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Predators of the short-tailed whipscorpions (Schizomida): Are they so few?

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Abstract: Until now, only four species of vertebrates (two caecilian amphibians from Tanzania, a frog from Mexico, and an anole lizard from Colombia) and three invertebrate species (two army ants from Brazil, and a whip spider from Cuba) have been recorded as predators of schizomids. Among the prey species, only *Stenochrus portoricensis* has been identified. This situation reveals the insufficient attention paid to this important aspect of the natural history of schizomids.
Key words: Schizomida, Hubbardiidae, *Anolis agassizi*, *Eciton*, *Eleutherodactylus planirostris*, *Phrynus marginemaculatus*, *Stenochrus portoricensis*, caecilian, predators.

Depredadores de los esquizómidos (Schizomida): ¿son tan pocos?
Resumen: Hasta ahora, únicamente se han reportado cuatro especies de vertebrados (dos cecilias de Tanzania, una rana de México y un lagarto anolino de Colombia) y tres de invertebrados (dos hormigas legionarias o cazadoras de Brasil y un amblipígido de Cuba) como depredadores de esquizómidos. Entre las especies depredadas, solamente *Stenochrus portoricensis* ha sido identificada. Esta situación revela la insuficiente atención que se le ha dedicado a este importante aspecto de la historia natural de los esquizómidos.
Palabras clave: Schizomida, Hubbardiidae, *Anolis agassizi*, *Eciton*, *Eleutherodactylus planirostris*, *Phrynus marginemaculatus*, *Stenochrus portoricensis*, cecilia, depredadores.

The arachnid order Schizomida Petrunkevitch, 1945, is a mesodiverse group that contains little more than 365 described species (Monjaraz-Ruedas *et al*., 2019, 2020), distributed in most of the tropical and subtropical regions of the world, although at least four of them have been introduced into Europe (Reddell & Cokendolpher, 1995; Armas & Rehfeldt, 2015; Lauterbach *et al*., 2020 and other references therein).

These small-sized arachnids (most species are less than 5.0 mm in total length) inhabit the soil and litter, mainly in wooded areas, but also in caves, termite nest, and anthropic spaces as banana plantations, grasslands, and cities, among others, since the coast to 3100 m a.s.l. (Reddell & Cokendolpher, 1995).

Until approximately one-half century ago, the schizomids remained as a neglected order of Arachnida. Before the 1990s, the systematics of the group was confused, whereas data on the natural history of the species were scanty. With respect to their predators, Reddell & Cokendolpher (1995) only mentioned an amblypygid recorded by Armas (1989), which was then repeated by Armas & Melic (2015). Although predation on these small arachnids by an anole, two caecilian amphibians, one frog, and two army ants (Wolda, 1975; Vieira & Höfer, 1994; Jones *et al*., 2006) had been recorded, they went unnoticed by the arachnologists.

The scarce information on the predators of the schizomids reveals the insufficient attention payed to this important aspect of the natural history. It is known that some generalist and opportunist fossorial lizards and snakes predate upon spiders, opilions, scorpions, whip-scorpions, and mites (e.g., Colli & Zamboni, 1999; Montechiaro *et al*., 2011), being capable of also feeding on schizomids. On the other hand, some zoophagous edaphobiontics, as spiders, opilions, ricinuleids, scorpions, pseudoscorpions, carabid beetles, and centipedes, among others, can be included in the list of potential predators of schizomids. However, no record exists of a short-tailed whipscorpion predated by one of these organisms whatever.

Laboratory observations (not included in Table I) demonstrated the occurrence of cannibalism among the schizomids [Rowland (1972), on *Hubbardia pentapeltis* (cited as *Trithyreus pentapeltis*); Humphreys *et al*. (1989), on the Australian *Draculoides vinei*); Oliveira & Ferreira (2014), on *Rowlandius portiguar*; J. A. Moreno-Gonzalez, pers. obs., on a Colombian *Surazomus* sp.]; whereas Miranda *et al.* (2016: 553) suggested that the Central American *Belicenochrus peckorum* Armas & Víquez, 2010 might be part of the diet of *Charinus reddelli* (Amblypygi: Charinidae).

In the present note, a list of the seven present-day known predators of short-tailed whipscorpions is provided (Table I). Geographical coordinates have been taken from the cited references, but that of the Cuban locality, which was obtained from Google Earth.

Table I. List of the recorded predators of short-tailed whipscorpions (Schizomida).

Prey	Predator(s)	Locality (reference)	Remarks
Stenochrus portoricensis [cited as *Schizomus portoricensis*]	Amblypygi: Phrynidae: *Phrynus marginemaculatus*	Jibacoa (23°08'N, 81°51'W, approximately 50 m a.s.l.), La Habana Province, Cuba. (Armas, 1989).	An adult female predated by a protonymph of the whip spider, at 09:30 hr, under stone in subcostal forest.
Undetermined Hubbardiinae [cited as Schizomida; likely *Adisomus duckei* or *Surazomus brasiliensis* (or both)]	*Eciton burchellii* and *Labidus praedator*	Approximately 80 km north of Manaus (2°25'S, 59°48'W), Amazonas Province, Brazil. (Vieira & Höfer, 1994: tables 1 and 5).	For *E. burchellii*: 2 instances; for *L. praetor*: 4 instances.
Undetermined Hubbardiidae [cited as Schizomida]	Amphibia: Gymnophiona: *Boulengerula boulengeri* and *Scolecomorphus vittatus*	Nilo Forest Reserve (4°48'- 4°13'S, 38°32' – 38°48'E; 400 – 1506 m a.s.l.), NW of East Usambara Mountains, Tanzania. (Jones *et al*. 2006: table 3).	A single specimen in the digestive tract (gut) of each caecilian (n = 2).
Undetermined Hubbardiinae [cited as Schizomida]	Amphibia: Eleutherodactylidae: *Eleutherodactylus planirostris*	Mexico: (1) El Rey del Caribe Hotel (21°09'51"N, 86°49'23"W), Cancún, Quintana Roo State; (2) Parque Zoológico Bicentenario Animaya (20°58'59"N, 89°41'26"W), western periphery of Mérida City; and (3) Emiliano Zapata town (20°13'32"N, 89°28'02"W), municipality of Oxkutzcab, Yucatán State. (Ramírez-Valverde *et al*., 2020: table 2).	Remains of the schizomids were found in the stomach contents of the frogs in the three Mexican anthropic localities. Ramírez-Valverde *et al*. (2020: 6) suggested that they possibly belong to *Stenochrus portoricensis* and/or *Heteronochrus goodnightorum*, the only known schizomids from the studied area.
Undetermined Hubbardiinae [cited as Schizomida]	Reptiles: Dactyloidae: *Anolis agassizi*	Malpelo Island (3º58'N, 81º35'W), Buenaventura municipality, Valle del Cauca department, Colombia. (Wolda, 1975: table 1).	Wolda (1975: 24) stated that 24 predators identified by him in this Colombian island (including millipedes, pseudoscorpions, schizomids, spiders, opilions, ants, bugs and beetles) "are all eaten by *Anolis*"; although he did not provide neither working methods nor statistical data, Rand *et al*. (1975: 30), in the same monograph, mentioned that Wolda examined 43 guts of *A. agassizi* and also added that excepting earthworms, the invertebrates all were part of the diet of this lizard.

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