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Biological notes on and population size of *Pachylospeleus strinatii* Šilhavý, 1974 in the Gruta das Areias de Cima, Iporanga, south-eastern Brazil (Arachnida, Opiliones, Gonyleptidae)

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Summary

The population size of *Pachylospeleus strinatii* Šilhavý, 1974 at the Córrego Grande area in the Gruta das Areias de Cima, south-eastern Brazil, was estimated by Petersen's method as modified by Bailey. The captures/recaptures were carried out during May and June 1993 and the population size was estimated at 199.95 individuals (SE 35.74). The possible troglomorphisms are discussed. Based on its endemic cave-dwelling distribution, depigmentation of body and appendages, and large number of segments (4–5) on distitarsus II, it is concluded that *P. strinatii* is a troglobite.

Introduction

In 1974, Šilhavý proposed the subfamily Pachylospeleinae for a new genus and new species, *Pachylospeleus strinatii*, based on material collected by Pierre Strinati from Gruta das Areias de Cima. This species, the first gonyleptid troglobite known, showed according to Šilhavý (1974) depigmentation of the body and appendages, reduced eyes, long legs and a high number of segments on distitarsi I-II. All these characters (except the last) are usually considered as specialisations of harvestmen restricted to cave life (Goodnight & Goodnight, 1960).

P. strinatii was recorded in the Gruta das Areias de Cima, Gruta das Areias de Baixo and Ressurgência das Areias das Águas Quentes (cited as *Pachylospeleus* sp.) by Trajano (1986, 1987). These caves are located in the same system and are crossed by the same stream. The fauna of Areias cave was listed by Gnaspini & Trajano (1994) and Trajano (1987).

The Gruta das Areias de Cima is the best known Brazilian cave and has the largest number of troglobites described hitherto in this country. Besides *P. strinatii*, the following troglobites have also been described (Gnaspini & Trajano, 1994): *Pimelodella kronei* (Osteichthyes, Siluriformes), *Katantodesmus* sp. (Diplopoda), *Leptodesmus yporangae* (Diplopoda), *Aegla cavernicola* (Decapoda, Anomura), *Pseudochthonius strinatii* (Pseudoscorpiones), *Trogolaphysa aelleni* (Collembola), *Schizogenius ocellatus* (Coleoptera).

The number of Neotropical species of harvestmen known from caves is very small compared with Nearctic and Palearctic cave faunas. The following Laniatores have been recorded in the Neotropical region: Triaenonychidae, *Pichunchenops spelaeus* (Argentina); Samoidae, *Hoplobunus* spp. (Belize and Mexico); Stygnommatidae, *Stygnomma* spp. (Belize, Ecuador, Jamaica and Venezuela); Phalangodidae, *Spaeleoleptes spaeleus* (Brazil); Agoristenidae, *Vima* spp. and *Phalangozea bordoni* (Venezuela). All of these groups show depigmentation, and some of them show hypertely of the appendages and reduced eyes (Goodnight & Goodnight, 1971, 1973, 1977; Maury, 1988; Muñoz-Cuevas, 1975; Rambla, 1969, 1976, 1978; Soares, 1966).

The aim of this study is to present biological data on the population of *P. strinatii* in the Gruta das Areias de Cima and to increase our knowledge of Neotropical cavernicolous harvestmen.

Material and methods

The Gruta das Areias (24°35′20″S - 48°42′05″W, Iporanga County, São Paulo State, Brazil) is located in Subtropical Humid Forest between the Tropical Atlantic Domain and Araucaria Forest Domain (Ab'Saber, 1977). The climate is subtropical humid without a dry season (Monteiro, 1973 in Trajano, 1991), with an annual mean temperature between 18 and 19°C. The cave has a length estimated at 3,260 m and is located in limestone of the Açungui group in the north of the Speleological Province Vale do Ribeira (Karmann & Sánchez, 1986). It has a Y outline and two different streams, one running throughout most of its length (the Areias stream), and the other on the Y apex (the Córrego Grande stream) (Fig. 1). The Córrego Grande sinks into the ground (from the surface) for about 200 m

where it enters the tributary gallery, and then extends down the corridor of the cave for 150 m before it disappears into the rock. This occurs during most of the year, but when the rain is very intensive the water volume increases so much that it flows all along the tributary gallery towards the Areias stream (Trajano, 1991).

