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On commensalism between microhylid frogs of the genus *Uperodon* Duméril & Bibron, 1841 (Anura: Microhylidae) and scorpions (Scorpiones: Scorpionidae)

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Abstract: A recent article erroneously attributing two scorpions as “theraphosids” when discussing commensalism between spiders and microhylid frogs is discussed. Three other works which discussed commensalism between microhylids and scorpions are also reviewed, highlighting that little is currently known about commensal relationships between these taxa.
Key words: *Ramanella symbiotica*, frog, scorpion, theraphosid spider, commensalism.

Comensalismo entre ranas microhílidas del género *Uperodon* Duméril & Bibron, 1841 (Anura: Microhylidae) y escorpiones (Scorpiones: Scorpionidae)
Resumen: Se discute un artículo reciente que atribuye erróneamente a dos escorpiones como "terafósidas" al discutir el comensalismo entre arañas y ranas microhílidas. También se revisan otros tres trabajos que discutieron el comensalismo entre microhílidos y escorpiones, destacando que actualmente se sabe poco sobre las relaciones comensales entre estos taxones.
Palabras clave: *Ramanella symbiotica*, rana, alacrán, araña terafósida, comensalismo.

Bascoulés & Smith (2021) recently reported a new record of commensalism between a microhylid frog, *Chiasmocleis albopunctata* (Boettger, 1885), and a theraphosid spider, *Eupalaestrus campestratus* (Simon, 1891). They cite Rao & Ramanna (1925) and Vyas (2010) as other examples of frog and theraphosid commensalism, repeating this information in a table later in their work, identifying the supposed "theraphosid" in both cases to be "*Heterometrus* sp." (Bascoulés & Smith, 2021: 60, Tab. 1). *Heterometrus* Ehrenberg, 1828 is, in actuality, a well-known genus of scorpions from south-east Asia, recently revised in an exhaustive monograph (Prendini & Loria, 2020), and split into a number of genera, some resurrected and some newly described. Only eight taxa remain *Heterometrus sensu stricto* (Prendini & Loria, 2020). The generic nomen *Heterometrus* has never been used in the order Araneae Clerck, 1757.

Rao & Ramanna (1925: 589) state of the frog *Ramanella symbiotica* Rao & Ramanna, 1925, newly described in their work as the type species of *Ramanella* Rao, 1925[1]: "It affects practically dry situations, sharing the burrows of the Black Scorpions (*Palamneus* [*sic*] *fulvipes*) under heavy stones and boulders. When uncovered it remains quietly until disturbed, when it runs about briskly, toppling over the scorpions unmolested. When the scorpions crawl over the Frog, the latter crouches flat on the ground, absolutely motionless.". Later, when detailing skin secretions made by the frog, they state it "... gives the Frog a measure of immunity, which it enjoys in the midst of the pugnacious scorpions" (Rao & Ramanna, 1925: 590). No mention of spiders of any kind is found in the article. *R. symbiotica* has subsequently been treated as a junior synonym of *Uperodon variegatus* (Stoliczka, 1872).

Whilst Vyas (2010) does cite and discuss other cases of commensalism which involved theraphosids, he makes it clear that he is newly reporting an instance of commensalism between the frog *Ramanella montana* (Jerdon, 1853) [now *Uperodon montana*] and "a black scorpion (*Heterometrus* sp.)." Vyas (2010: 25). Vyas (2010) also referred to the scorpion identified by Rao & Ramanna (1925) [as *Palamneus fulvipes* (C. L. Koch, 1837) which, *sensu stricto*, is now *Chersonesometrus fulvipes* per Prendini & Loria (2020)] as simply “*Heterometrus* sp.”.

It is unclear to which genus under the new taxonomic frameworks of Prendini & Loria (2020) the scorpion Vyas (2010) observed belongs to, and the same can be said for the scorpion identified as *P. fulvipes* in Rao & Ramanna (1925). There are no photographs or preserved scorpion specimens in relation to either work that can be examined, thus secure determination at the generic level (let alone the species level) in these works is not possible. They are thus hereby considered as Scorpionidae sp. (Table I). Future workers could try to establish the generic and species-level identity of the scorpions by sampling in the areas where Rao & Ramanna (1925) and Vyas (2010) made their observations.

