Aspects of the biology of *Heterophrynus brevimanus* (Amblypygi: Prhynidae) in a Brazilian cave

Aspectos da biologia de *Heterophrynus brevimanus* (Amblypygi: Prhynidae) em uma caverna brasileira

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ABSTRACT

We estimated the population size, individual movement and alometric variations in *Heterophrynus brevimanus* in Passa Três cave. The population size was estimated in 55±16 individuals. The recaptured individuals had been found next to the acquittal places indicating territoriality. The wide distribution of *H. brevimanus* in the cave can be due the distribution of potential scavenger preys. Two classes of body size were identified. Two peaks in pedipalp size can indicate the existence of sexual dimorphism. The alometric variation on sensorial structure (antenniform legs) wasn't evidenced.
Keywords: Caves; Amblypygi; Population size; Morphometry.

RESUMO

Foram estimados o tamanho da população, movimento dos indivíduos e variações alométricas de *Heterophrynus brevimanus* na gruta de Passa Três. O tamanho da população foi estimado 55±16 indivíduos. Os indivíduos foram recapturados próximos ao local de soltura, indicando territorialidade. A distribuição de *H. brevimanus* pode estar relacionada à distribuição de suas presas. Foram visualizadas duas classes de tamanho corporal. Dois picos no tamanho dos pedipalpos podem indicar a existência de dimorfismo sexual. Variações alométricas nas estruturas sensoriais (patas anteniformes) assim como no pedipalpo não foram evidenciadas.
Palavras-chave: Cavernas; Amblypygi; Populações; Morfometria.

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INTRODUCTION

The caves are part of a system called karst, that can be characterized as a dynamic geologic complex in constant modification, mainly for the action of the water acting in the formation, molding and deposition of several geological traits (Gilbert *et al.*, 1994).

The cave environment is characterized by a high stability and a permanent lack of light (Poulson & White, 1969). In general, the physical environment varies them less than the epigean (external) environment (Barr & Kuehne, 1971). The physical conditions vary not only in time, but also between different caves and even between distinct areas inside a single cave (Culver, 1982).

Primary producers are not present in caves, with the rare exception of a few chemoautotrophic bacteria that can use iron or sulphur as electron donors. So all the energy or food that enters a normal cave system is imported from the external environment.

Food enters in the caves in three different ways (Culver, 1982). Organic matter is carried directly by streams and vertical shafts, and this source can be important for the terrestrial as well as the aquatic community, because a layer of plant detritus can be left by floodwaters. Beyond it, the dissolved organic matter, together with bacteria and protozoans in percolating waters penetrates through the limestone. Finally, feces or corpses of animals that transit between caves and the epigean system with regularity are also important sources of food, mainly in permanently dry caves. Cave communities are, in general, essentially based upon detritivorous species (Ferreira, 1998; Ferreira and Martins, 1998).

Cave organisms show different degrees of morphological, physiological and behavioral specializations (Holsinger & Culver, 1988; based on Schinner-Racovitza' system). Trogloxenes are those who can be found regularly in caves, but need to leave the cave to feed, so they are unable to complete their entire life cycle inside caves. Many of these organisms act as importers of energy from the external environment, often being primarily responsible for the energy input in permanently dry caves. Troglophiles can complete their life cycle in the external environment or in caves. Troglobytes are the most specialized organisms, occurring only in caves. These animals can show morphological, physiological, and/or behavioral specializations, probably evolved either in response to the selective pressures found in caves or in the absence of normal external selective pressures.

The Amblypygi Order have near 100 species, amongst which many can be found in caves. These arachnids have flattened bodies and well developed pedipalps. The first pair of legs is antenniform and has sensorial function (Weygoldt, 1970). They possess nocturnal habits and have predominantly tropical distribution. The sexual dimorphism is not evident in many species but in others, as *Charinus brasilianus*, *Heterophrynus batesii*, and *Trichodamon froesi*, the males have the pedipalps more developed (Weygoldt, 1994). The female lay the eggs some weeks or months after copulation. After eclosion the immature individuals are called pre-nymphs, and soon after its birth, they adhere to the abdomen of their mother. After approximately one week, the individuals suffer the first ecdise, and then they start to have a free life, passing throw many ecdises until reach the adult phase (Weygoldt, 1970).