The captures were made on 15/16 May and 11/12 June 1993. I spent 6 hours per day, for a total of 24 hours of observations during the 4 days. All of the area marked on Fig. 1 with dashed lines was studied by the author. However, the population size was calculated only for the Córrego Grande area because only a few individuals were observed in the other regions. Only adults and last nymphal instars (legs I-IV without arolium according to Muñoz-Cuevas, 1971) were marked with a small drop of acrylic paint on the dorsal scute (between areas I-IV). A separate colour was used each day. After marking, the sex and habitat where they were found (floor, wall or corner) were noted. The corner is defined as the area within 1 m of the junction of the floor and wall.

To calculate the population size and standard error, Petersen's method as modified by Bailey according to Begon (1979) was used.

The total area of the horizontal projection of the ground plan is about 56,370 m^2 and the Córrego Grande area is 4,800 m^2.

Preserved material studied is deposited in the Museu de História Natural "Capão da Imbuia", Curitiba (MHNCI) and Museu de Zoologia, Universidade de São Paulo, São Paulo (MZSP): Brazil, São Paulo State, Iporanga, Gruta das Areias de Cima, E. Trajano coll., 30 April 1990, 1♂ 1♀ (MHNCI-6731); same locality, R. Pinto-da-Rocha coll., 12 August 1993, 1♂ 1♀ and 2 immatures (MZSP-14898); Gruta Areias de Baixo, 8 April 1966, 1♂ (MZSP-9951).

Results and discussion

Population size and biological notes

A total of 119 individuals of *P. strinatii* were marked: 4 in the gallery of the Areias stream (including 2 near the stream junction), and one in the dry gallery near the Areias stream (indicated with arrows in Fig. 1) and 114 (53 in May and 61 in June) in the Córrego Grande area. The population size was calculated for the Córrego Grande area only, because the largest numbers of specimens were captured there, against a very small number in the other areas. It is probable that most of the harvestmen inhabit the vicinity of the Córrego Grande sink (see asterisk in Fig. 1), because there are more food sources available (sediments, epigean animals and vegetable debris). For the same reason, it is expected that another portion of the population is concentrated near the Areias stream sink. During the second sampling, 21 individuals marked during the first sampling were recaptured. Petersen's method, as modified by Bailey, showed a population estimate of 199.95 (± 35.74) individuals in the Córrego Grande area for May/June 1993. This means that the estimated population was between 164 and 236 specimens (with 95% probability). This estimate seems to be good because it was based on the large number of recaptured individuals at the second sampling, resulting in a low standard error. The Petersen method has some limitations: the population has to be closed, with no birth, death, emigration or immigration. During June, I found 2 dead marked females. I did not observe emigration/immigration and no last nymphal stage moulted. However, this does not mean that these events did not occur. According to Begon (1979), these phenomena reduce the accuracy of the estimate. However, I believe that the population size estimate was good because the time between the samples was short ($3\frac{1}{2}$ weeks), reducing the effects of these phenomena.

