

Predation by three species of spiders on a cave fish in a Mexican sulphur cave

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Summary

Previously, giant water bugs (*Belostoma* sp., Belostomatidae) were thought to be the only predators of the cave-dwelling fish *Poecilia mexicana* (Poeciliidae) in a southern Mexican sulphur cave (Cueva del Azufre). Here, we report on three species of Araneae [Ctenidae gen. sp., *Timus* sp. (Pisauridae), and *Hemirrhagus pernix* (Theraphosidae)] from that cave, which also prey on *P. mexicana*. To our knowledge, this is the first report of spider predation on a cave fish.

Introduction

Caves have often been assumed to be predator-free environments for fish living in them (Romero & Green, 2005; Tobler, Schlupp *et al.*, 2006). Only recently we have demonstrated a previously unreported case of a predator–prey interaction between an aquatic insect of the genus *Belostoma* Latreille, 1807 (Heteroptera: Belostomatidae) and a cave fish (i.e. the cave molly), a cave-adapted form of the Mexican livebearer *Poecilia mexicana* Steindachner, 1863 (Teleostei: Poeciliidae; Tobler, Schlupp *et al.*, 2007; Tobler, Franssen *et al.*, 2008; Tobler, 2009). In the southern Mexican Cueva del Azufre (also known as Cueva de las Sardinias or Cueva de Villa Luz), cave mollies not only live in permanent darkness, but also have to cope with high concentrations of hydrogen sulphide (H₂S; Gordon & Rosen, 1962; Tobler, Schlupp *et al.*, 2006), which are acutely toxic to metazoans (Grieshaber & Völkel, 1998). Hydrogen sulphide leads to extreme hypoxia in the water (Tobler, Schlupp *et al.*, 2006); hence cave mollies perform so-called Aquatic Surface Respiration (ASR) to exploit the more oxygenated (and thus less sulphidic) top-most layer of the water column (Plath, Tobler *et al.*, 2007; Tobler, Riesch *et al.*, 2009). This behaviour exposes the mollies to predation by the sit-and-wait predator *Belostoma* sp., which waits for passing, surfacing fish at the edge of the water (Tobler, Schlupp *et al.*, 2007; see also Kramer, Manley *et al.*, 1983 for increased predation risk for fish exhibiting ASR).

The high abundance of *Goeldichironomus fulvipilus* (Rempel, 1939) (Diptera: Chironomidae) in the Cueva del Azufre may be the reason for a rich araneofauna with mostly small-sized species (Lavoie & Evans, 2002). We also observed two species of unidentified ensiferan

crickets and a species of veliid water strider at high abundance. During our annual fieldwork in the cave, we also repeatedly noticed several larger species of Araneae sitting on stones near the water's edge with the tarsi of their front legs sometimes touching the water surface, potentially also preying on surfacing fish. Further, on one of our trips into the cave in 2008, we observed a large unidentified ctenid that entered the water body and actively swam across a 3-m pool of water to emerge on the other side. Clearly, at least some of the large-bodied Araneae observed in the cave do not completely shun the toxic waters.

Furthermore, other spiders are also known to hunt on the water surface and some of them feed both on fish or amphibians and insects, e.g. *Dolomedes* Latreille, 1804 (Pisauridae; worldwide) (Breene, Sweet *et al.*, 1988; Suter, 1999; Bleckmann & Bender, 1987), *Thalassius* Simon, 1885 (Pisauridae; Africa, Asia) (Abraham, 1923; Sierwald, 1988), *Ancylometes* Bertkau, 1880 (Pisauridae; South America) (Schiapelli & Gerschman, 1970), *Trechalea* Thorell, 1869 (Trechaleidae; South America) (Berkum, 1982), *Pirata* Sundevall, 1832 and *Pardosa* C. L. Koch, 1847 (both Lycosidae; worldwide) (Breene, Sweet *et al.*, 1988), *Heteropoda natans* Jäger, 2005 (Sparassidae; Sabah, Borneo) (Airamé & Sierwald, 2000; Jäger, 2005). Diving has been reported for *Dolomedes* and *Thalassius spinosissimus* Simon, 1891 (Sierwald, 1988; Jäger, unpubl. data). Hence, spider predation on cave mollies seems highly likely, and the present study represents the first attempt to investigate the presumed role of fish predation by several species of Arachnida in this particular cave system.

Material and methods

During September 2008 we were able to collect ten individuals of large-bodied Arachnida in various parts of the Cueva del Azufre (location of cave entrance: 17°26'32"N, 92°46'31"W). An additional experiment was conducted with one spider in September 2004 (Table 1, Fig. 1). We used an experimental approach as described in previous studies (see Tobler, Schlupp *et al.*, 2007; Tobler, Franssen *et al.*, 2008 for methodological details) to test which Arachnida would prey on mollies. Briefly, individual arachnids were initially housed inside the cave in empty, perforated 1.5-l plastic bottles and were not fed for a 48 h acclimation period. At the start of the experiment, the arachnids were transferred into individual perforated 5-l plastic bottles, which were submerged in the water to approximately one fourth of their depth. We also introduced four mollies per bottle as potential prey items [2 small (mean ± SD length: 18.75 ± 2.22 mm) and two large (28.20 ± 2.86 mm)]. Each bottle was checked for fish-predation after 24 h and, if predation had occurred, the experiment was terminated and the arachnid collected for species identification. If no predation was observed, the bottles were left on site for an additional 24 h. Unfortunately, we were unable to recover three bottles after the second 24-h trial period, possibly because they were removed by other visitors to the cave.

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