




Predation of *Tropidurus oreadicus* (Reptilia, Tropiduridae) by *Heterophrynus* sp. (Arachnida, Phrynidae) in a cave in the Chapada das Mesas National Park, state of Maranhão, Brazil

Fábio Antônio de Oliveira¹, Gabriel de Avila Batista², Karla Dayane de Lima Pereira³, Lucas Gabriel Machado Frota⁴, Victoria Sousa⁵, Layla Simone dos Santos Cruz⁶, Karll Cavalcante Pinto⁷


1. Biólogo (Pontifícia Universidade Católica de Goiás, Brasil). Doutorando em Geologia (Universidade de Brasília, Brasil).


 paleofabio@gmail.com

 <http://lattes.cnpq.br/6651314736341253>

 <http://orcid.org/0000-0001-8125-6339>


2. Biólogo (Anhanguera Educacional, Brasil). Doutorando em Recursos Naturais do Cerrado (Universidade Estadual de Goiás, Brasil).


 paleogenetica.gabriel@gmail.com

 <http://lattes.cnpq.br/1131941234593219>

 <http://orcid.org/0000-0003-4284-2591>


3. Bióloga (Anhanguera Educacional, Brasil). Mestranda em Conservação de Recursos Naturais do Cerrado (Instituto Federal Goiano, Brasil).


 karla.biologia@yahoo.com.br

 <http://lattes.cnpq.br/4328373742442270>

 <http://orcid.org/0000-0003-1578-8948>


4. Biólogo (Pontifícia Universidade Católica de Goiás, Brasil). Analista Ambiental da Biota Projetos e Consultoria Ambiental LTDA, Brasil.


 lucasgmfrota@gmail.com

 <http://lattes.cnpq.br/7083829373324504>

 <http://orcid.org/0000-0001-6907-9480>


5. Bióloga (Pontifícia Universidade Católica de Goiás, Brasil). Mestranda em Ecologia e Evolução (Universidade Federal de Goiás, Brasil).


 victoria182@hotmail.com


 <http://lattes.cnpq.br/0747140109675656>

 <http://orcid.org/0000-0002-2818-5698>


6. Bióloga (Centro Universitário de Goiás, Brasil). Especialista em Perícia, Auditoria e Gestão Ambiental (Instituto de Especialização e Pós-Graduação (IEPG)/Faculdade Oswaldo Cruz, Brasil).


 laylasantos1113@gmail.com


 <http://lattes.cnpq.br/3902005396931655>

 <http://orcid.org/0000-0003-4655-7595>

7. Biólogo (Centro Universitário de Goiás, Brasil). Mestrando em Conservação de Recursos Naturais do Cerrado (Instituto Federal Goiano, Brasil).

 karllcavalcante@gmail.com

 <http://lattes.cnpq.br/3845114585099468>

 <http://orcid.org/0000-0001-7072-7262>

ABSTRACT

In the area of the Chapada das Mesas National Park, south of the state of Maranhão, Brazil, the sandstone of the Sambaíba Formation (Triassic) predominate, demonstrating to be an area with potential for the occurrence of groundwater natural cavities. Cavernous ecosystems do not have vegetation cover and light (aphotic). Its trophic resources originate from external physical and biotic agents. The fieldwork found and identified 87 caves and evaluated its degree of relevance, including a biospeleological survey. During the effort, among the representatives of the cave fauna of the park, one of the most common was the amblypygids of the genus *Heterophrynus*, troglóphiles animals, with representatives found in all the tropical and semitropical zones around the world. This group assumes a tertiary or secondary consumer role in the ecosystems where it occurs, with predation records ranging from arthropods to birds such as the hummingbirds (Aves, Trochilidae). One of the *Heterophrynus* records that deserves prominence, occurred in a cave which is in a region where the predominant vegetation of the surrounding area is the *Cerradão*. In this cavity, a trophic relationship of predation was recorded between an amblypygid from the *Heterophrynus* genus and a *Tropidurus oreadicus* lizard. The importance of registering for biodiversity is mainly related to the characteristics of the amblypygids, which makes up one of the orders of less diverse arachnids.