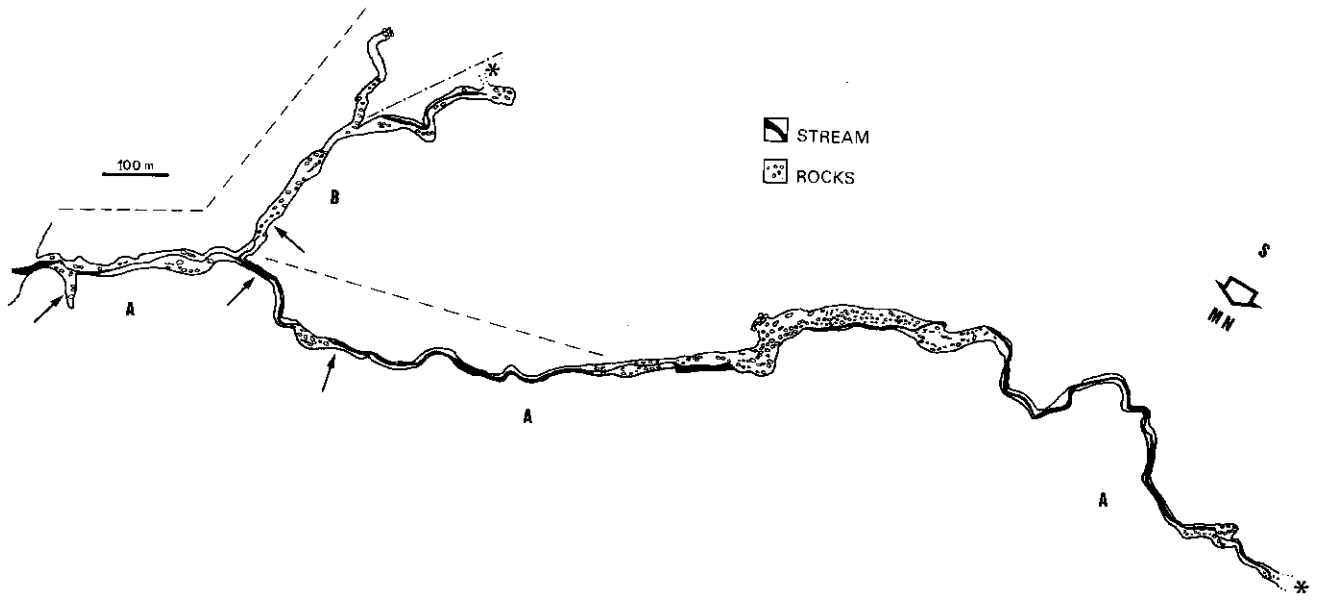

Fig. 1: Horizontal plan of the Gruta das Areias de Cima, Iporanga, Brazil. The arrows indicate where isolated specimens were recorded; "– – – –" shows the area searched; "– · – · –" shows the Córrego Grande area where the population size was estimated; asterisks (*) indicate the sink area of the streams. A=Areias stream, B=Córrego Grande stream.

Habitat (% of the area)	No. of specimens collected	No. of specimens expected for equal distribution	$(O-E)^2/E$
Corners (10%)	62	11.00	236.45
Walls (45%)	42	49.50	1.14
Floor (45%)	6	49.50	38.23
Total	110	110	χ^2 275.82

Table 1: Preference for corner/wall/floor shown by *Pachylospeleus strinatii* (last nymphal stage and adults) collected at Córrego Grande area in the Gruta das Areias de Cima, Iporanga, Brazil. O = observed; E = expected.

The animals were commonly found in a resting position (body and legs close to the substrate and legs held backwards). It was observed that *P. strinatii* shows a preference for the corners and walls rather than the floor. Using the χ^2 test, the preference for the corners and walls was significant at the 0.01 level (Table 1), with 62 and 42 specimens being recorded, respectively. Only 6 specimens were captured while they were walking on the floor. This preference can be related to the sudden rise in level of the Córrego Grande after heavy rains that occur during the rainy season, inundating part of the "dry" floor as the water moves towards the Areias stream. This was observed by Trajano (1991) and by me on 11/12 June. The sudden rise and fall of the Córrego Grande stream level deposits food sources (sediment, leaves) on the floor and walls. The preference for corners and walls allows the opilionids a fast flight from rising waters. The avoidance of water would appear to be of greater importance than the avoidance of predators, because the predators of *P. strinatii* occur mostly in the corners and on the walls. *Loxosceles adelaida* Gertsch (Araneae, Sicariidae) builds its webs in corners and in recesses on the walls, and *Zelurus travassosi* (Hemiptera, Reduviidae) is a wandering predator that is found widely throughout the cave system. Of the 119 specimens marked, 63 were males and 56 females. Therefore the sex ratio was 1:1 (χ^2 not significant at 0.01 level). The same sex ratio was also observed for another troglophilic opilionid, *Daguerreia inermis* (Gonyleptidae; Pachylinae), at Gruta da Lancinha, Paraná, south Brazil (Pinto-da-Rocha, unpublished data).