Studies regarding the population ecology of

Heterophrynus, especially in caves, are rare (Rodrigues, 1998; Morales & Amado, 1986). The aim of this study was to estimate the population size of *Heterophrynus brevimanus* in Passa Três cave, and also to verify the degree of individual movement in this cave as well as identify the eventual sexual dimorphism and alometric variations existing in this population.

METHODOLOGY

Study area

The Passa Três cave (13°36'14"S, 46°23'26"W) is situated in São Domingos city (GO), Brazil. The cave presents a horizontal projection of 775 meters, having its entrance located at an altitude of 645 meters. Most part of the main conduit is covered by a stream, which continuously brings organic matter to the system. Bat guano piles are found in both cave levels, near the stream and also in upper galleries (droughts). The cave can be characterized as meso to eutrophic, given the amount and diversification of resources present, as well as the diversity of detritivorous found.

Methods

The study was token in the month of August of 2000. All the individuals of *H. brevimanus* found in the cave were captured, measured, marked and then freed. The cephalothorax width and length, femur and total first pair of legs length, and first and second segments length of pedipalps of each individual were measured with a pachymeter (Fig. 1).

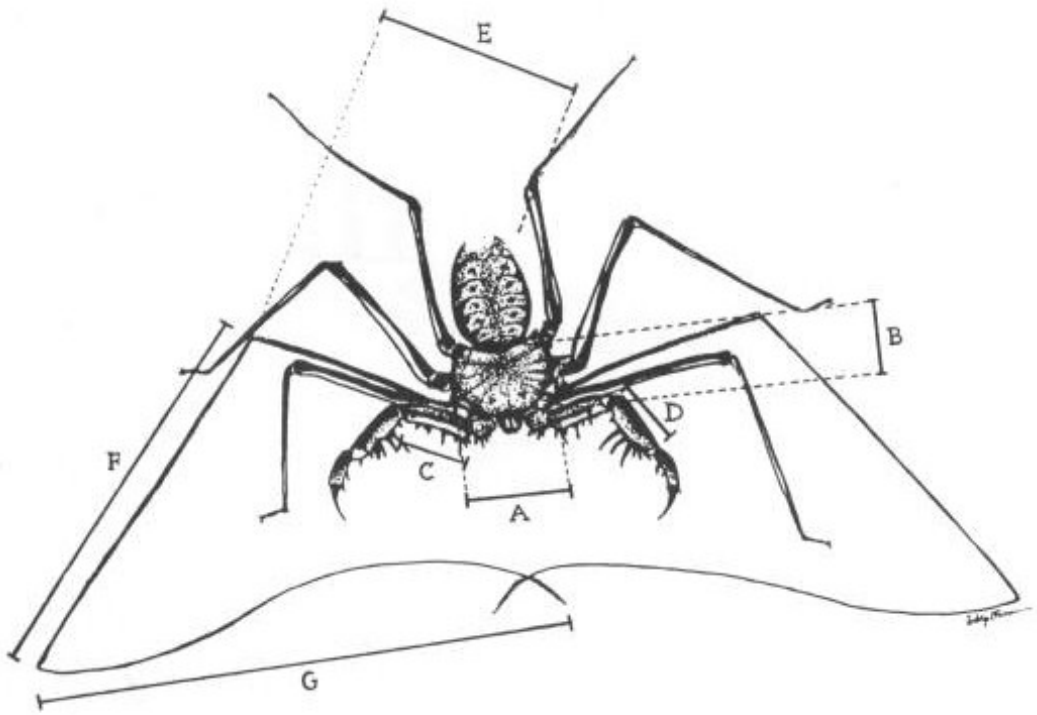


Figure 1. Measured portions of the individuals of *Heterophrynus* sp., described as follow: A – Cephalothorax width; B – Cephalothorax length; C – Length of the first segment of pedipalp; D – Length of the second segment of pedipalp; E – Femur of the antenniform leg; F – Tibia of the antenniform leg; G – Distal segments of the antenniform leg.

