degree of solubility, great mechanical resistance and still they occur in layers separated by joints, which may be folded or fractured by tectonic movements (what could facilitate the cave genesis). All these factors collaborate to the carbonate rocks being the most propitious lithology to development of caves. On the other hand, in Brazil and in all the world, there are also caves in other rock formations, for instance, in sandstone. The great majority of the surveys of the cavernicolous animals focused on carbonate regions, although there are some surveys in sandstone regions. With the intention to contribute to the knowledge of fauna in sandstone caves, this study presents the results of observations and analysis made in Serra Geral Speleological Province, São Paulo state, for terrestrial invertebrates.

### Regional Geology

The following five sandstone caves have been studied during the present project:

**Fazendão cave** (SP-170, 22°24'37" S, 47°47'34" W, Ipeúna, São Paulo state): 200m long, dry, gallery in a ring way, large organic material accumulation (guano).

**Paredão cave** (SP-93, 22°25'45" S, 47°47'46" W, Ipeúna, São Paulo state): A single dry conduit, 60m long.

**Boca do Sapo cave** (SP-182, 22°24'65" S, 47°47'41" W, Ipeúna, São Paulo state): A single dry conduit in a ring way, 120m long. One large entrance with a waterfall near.

**Gruta da Toca cave** (SP-95, 22°11'901" S, 47°44'866" W, Itirapina, São Paulo state): Gallery of about 300m long., with stream. Large organic material accumulation (guano and plants detritus), one entrance.

**Nossa Senhora de Lurdes cave** (unknown geographic coordinates, Analândia, São Paulo state): Rock shelter, dry, 3m long. With civil construction at the entrance (an altar).

These caves belong to the area recognized as Rio Claro - São Carlos sandstone district, in Serra Geral Speleological Province (LINO, 1989). Fazendão, Paredão and Boca do Sapo caves are on Itaqueri mountain range and Nossa Senhora de Lurdes cave is on Cuscuzeiro mountain range. The litho-structural sequence is evident on these mountain ranges, and it is represented by the Cenozoic coverage after São Bento Group of Mesozoic, distributed in Serra Geral, Pirambóia e Butucatu Formations. Caves from Itaqueri mountain occur in Botucatu Formation, N. Sra. Lurdes in Serra Geral Formation and Gruta da Toca occurs in Pirambóia sandstone. The differences between these kinds of geological formations are reflected through the caves architecture (WERNICK, 1973).

## Methodology

From April 9<sup>th</sup> to June 6<sup>th</sup>, 2000, eighteen expeditions were made to the caves in Serra Geral Speleological Province: 6 times exploring Gruta da Toca cave, 4 exploring Fazendão and Paredão caves, 3 times to Boca do Sapo cave and once to N. Sra. Lurdes cave. Sampling of macroscopic terrestrial invertebrates was done in all potential habitats, including rocky substrate (walls and ceiling) and fallen blocks, sediment banks, organic detritus (e.g. wood, guano), decomposing animals (bats), streams and pools. Collections were made using tweezers, brushes, glass and plastic pots, with and without 70% ethanol, and plastic bags. All the clues of animal presence were also observed, like eggs, eggsacs and carapaces.

A Garmin GPS model 45XL was used for confirmation of the location of the caves.

In the laboratory, sampling was made using an estereomicroscope. Subsequently, each sample was separated according to collection date and respective cave. The great majority of the biological material was identified to, at least, the family level, counting on the supervision and help from Brazilian specialists.

## Results

### Taxa Recorded

Table 1 shows the taxa collected during the present study. The most frequent groups were Araneae, Opiliones, Diplopoda and Orthoptera. These taxa have been considered to be frequent among the Brazilian cave-dwelling fauna in general (DESSEN et. al., 1980).

Our results corroborate the idea that the most common spider species in Brazil belong to the genera *Ctenus* (Ctenidae), *Loxosceles* (Sicariidae), *Plato* (Theridiosomatidae), and, less commonly, *Blechnoscelis* (Pholcidae) (TRAJANO & GNASPINI-NETTO, 1990); still, other families were also found, like Trechaleidae, Uloboridae and Lycosidae, which could be considered accidental. Amongst the Opiliones, many individuals were observed in all the studied caves, such as eggs and young individuals. Diplopoda were only found at Gruta da Toca cave, near the stream. In this cave, a large population of Pseudonannolenidae (O. Spirostreptida) was registered. Finally, the most common macroinvertebrate, with large occurrence in Brazilian caves, were the Orthoptera, which were observed on several different substrates and in almost all the studied caves.

Other groups registered in many (or all) caves, or registered as a numerous population were: O. Collembola, O. Diptera, O. Hymenoptera, and O. Lepidoptera. Still, some groups were observed, but in small populations, like O. Pseudoscorpionida, O. Acari, O. Heteroptera, O. Blattodea, and O. Coleoptera.