The density estimated was 0.042 ($\pm$ 0.007) individuals/m^2 for the 4,803 m^2 of the Córrego Grande gallery. Six specimens/m^2 were observed on some sediment banks near the stream. However, they were not closely aggregated.

Pachylospeleus strinatii is an omnivorous species and Trajano & Gnaspini-Netto (1991) hypothesised that it feeds on vegetable debris, dead animals, guano and fungi. I observed one immature feeding on a dead *Pseudonannolene strinatii* (Diplopoda: Pseudonannolenidae). Possibly the diet of *P. strinatii* also includes small insects such as larvae of Coleoptera.

Ecological classification and phylogenetic relationships

Šilhavý (1974) classified *P. strinatii* as "eutroglobic" (= troglobitic) based on depigmentation, reduced eyes, hypertelic appendages, and large number of segments on distitarsi I and II. In the specimens observed alive in the Gruta das Areias and preserved material examined, the colour varied from pale yellow to a little darker, differing from the colour patterns of other epigean gonyleptid species that are usually dark brown to black. Šilhavý's types have not been examined, but all the specimens in the present study have the eyes pigmented (black, as in epigean species) and of normal size. In order to know if a structure is a troglomorphism or a plesiomorphic character of an epigean group, we have to compare cavernicolous forms with related taxa. Kury (1994) presented a hypothesis of relationship to the early lineages of Gonyleptidae. The branching pattern obtained by him was (Metasarcinae (Heteropachylinae (Cobaniinae (Bourguyiinae + the other Gonyleptidae)))). I included Pachylospeleinae in Kury's data matrix, because it has a "primitive" character (dorsal glans process), and obtained two equally parsimonious trees. The only topological difference is the rank of *P. strinatii* and the occurrence of a single different homoplasy on each tree. In the first tree, *P. strinatii* is the sister group of Bourguyiinae based on elongated femur IV, and both are the sister group of the other Gonyleptidae based on the bifurcated apophysis of male coxa IV and presence of ventral process on the penis (presumably lost in *P. strinatii*). In the other tree, *P. strinatii* is the sister group of Bourguyiinae plus other Gonyleptidae based on the bifurcated apophysis of coxa IV and elongated femur IV (reverted to the plesiomorphic state, short, in the other Gonyleptidae). It is difficult, with the available data, to know if the elongated femur IV is a troglomorphism (convergent with Bourguyiinae) or if it is a synapomorphic feature of *P. strinatii* and Bourguyiinae. The large number of tarsal segments on distitarsus I (3) is present in almost all Gonyleptidae and it does not represent a specialisation, but the presence of 4 or 5 segments on distitarsus II (leg with sensorial function in Laniatores) is apomorphic when compared with related groups and seems to be a specialisation to cave life.

The endemic distribution of *Pachylospeleus strinatii*, recorded only from three caves (Ressurgência das Águas Quentes das Areias, Gruta Areias de Baixo and Gruta Areias de Cima), all situated on the same stream (Areias) and limestone lenses, and the presence of at least two troglomorphisms, depigmentation of body/appendages and large number of segments on distitarsus II, are indications that this species is a troglobite.

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