Keywords: Behavior; Amblypygi; Reptile; Conservation Unit.

Predação de *Tropidurus oreadicus* (Reptilia, Tropiduridae) por *Heterophrynus* sp. (Arachnida, Phrynidae) em uma caverna no Parque Nacional Chapada das Mesas, Maranhão, Brasil

RESUMO

Na área do Parque Nacional da Chapada das Mesas (PNCM), ao sul do estado do Maranhão, Brasil, predominam os arenitos da Formação Sambaíba (Triássico), demonstrando ser uma área com potencial para ocorrência de cavidades naturais subterrâneas. Os ecossistemas cavernícolas não possuem cobertura vegetal e luz (afóticos). Seus recursos tróficos são oriundos de agentes físicos e bióticos externos. O trabalho de campo encontrou e identificou 87 cavernas e avaliou seu grau de relevância, incluindo levantamento biospeleológico. Durante o esforço, dentre os representantes da fauna cavernícola do parque, um dos mais comuns foram os amblipígios do gênero *Heterophrynus*, animais troglófilos, com representantes encontrados em todas as zonas tropicais e semitropicais ao redor do mundo. Este grupo assume papel de consumidor terciário ou secundário nos ecossistemas onde ocorre, com registros de predação que variam de artrópodes até aves como o beija-flores (Aves, Trochilidae). Um dos registros de *Heterophrynus* que merece destaque, ocorreu em uma caverna que está localizada em uma região onde a vegetação predominante do entorno é o Cerradão. Nesta cavidade foi registrada uma relação trófica de predação entre um amblipígio do gênero *Heterophrynus* e um lagarto *Tropidurus oreadicus*. A importância do registro para a biodiversidade está relacionada principalmente às características dos amblipígios, que compõe uma das ordens de aracnídeos menos diversas.

Palavras chave: Comportamento, Amblipígio, Réptil, Unidade de Conservação.

Caves are complex environments that present in rocky outcrops (INIESTA et al., 2012). These chambers harbor unique ecosystems, due to the unique characteristics they possess temperature, absence of light (aphotic zone) and vegetal cover (GANEM, 2009; INIESTA et al., 2012). Brazil owns approximately 4.200 caves (AULER, 2006). However, the country's cave fauna is still underestimated (SILVA et al., 2011). The main papers carried out are concentrated in the southeast, center-west and some in the northeast region (TRAJANO; GNASPINI-NETTO, 1990; MOTTA; PEÑA, 1999; AULER et al., 2003; LOBO; MORETTI, 2009; FERREIRA et al., 2010; TRAVASSOS; BETELLA, 2010; SILVA et al., 2011; INIESTA et al., 2012; SIMÕES, 2013). These sites are usually colonized by invertebrates of the orders Arachnida, Diptera, Neuroptera, Acarina, Hymenoptera, as well as some vertebrate species, such as fish, bats and amphibians (TRAJANO; GNASPINI-NETTO, 1990; WEYGOLDT, 2000; LEÃO et al.,

2007; INIESTA et al., 2012). The colonization of this environment is deeply related to the allochthonous origin (generated from outside the cave) and availability of the trophic resources (CULVER, 1982; GANEM, 2009; FERREIRA et al., 2010; INIESTA et al., 2012).

In the Chapada das Mesas National Park (CMNP), located in an area of the Cerrado biome (Brazilian savannah) in southern Maranhão state, Brazil, the sandstone of the Sambaíba Formation (Triassic age) predominates, demonstrating to be an area with potential for the occurrence of underground natural cavities. Between 2012 and 2013 the outsourced environmental consulting company "Biota Projetos e Consultoria Ambiental Ltda" conducted a speleological survey in the CMNP (BIOTA, 2013). The study was carried out for the environmental diagnoses of the Estreito Hydroelectric Plant. The fieldwork found and identified 87 caves and evaluated its degree of relevance, including

a complete biospeleological survey.