Commensalism between scorpions and frogs is poorly known. However, in addition to Rao & Ramanna (1925) and Vyas (2010) it has been reported in at least three other works. Henderson (1919) described *Palamnaeus tristis* Henderson, 1919 [= *Chersonesometrus tristis* per Prendini & Loria (2020)] and states later in the work that: "Mr. Sundara Charlu informed me that in some cases the burrow also afforded shelter to a small frog -- *Callula variegata*, Stol.” (Henderson, 1919: 380). Bastawade (2006: 135) contributed a record between *Deccanometrus phipsoni* (Pocock, 1893) (as *Heterometrus* (*Chersonesometrus*) *phipsoni*) and a species of *Ramanella* (with no mention that this genus was a synonym of *Uperodon* Duméril & Bibron, 1841) but with some trepidation as to the nature of the relationship and to the identity of the frog: "At two of the excavated burrows of this species, yielded one specimen each of a tiny frog belonging to the genus *Ramanella*, which were seen seating beneath the mesosoma of this scorpion. However such association in the burrow was confusing. The proper identification of frog species is awaited.". This record is discussed again in Bastawade (2009: 220), but without further comments other than observation: "At two of the excavated burrows of the species, a specimen each of a tiny frog belonging to the genus *Ramanella*, were seen seated beneath the mesosoma of this scorpion.". Whilst no photographs were provided for the records in Bastawade (2006, 2009) he is a recognised specialist on Indian scorpions, and there is therefore no reason to doubt the accuracy of the identifications.

It is demonstrable that commensalism between microhylid frogs of the genus *Uperodon* (as *Ramanella* or *Callula*) and scorpions has been recorded in only a handful of instances (Table I). More research is necessary to elucidate the intricacies of commensal relationships between microhylids and scorpions, and indeed to assess if there are other vertebrates (anuran or non-anuran) which may have commensal relationships with scorpions. Until such time, this phenomenon will remain a poorly-known aspect of scorpion biology.

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[1] For discussion on the authorship and date of the nomina *Ramanella* and *Ramanella symbiotica* and the correct spelling of the specific epithet, see Sherwood (2022).

Table I. A summary of presently recorded cases of commensalism between microhylid frogs and scorpions.

	Original identification of		Updated identification of		
Work	**scorpion**	**microhylid**	**scorpion**	**microhylid**	**Notes**
Henderson (1919)	*Palamnaeus tristis* Henderson, 1919	*Callula variegata* Stoliczka, 1872	*Chersonesometrus tristis* (Henderson, 1919)	*Uperodon Variegatus* (Stoliczka, 1872)	First known record of frog-scorpion commensalism.
Rao & Ramanna (1925)	*Palamnaeus fulvipes* (C. L. Koch, 1837)	*Ramanella symbiotica* Rao & Ramanna, 1925	Scorpionidae sp.	*Uperodon variegatus* (Stoliczka, 1872)	Scorpion originally referred to as *Palamneus* [*sic*] *fulvipes* and unable to be securely determined at generic level based only on the literature reference.
Bastawade (2006)	*Heterometrus* (*Chersonesometrus*) *phipsoni* (Pocock, 1893)	*Ramanella* sp.	*Deccanometrus phipsoni* (Pocock, 1893)	*Uperodon* sp.	Records subsequently repeated in Bastawade (2009). No mention is given to *Ramanella* Rao, 1925 being a junior synonym of *Uperodon* Duméril & Bibron, 1841.
Bastawade (2009)	*Heterometrus* (*Chersonesometrus*) *phipsoni* (Pocock, 1893)	*Ramanella* sp.	*Deccanometrus phipsoni* (Pocock, 1893)	*Uperodon* sp.	Repetition of the records made by Bastawade (2006). No mention is given to *Ramanella* Rao, 1925 being a junior synonym of *Uperodon* Duméril & Bibron, 1841.
Vyas (2010)	*Heterometrus* sp.	*Ramanella montana* (Jerdon, 1853)	Scorpionidae sp.	*Uperodon montanus* (Jerdon, 1853)	Scorpion unable to be securely determined at generic level based only on the literature reference. Vyas (2010) considered the scorpion reported by Rao & Ramanna (1925) to be "*Heterometrus* sp.".

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