

GrottoCenter, searching for natural caves in the Sonoran Desert and beyond.

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Abstract--Cave definition is ambiguous, limited and depends on our personal perspective and knowledge about the subterranean systems and habitats. Speleological groups focus on several cavities such as caves, caverns, lava tubes and mines, which are all described as caves, despite their diverse origin, dimensions and environmental conditions. Classification systems have been proposed for all the subterranean habitats even though no single definition has been accepted. Nevertheless, there are basic categories that could guide us on fieldwork. The Pioneer Speleological Group of Sonora (G-PES, in Spanish) is a newly group dedicated to explore, study and conserve caves and others subterranean habitats, mainly in Sonora. Finding cavities in Sonora may seem, at first sight, rather difficult; however, the increasing collaboration between groups and associations, and development of new tools and specialized software strongly support the future search for new cavities. our pursuit for new cavities. For that reason, our main objectives are to publicize general characteristics of different subterranean habitats and learn the use including of GrottoCenter platform. GrottoCenter is a recent community database developed for and by cavers on a wiki-like system. This platform works with cavers contributions; however, anyone who has an Internet access can use it. The system allows to document and modify any cavity and search the "entries" entered by others. Until now, 22 cavities have been recorded in GrottoCenter, but we are looking for more. Great results are being provided by Sonoran explorers who are recording the biodiversity by different programs and we believe that their help could be a valuable resource to continue with search of cavities in Sonora.

INTRODUCTION

Every year, there has been an increasing concern about biodiversity worldwide. Books and publications with a focus on biodiversity have appeared and a rapidly growing up of the amount of information is available (Bribiesca-Contreras and Solís-Marín, 2014; Culver and Sket, 2000; Palacios-Vargas *et al.*, 2014). The same can be said about ONG's that provide different volunteer programs or public outreach tools to participate on biological inventories and collaborative conservation (e.g. Buckley, 2015; Girard and Campbell, 2016; Sky Island Alliance, 2017).

Molina-Freaner and Van Devender (2010) published a book about the biological diversity of Sonora, Mexico, identifying topics lacking previous knowledge as in the field of speleology. Speleology means the study of caves and treats the physical and biological aspects of cave environment (Montero-García, 2000; Moore and Sullivan, 1997; Palacios-Vargas, 1993; Palmer, 2012). Nevertheless, caves are not only subterranean environment. There are more subterranean habitats to explore and study (Carabajal *et al.*, 1996; Culver and Pipan, 2009; Galán, 1993).

Even though Sonora state is the second biggest in surface in the country, there is a lack of information about many aspects of the speleology. Compared with the current knowledge of cavities of Mexico, Sonora represents 1.2% of the current knowledge (caves and cave dwelling fauna), but the geological evolution and variety of ecosystems that it presents in this state could be an ideal place to research several underground cavities of great biological and cultural value (Calva, 2017; Calva and Castillo-Gámez, 2014; Carabajal *et al.*, 1996; Espinasa, 1994; González-León, 2010; Martínez-Hernández, 2004; Martínez-Yrizar, 2010; Moore and Sullivan, 1997; Palmer, 2012). Unfortunately, the understanding of cave definition and the extension of Sonora complicate our objectives about research, exploration and study of all the subterranean environments. However, there are several proposals that might help to understand the complexity of the subterranean habitats and what should we expect in Sonora.

Subterranean Environment

Cave has several definitions, for example, a cave is an empty space of natural origin that is in the underground, large enough to allow human to access. However, this definition excludes a variety of environments that are below the Earth's surface and have the potential to harbor similar physical conditions for living forms (Culver and Pipan, 2009; Montero-García, 2000; Palmer, 2012).

It has been established from the biological perspective that caves as part of the environment or subterranean habitat, which also includes lava tube, fissure system, underground surface, artificial cavities, etc. (Carabajal *et al.*, 1996, Culver and Pipan, 2009; Galán, 1993).

The subterranean environment has a characteristic and unique climate, which differentiates it from other habitats. Cavities are much less variable than the surface, being considered as stable environment. The principal factors are absence of light, stable temperature and high levels of water vapor (Carabajal *et al.*, 1996; Galán, 1993; Galán and Herrera, 1998; Hoffmann *et al.*, 1986; Moore and Sullivan, 1997; Palmer, 2012; Poulson and White, 1969; Rouch, 1986; Trombe, 1952).

Types of Subterranean Habitat

In the speleological literature of subterranean habitats research, the use of morphological terms is indistinct. Therefore, the most accepted definition about subterranean habitats is any cavity, regardless the size, which is a potential habitat for terrestrial, freshwater or marine species, only if there are energetic resources and they exhibit the characteristics of physical conditions. Based on the explorations carried out in the state of Sonora, we agreed with different descriptions from several subterranean habitats based on different authors (Carabajal *et al.*, 1996; Culver and Pipan, 2009; Galán, 1993; Medellín *et al.*, 2017; Montero-García, 2000; Moore and Sullivan, 1997; Palmer, 2012; Romero, 2009), as we show next:

Cave: Natural or artificial cavities excavated or by dissolutive action of the underground waters when they pass through the pores and fissures of the soluble rocks. It is usually of lesser dimensions without exceeding one kilometer of extension. Present different types of speleothems.

Cavern: Deep natural cavities, subterranean or between rocks. It originates by excavation or dissolution like caves. Its extension is greater than one kilometer and less than 10 km long. Those exceeding 10 km are considered cavern system. Present different types of speleothems.

Lava tube: Occurs in areas where basaltic lava has recently flowed from volcanoes. A tube forms when a tongue of lava, flowing down a marked slope, solidifies on its outer surface while the interior remains molten and continues to flow. When the lava has drained out of the interior of the tongue, a tubular cavity remains. Usually they could have long extension but not much depth.

Mine: Created artificially. Dimensions may vary.

Bat cave: Cavities that are regularly used by bats as roosts. Due to the ecological importance of bats, there is a priority to find their roosts. Special type of cavities could be involved, small space without extension and depth such as rocky coats.

GrottoCenter

The site www.grottocenter.org is an international multi-language database dedicated to speleology and fed by speleologists on the principle of a Wiki. Any natural cavity can be recorded there. This Wiki system is a website on which users collaboratively modify content and structure directly from the web browser.

The site is published by the association Wikicaves which is partner of the UIS (International Union of Speleology) and the FSE (European Federation of Speleology) It has set itself to encourage the development of caving around the world, especially through the collaborative participation, disseminate and share information related to the practice of speleology, facilitate access to information on natural cavities, especially via the Internet to highlight and contribute to the protection of natural cavities and their environment, help the exploration and scientific study of natural cavities.

Wikicaves and GrottoCenter have more than 50,000 cavities documented, more than 86 countries involved and more than 2,800 supporters. However, the project continues progress and need more hands to evolve. Anyone can use the site to share knowledge of the underground world, mark its support by becoming an active member of the association or even join the team of developers to implement innovative web technologies.

CONCLUSIONS

Special attention is required during the description of what is a subterranean habitat such as caves, caverns, grottos, lava tubes, mines or bats caves. Usually, locals have a different understanding of what is a cave, complicated our pursuit to find new cavities. These misunderstanding combined with the dimension of the state of Sonora are the obstacles to overcome. Wiki system such as GrottoCenter are useful tools for conducting inventories of subterranean habitats and will be even more beneficial if we collaborate with the explorers of Sonora to cover more gaps together.

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