In this note, we report a predatory trophic relationship between an adult amblypygid *Heterophrynus* sp. and a young lizard *Tropidurus oreadicus* that occurred in the CMNP. Our observations were made in cave MA46 (6°56'4" S; 47°23'5" W; 191 m a.s.l.), located in the CMNP area called "Porão do Farinha", in the municipality of Carolina (Figure 1). The vegetation around the cave MA46 is one of the types of the Cerrado biome called Cerradão. Compared to the other caves of CMNP, the MA46 was classified with low horizontal projection, being 3 m in length and the entrance is 60 cm high. Also, we found in this cave are spiders (*Sicarius* sp.), Crickets (*Laranda* sp.), cicadellids, the ants species *Camponotus rufipes*, *Crematogaster* sp., and *Paraponera clavata*, the Mamore robber frog (*Pristimantis fenestratus*), the common punaré (*Thrichomys* cf. *apereoides*), and Pallas's long-tongued bat (*Glossophaga soricina*).



Figure 1. Local of the record obtained during the Speleological Survey in the Chapada das Mesas National Park, state of Maranhão, Brazil.

Amblypygids, also known as whip spiders and tailless whip scorpions, represent a group of chelicerate arachnids. To date, there are approximately 200 extant named species of amblypygids (MIRANDA et al., 2016a) with worldwide distribution, especially in the tropics and sub-tropics (WEYGOLDT, 2000). The illustration below shows the main parts of an amblypygid (Figure 2). Their bodies are broad and flattened dorsoventrally. They exhibit pincer-like chelicerae to grind and chew on their prey, cephalothorax (prosoma), pedicel, and segmented abdomen (opisthosoma). These invertebrates also have four pairs of legs. However, the first pairs of legs (Leg 1) are not used for locomotion because they are modified into thin antenniform legs with sensorial function for vibration and smell (WEYGOLDT, 2000; CHAPIN; HEBETS, 2016). Finally, amblypygids have a pair of modified pedipalps to capture and hold prey. They are called raptorial pedipalps and are armed with various spines that impale the prey (LADLE; VELANDER, 2003).

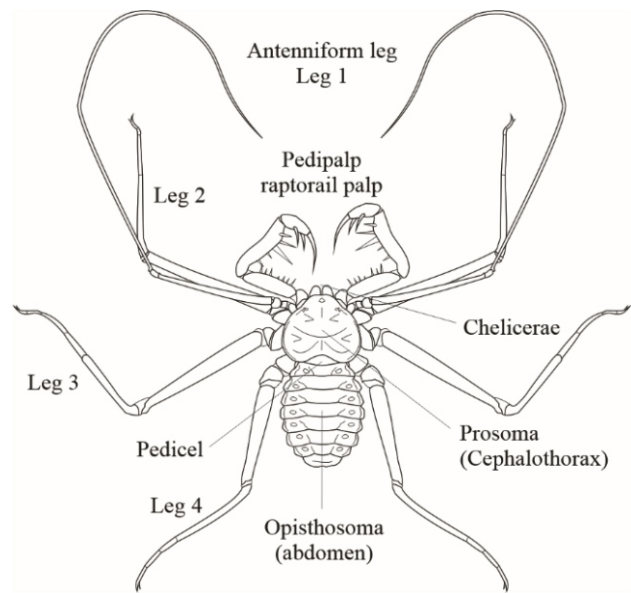


Figure 2. Dorsal view of amblypygid indicating main appendages. Like all arachnids, Amblypygi have four pairs of legs. Leg 1 is antenniform and used for communication and environmental detectability. Leg 2-4 used for walking. The raptorial pedipalps modified are armed with spines and are used to catch prey. The main body contain the pincer-like chelicerae to grind and chew, cephalothorax (prosoma), pedicel, and segmented abdomen (opisthosoma). Image is for illustrative purposes only based on the literature (WEYGOLDT, 2000; CHAPIN; HEBETS, 2016). Drawing by Oliveira, F. A. without scale.