All the *H. brevimanus* captured had received an individual marking in cephalothorax and were plotted on a cave map.

Three days after the capture we returned to the area for a recapture. The position of each recaptured individual was observed and each new individual captured was measured. The population size was estimated by the capture, marking and recapture method of Lincoln-Petersen (Fernandez, 1995).

The presence of an eventual sexual dimorphism was determinate using a histogram of the pedipalp adult individuals measures. The adult individuals were determined by a principal component analysis (PCA), using all the morphometric measures. The two groups (obatined by the PCA) were, then, compared with histograms of cephalothorax length and width, determining which group contained the adult individuals. This method was used since the growth of these organisms is not continuous, being possible to determine age instars by comparing different size categories (determined by the ecdysis). The presence of alometric relations in individuals of *H. brevimanus* was tested by linear regression between the compared morphometric variables.

RESULTS

A total of 33 individuals were captured in all cave extension and measured. In the first collection were found and marked 16 individuals, and in the second more 23, from which 6 individuals were marked from the first collection. The recaptured individuals had been found next to the acquittal places. The population size was estimated in 55 (±16) individuals.

The values of the measured structures of each individual were variable (Tab. I). The size and the width of cephalothorax had respectively varied from 0,45 cm to 0,90 cm and from 0,39 cm to 1,81 cm. The femur size varied from 1,70 to 4,90 cm. The size of the first leg varied from 19,5 to 23,9 cm. The pedipalp's femur size varied from 1,10 to 1,63 cm and the total size of pedipalp varied from 1,91 cm to 3,58 cm. The regressions between the measures of leg, pedipalp and cephalothorax did not suggested any alometric relation (type $y=ax^b$) between those structures.

The histograms of size and width of cephalothorax showed two groups (Fig. 2 a and b) that, compared with the two distinct groups

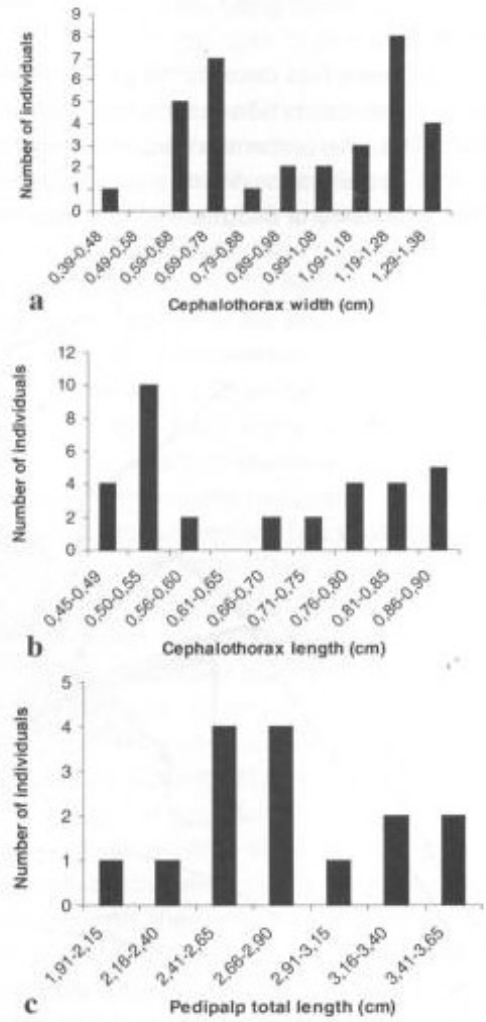


Figure 2. Individuals distribution of *Heterophrynus brevimanuson* on the differente classes of cephalothorax (a) width and (b) length, and (c) first leg lenths).