Considering the relative abundance of the Classes observed, it was possible to note that the Insecta presented larger abundance than Arachnida, which was followed by Diplopoda. However, it is important to note that really numerous populations of arachnids were recorded in some caves.

### Ecological Classification

Some lepidopterans, typical entrance-zone dipterans, and *Lycosa* were considered to be troglonexes, whereas all other observed individuals were considered as troglóphiles: Orthoptera, Blattodea, Collembola, Diplopoda, Pseudoscorpionida, Opiliones, Araneae, Heteroptera, other Lepidoptera etc. In São Paulo sandstone caves, no troglóbites were observed so far. This fact can be explained mainly by the numerous bat populations, providing large guano accumulation, and, therefore, more energy, what may reduce the selective pressures. The shorter development of the caves is another relevant characteristic of São Paulo caves: animals have possibility to go out looking for food. Finally, at least for terrestrial invertebrates, the relative humidity is lower??? than other caves (HOWARTH, 1980 ???).

### Comparison with other sandstone caves

Comparing the surveys of the invertebrates in Altinópolis sandstone district (TRAJANO, 1987), also located in Serra Geral Speleological Province, with the present study, Altinópolis presents a higher number of taxa. The fauna recorded in both districts are similar, occurring some differences. At the level of order or above, the same taxa were recorded (except Chilopoda, which was not observed in Rio Claro – São Carlos). However, in some cases, different families were recorded in each district.

Considering another Sandstone Speleological Province, Altamira – Itaituba, Pará state, where the caves are normally large, mainly horizontal and extensive, crossed by streams, and especially presenting really numerous bat populations and high temperatures (TRAJANO & MOREIRA, 1991), the biospeleological survey indicates several families and numerous invertebrates populations. In addition, there is the record of troglomorphic populations of some Crustacea. Both Speleological Provinces share many groups, including detritus-feeders and predators; however, obviously, in Altamira – Itaituba caves, the frequency and abundance are larger than in Rio Claro – São Carlos caves.

### **Comparison With Karstic Landscape**

The cave-dwelling invertebrate fauna of sandstone landscape basically includes the same groups found on karst landscape (e.g., Vale do Ribeira Speleological Province). One of the most conspicuous difference is the number of individuals, which is higher for sandstone caves, mainly those which feed on guano. Bat populations are more numerous in sandstone caves, due the lowest density of caves in this kind of landscape, and, therefore, bats show larger concentration in a small number of caves.

On the other hand, karstic caves show higher diversity and larger distribution of invertebrates. It comes from many factors, like caves in karst landscape generally presenting great dimensions, higher stability climate and, so, relative humidity, among other physical characteristics. Furthermore, it is relevant to note that Vale do Ribeira Speleological Province is, for instance, also a biospeleological study center in Brazil, providing much information about the life in limestone.

### **Comparison With Previous Surveys Done in Some Caves of the Present study**

Previous surveys done in Fazendão and Paredão caves (GNASPINI & TRAJANO, 1994), and in Gruta da Toca and Fazendão caves (TRAJANO, 1987) allow comparing the occurrence and diversity for these sandstone caves in a relatively short period of time.

In a general way, changes in occurrence have not been so relevant. There is no animal group registered in 1987 that was not observed on the subsequent years. Exclusively for 1994, there were Acari and Psocoptera; and exclusive groups for 2000 were Collembola, Blattodea and Trechaleidae (Araneae).

On the other hand, some common results among 1987, 1994 and 2000 were that crickets (Orthoptera) and Opiliones have been present in all the caves studied (Fazendão, Paredão and Gruta da Toca caves). In addition, Diptera, Hymenoptera, Lepidoptera, Aranea and Pseudoscorpionida occurred in all these surveys but not in all caves.

Many considerations could be made correlating these results, but the most important thing to evidence is that the cavernicolous environment have not changed so evidently during these years. Indeed, even Fazendão and Toca caves, which have a high frequency of visitors, seem to maintain the same fauna.

### **Final Considerations**

Considering the invertebrate records in caves from Altamira, Serra Geral and Vale do Ribeira, the communities from the two last Provinces have a higher degree of similarity. This suggests that lithology is not the preponderant factor in the fauna structure, and that the relative geographical proximity between the caves, and, therefore, similar climate and epigeal faunal components, would represent a strongest factor determining the occurrence of animal groups in the hypogean environment. Still, the caves physical environment in both lithologies are, in general, similar: darkness, low variation of temperature, high relative humidity, and all these factors are essential for determining and restricting the community, as does human action.

Quantitatively, sandstone caves are distinguished only for the large biomass, which could be explained by the numerous bat populations, providing a larger guano accumulation, and, therefore, more energy. Qualitatively, cave fauna from the cited sandstone provinces shares several taxa between them and with limestone cave communities.



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