The amblypygids of genus *Heterophrynus* Pocock, 1894 (Phrynidae) were commonly observed in the caves of CMNP (Figure 3a). The Phrynidae family inhabit the most diverse microenvironments, where they assume a secondary or tertiary consumer role (CHAPIN; HEBETS, 2016). Representatives of this family have a diverse diet, but mainly consume insects of the orders Orthoptera and Blattodea and, in some cases, practice cannibalism (WEYGOLDT, 2000; CHAPIN; HEBETS, 2016). Cases of predation or feeding of invertebrates have been reported in the literature as moths (HEBETS, 2002; CARVALHO et al., 2012), harvestmen, millipedes (HEBETS, 2002), crickets and katydids (HEBETS, 2002; CHAPIN, 2011; RAHMADI et al., 2010; PROUS et al., 2017), cockroaches (HEBETS, 2002; CHAPIN, 2015), spiders (HEBETS, 2002; CHAPIN, 2011; MIRANDA et al., 2016b), freshwater prawn (LADLE; VELANDER, 2003), scorpion (FORCELLEDO; ARMAS, 2014), centipede, isopods, booklice (MIRANDA et al., 2016b), termites (RODRÍGUEZ-CABRERA; TERUEL, 2016), and mollusk (TORRES et al., 2019). As for vertebrates, some cases have been reported as lizards of the genus *Anolis* (REAGAN, 1996; KOK, 1998), bats (RIVERA et al., 2009; PROUS et al., 2017), the Antillean crested hummingbird *Orthorhynchus cristatus* (OWEN; COKENDOLPHER, 2006), and the Cachabi robber frog *Pristimantis achatinus* (WIZEN; AZNAR GONZÁLEZ DE RUEDA, 2016).

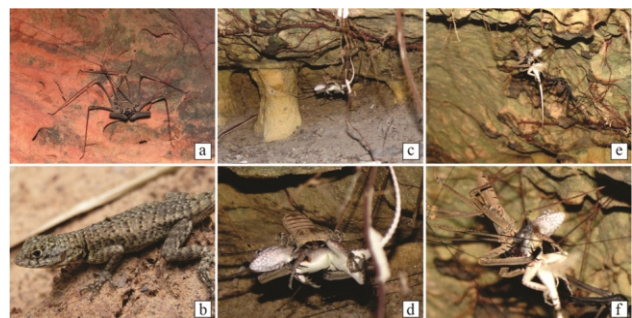


Figure 3. Examples of *Heterophrynus* sp., Arachnida, Phrynidae (a) and *Tropidurus oreadicus*, Reptilia, Tropiduridae (b) recorded in the caves of Chapada das Mesas National Park, state of Maranhão, Brazil. Original (c) and enlarged photo (d) of the capture register of *Tropidurus oreadicus* by *Heterophrynus* sp. in the cave MA46. Original (e) and enlarged photo (f) of *Heterophrynus* sp. feeding on *Tropidurus oreadicus* in cave MA46. Note in the original photo (e) the presence of another amblypygid. Photos: Oliveira, F. A.

The lizard *Tropidurus oreadicus* Rodrigues, 1987 (Tropiduridae) is common in the Cerrado biome (RODRIGUES, 1987) and generally abundant in open vegetation (COLLI et al., 1992; MEIRA et al., 2007; ROCHA; SIQUEIRA, 2008). Like amblypygids, *T. oreadicus* was also commonly observed in CMNP caves. However, no specimens were observed in aphotic areas. The records always occurred near the entrance of the caves, where there is the influence of light. They were observed in cracks or on rock surfaces (Figure 3b). This microhabitat is preferential by *T. oreadicus* and because of this, it is considered an animal of the saxicolous habit (MEIRA et al., 2007).