Table 1. Measures of cephalothorax lenght and width, first leg femur lenght, first leg length and first and second pedipalp segment length (In cm)

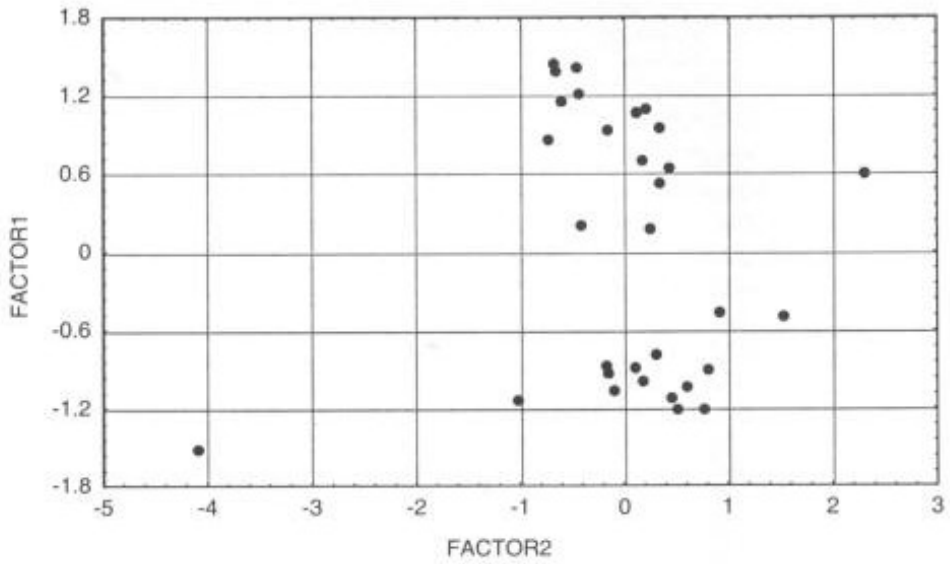
Individual	Ceph. length	Ceph. width	Femur length	Leg 1 length	1st ped. Seg. Length	2nd ped. Seg. length
1	0,75	1,13	4,00	19,50	1,21	1,19
2	0,80	1,22	4,70	23,00	1,50	1,56
3	0,55	0,75	2,00	12,80	0,53	0,72
4	0,90	1,35	4,80	23,70	1,70	1,75
5	0,82	1,21	4,70	21,30	1,31	1,40
6	0,56	0,90	2,80	14,40	0,67	0,85
7	0,87	1,25	4,70	23,40	1,41	1,46
8	0,82	1,16	4,50	21,50	1,26	1,36
9	0,79	1,20	3,90	19,70	1,10	1,39
10	0,51	0,72	2,40	12,40	0,59	0,70
11	0,52	0,74	2,40	12,10	0,60	0,71
12	0,59	0,90	2,80	14,00	0,70	0,80
13	0,80	1,23	4,40	21,90	1,40	1,51
14	0,90	1,33	4,90	23,10	1,60	1,75
15	0,50	0,39	1,70	8,50	0,40	0,44
16	0,55	0,79	2,50	12,10	0,61	0,65
17	0,89	1,33	4,90	23,70	1,63	1,95
18	0,68	1,01	3,70	17,80	1,01	1,11
19	0,45	0,65	2,30	11,10	0,48	0,60
20	0,50	0,68	2,20	11,00	0,45	0,62
21	0,52	0,71	2,30	12,10	0,52	0,68
22	0,45	0,65	2,00	10,60	0,44	0,56
23	0,48	0,59	2,20	11,30	0,51	0,62
24	0,45	0,67	2,10	10,10	0,43	0,56
25	0,50	0,75	2,20	9,70	0,51	0,70
26	0,50	0,70	2,30	11,80	0,52	0,60
27	0,50	0,75	2,40	12,10	0,52	0,68
28	0,71	1,02	3,60	17,20	1,02	1,24
29	0,88	1,81	4,50	22,40	1,60	1,61
30	0,84	1,27	4,60	22,80	1,28	1,60
31	0,81	1,15	4,50	22,20	1,30	1,43
32	0,80	1,19	4,00	20,60	1,20	1,29
33	0,69	1,19	4,10	20,90	1,21	1,34

obtained by the PCA analysis, confirmed the existence of two well distinct groups (Fig. 3). The histogram of pedipalp size presents two peaks that suggests sexual dimorphism in *H. brevimanus* (Fig. 2c).