The predatory trophic relationship we found occurred on April 16th, 2013. We arrived at the MA46 cave early in the evening, around 6 pm. When we illuminate the interior of the cave, we saw 2 m from the entrance an adult *Heterophrynus* sp. with open pedipalps, very close to a young *Tropidurus oreadicus*. Young *T. oreadicus* was on a rock and *Heterophrynus* sp. it was on the cave wall, about 20 cm above. The adult amblypygid captured with its raptorial pedipalps the young lizard. Afterward, holding the lizard with its pedipalps, the amblypygid climbed onto the ceiling of the cave and into the deepest part. At this time the first photographic record took place at 6:04 pm (Figure 3c). The same enlarged photo shows the amblypygid holding the young lizard with the pedipalps (Figure 3d). He spent about 10 minutes just holding the young lizard and then began to feed. Neither our presence, the flashlights, or the camera's flash disturbed the amblypygid enough to make it stop eating. This same behavior was observed in an amblypygid feeding on a bat in a cave in Canaã dos Carajás, Pará state, Brazil (PROUS et al., 2017) approximately 195 miles (ca. 314 km) from the MA46 cave at CMNP. Subsequently, a second amblypygid appears and is close to the first amblypygid, which fed on the young lizard. The last photographic record was obtained at 07:25 pm. You can see the second amblypygid next to the first (Figure 3e). The same enlarged record shows in greater detail the amblypygid while feeding on the young *Tropidurus oreadicus* (Figure 3f).

After the last photographic record, amblypygid led the young lizard into one of the holes in the deepest part of the MA46 cave and disappeared. These holes can be seen in Figure 3c. It was not possible for the collection of the specimens due to the difficult access to the deepest part of the cave MA46, which is about 20 cm high. However, its species was identified by other biological samplings in the near cavities. All Tropiduridae specimens we collected were only *Tropidurus oreadicus*.

The amblypygids compose one of the orders of arachnids with less representation (CHAPIN; HEBETS, 2016). There are few records of the eating behavior of amblypygids in the literature and are still unknown to most species (WEYGOLDT, 2000; LADLE; VELANDER, 2003). As already mentioned, there have been records of amblypygid feeding on lizards (REAGAN, 1996; KOK, 1998). However, these records did not occur in caves. To date, the only records of vertebrates consumed by amblypygids in caves have been by bat necrophagy, with records in the Dominican Republic (ARMAS; ABREU-COLLADO, 1999 apud RIVERA et al., 2009), Cuba (RIVERA et al., 2009), and Brazil (PROUS et al., 2017). The 1999 Armas and Abreu-Collado record are the first of bat necrophagy, but it was published in a local

Dominican newspaper, with almost no scientific readiness. However, Rivera et al. (2009) reproduced the content in their paper.

The amblypygid ethology indicates basal levels of social behavior, tactile learning, recognition of individual characteristics, and intraspecific divergence of behavior (CHAPIN; HEBETS, 2016). Apparently, necrophagy may be a feature adopted by amblypygids in some situations (TORRES et al., 2019), as recorded in some caves. However, Chapin (2015) suggests behavioral variation in cave amblypygids, which were more vigilant and active in hunting. Another behavioral variation of hunting influenced by the environment was observed in amblypygids that immerse their antenniform legs in the water and await physical contact of the shrimps to hunt them with the raptorial pedipalps (LADLE; VELANDER, 2003).

The predation record of *Tropidurus oreadicus* by *Heterophrynus* sp. at CMNP is of great importance for biodiversity since it is mainly related to the characteristics of the amblypygids. Here we present the first record of amblypygid predation in Tropiduridae lizard, the first record of vertebrate predation in Brazil, and the first record of cave vertebrate predation. It also demonstrates how the group's diet is varied and helps to understand how species adapt to varying environments.

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