Individuals of *Endecous* sp. (Ensifera, Phalangopsidae) and Dictyoptera had been observed in the cave, those are potential preys of *H. brevimanus*.

DISCUSSION

Studies regarding biology and population dynamics of Amblypygi are scarce (Gonzales & Morales, 1986a, 1986b). The majority of the researches involving this Order are related to systematics and biogeography (Weygoldt, 1998; Griffin, 1998; Harvey & West, 1998; Weygoldt, 1999; Shultz, 1999). The study of



Variable	Factor 1	Factor 2
Cephalothorax length	0.989239	-0.122060
Cephalothorax width	0.987617	0.145521
Leg1 Length	0.993625	0.015853
Total pedipalp length	0.993136	-0.038992
Eigenvalues	3.927590	0.037847
% Variance	0.981898	0.009462

Figure 3. Factor 1 versus Factor 2 extracted from the PCA analysis.

biology of these arachnids in caves are very important, since these organisms can act as top-predators in the caves where they occur, influencing in the communities structure (Quintero, 1981).

The inexistence of studies about population size of cave whip-spiders species does not allow a satisfactory evaluation concerning the population size of *H. brevimanus* in the Passa Três cave. However, Howarth (1983) pointed out that is difficult to determine the actual population sizes in caves, since these environments possess inaccessible extensions to the man, what can lead to a sub-estimate of the population size.

Passa Três cave possess two basic types of resource. The first consists mainly of vegetable material, continuously brought by the river. Beyond this, bat guano deposits can be found, that can be considered as ephemeral resources, but attract equally great amount of scavengers species. According to Ferreira (1999b), cave whip-spiders can be attracted for bat guano deposits that present great number of preys, as crickets and cockroaches. Such attraction can occur mainly in permanently dry caves, where guano represents the main source of organic substance that supports the invertebrate community (Ferreira & Pompeu, 1997; Ferreira & Martins, 1998; Ferreira & Martins, 1999a, 1999b). Such fact, however, does not exclude the possibility of attraction of these organisms for deposits located in caves with streams. So, the occur-

rence of a great number of *H. brevimanus* in virtually all the extension of the cave can be due to the wide distribution of potential preys, associated to vegetable material brought by the river as well as to the guano deposits placed mainly in upper conduits, where the resource carried by water practically doesn't exist.

Some species of whip-spiders can be territorialists, and fights between males to defend their territory are quite common (Weygoldt, 1972). The six *H. brevimanus* recaptured near the acquittal places, represent an slight evidence that this species can shows a certain degree of territoriality in this cave, as well as the described by Quintero (1981), for the species *Phrynus gervaissii.*

The existence of two groups in the PCA can indicate at least two well-defined development periods in that population. The non-existence of a third group indicating "younger" individuals can be due to the difficulty of capture of these. According to Weygoldt (1994), young individuals of whip-spiders, which still do not have the antenniform legs completely developed, are not capable to produce intraspecific recognition signs. So they would remain more time hidden from the adults in cracks and holes, probably to prevent them to be predated by the adults.

Perhaps the two peaks found in pedipalp size indicate the existence of sexual dimorphism in this species. Such fact corroborates with the comments of Quintero (1981), which described that the males of some species of the *Heteroprhynus* possess pedipalps more elongated than females.

In cave populations of *H. elephus* were evidenced alometric relations in the size of the anteniform legs (Igelmund, 1989). However, since we found only two size classes in *H. brevimanus*, it is difficult to evaluate the presence or absence of alometric variations in individuals of this species. The actual pattern can only be evidenced if we compare at least three size classes, and, since we did not collect any first instar individuals (pre-nymphs), it is practically impossible to verify a possible maximization of structures in this population of *H. brevimanus.*

The information concerning this species reveals of great importance for the actual characterization of that cave ecosystem. Since *Heteroprhynus brevimanus* can be considered "top-predator" in the system, any changes in its population can cause modifications on the ecosystem structure, that could only effectively be conserved when the species dynamics (as of the present work) were effectively elucidated.

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