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ARE THERE ANY BOTHRIURIDS (ARACHNIDA, SCORPIONES) IN SOUTHERN AFRICA?

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ABSTRACT

As Gondwanaland fragmented due to plate tectonics, each of the southern continents carried with it a sample of the ancestral biota. Bothriurid scorpions are known from South America and Australia, and if this taxon was part of that ancestral biota then bothriurids would be predicted to occur in southern Africa as well. The genus *Lisposoma* Lawrence, currently placed in the Scorpionidae, lacks any demonstrable synapomorphies with other members of that family. The trichobothrial pattern and the structure of the tarsi represent synapomorphies between *Lisposoma* and the Bothriuridae. *Lisposoma* contains two species, both from Namibia, which represent the bothriurids in southern Africa.

INTRODUCTION

> "The characters I have used are taken exclusively from the external structure. . . . The character that I believe to be new and, I hope, of considerable importance is the presence or absence of one of the spurs of the pair that is found upon the articular membrane connecting the foot or terminal segment of the legs with the segment that precedes it. . . . *Of course it is hardly expected that this character*, more than any other, *will prove invariable*; but it adds one more to the sum of characters upon which, as I have long suspected, the families or subfamilies of scorpions must be based." Pocock 1893:303. (italics added)

The scorpion family Bothriuridae is very interesting from a zoogeographic viewpoint. The two monobasic subfamilies Brachistosterninae and Vachonianinae are endemic to South America, while the Bothriurinae has eight genera in South America and one genus endemic to Australia and Tasmania (Maury 1973). Therefore, according the theory of vicariance biogeography (Platnick and Nelson 1978), either a bothriurid or their immediate sister group might be predicted to occur in southern Africa. A more specific prediction could be made if a cladogram expressing the phylogenetic relationships among bothriurids were available; however, Brachistosterninae and Vachonianinae were established on the basis of generic autapomorphies, and their phylogenetic relations to other bothriurid genera remain unknown. Nonetheless, the objective of this contribution is to test the hypothesis that a bothriurid scorpion does indeed occur in southern Africa.

THE SCORPION FAUNA OF SOUTHERN AFRICA

The scorpions of southern Africa are relatively well known in comparison to those of other parts of the world (Hewitt 1918, 1925; Lamoral and Reynders 1975, Lamoral 1979, Lawrence 1955). Therefore, it is reasonable to assume that any bothriurids from that region are likely to have been collected and reported in the literature. Since there are no published records on bothriurids from southern Africa, it becomes quite possible that they have been classified under some other family to which they do not actually belong.

There are only two scorpion families reported from Africa, Buthidae and Scorpionidae. Buthids are so distinct, and so far removed phylogenetically from bothriurids that the likelihood of confusion is minimal. The scorpionids are represented in southern Africa by three subfamilies: Scorpioninae, Ischnurinae, and Lisposominae. The former two taxa contain several genera in both the Ethiopian and Oriental regions, and are well characterized. The Lisposominae, on the other hand, is monobasic and has been reported to have "affinities" with bothriurids (Lawrence 1928, Vachon 1974).

THE GENUS *LISPOSOMA* LAWRENCE, 1928

The genus *Lisposoma* Lawrence is endemic to Namibia. Its two recognized species, *Lisposoma elegans* Lawrence, 1928, and *Lisposoma josehermana* Lamoral, 1979, present a combination of external morphological features that made their taxonomic placement rather difficult.

STERNUM: *Lisposoma* has a pentagonal sternum, a feature which under the present classification excludes it from the Buthidae (subtriangular sternum) and the Bothriuridae (sternum reduced to a narrow transverse sclerite).

PEDAL SPURS: *Lisposoma* has prolateral pedal spurs, but lacks retrolateral pedal spurs, a feature which, if invariable, according to Pocock (1893; see opening quote above) places it within the Scorpionoidea (Scorpionidae and Diplocentridae).

SUBACULEAR TUBERCLE: *Lisposoma* lacks a subaculear tubercle, which excludes it from the Diplocentridae.

Thus, using a "process of elimination" approach to classification, *Lisposoma* turns out to be a scorpionid. However, it has several other features which exclude it from any of the recognized scorpionid subfamilies, which is why the Lisposominae was erected. However, if we use a cladistic approach to classification, what is *Lisposoma*?

What is the phylogenetic importance of the characters used to place *Lisposoma* in the Scorpionidae? Are they primitive characters (i.e., plesiomorphies) or derived characters (i.e., apomorphies)? A pentagonal sternum is plesiomorphic among Recent scorpions, as indicated by ontogeny (both buthids and bothriurids have a pentagonal sternum as first, and sometimes second, instars). The loss of retrolateral pedal spurs is a derived character (by out-group comparison to buthids and eurypterids), but it has occurred independently at least three times: in *Typhlochactas* (Chactidae), in *Vachonia, Thestylus* and *Phoniocercus* (Bothriuridae), and in the Scorpionoidea. Is the loss of retrolateral pedal spurs in *Lisposoma* the fourth independent occurrence of this transformation, or is it a synapomorphy with scorpionoids, with some bothriurids, and/or with *Typhlochactas*? At present, the character transformation contains little useful information with respect to phylogeny at this level. Finally, the lack of a subaculear tubercle is considered plesiomorphic based on the fact that many more scorpions lack it than have it. Therefore, other characters need to be examined to understand the phylogenetic relations of *Lisposoma*.

OVARIUTERUS: The ovariuterus of Scorpionoidea bears numerous diverticula where embryonic development occurs; this is probably the most important apomorphic character for the superfamily. I have examined adult females of both species of *Lisposoma*, and they lack ovariuteral diverticula.

CHELICERAL DENTITION: Scorpionoids have been characterized as having a single subdistal tooth on the dorsal margin of the movable finger of the chelicera (Vachon 1963). *Lisposoma*, however, has two (as is the case in more chactids, vaejovids, and bothriurids). Two subdistal teeth appears to be a derived character (our group comparison with buthids and chaerilids), but there are some indications that it has appeared more than once among Recent scorpions, and thus will not be hypothesized to represent a synapomorphy among some scorpion taxa until further studies are made.

TRICHOBOTHRIAL PATTERN: Vachon (1974) indicated that *Lisposoma* was very unusual among scorpionoids by having three trichobothria in line along the ventral articulation of the movable finger of the pedipalp, whereas all other scorpionoids with the same total number of trichobothria on the chela possess only two trichobothria in that position (some scorpionids have a very high number of trichobothria on the ventral aspect of the palm instead of the 'usual' 5-6, and in those, three can occur along the ventral hinge of the movable finger, although they are seldom in line). Vachon also pointed out that the pattern observed in *Lisposoma* is constant in all the bothriurid species that have the same total number of trichobothria as *Lisposoma*. This pattern appears to be unique to *Lisposoma* and bothriurids, and I hypothesize that it represents a synapomorphy between them.

TARSI: In *Lisposoma* the tarsi are truncated distally, and the formula of ventral submedian spines is 2/2:3/2:3/3:3/3. Truncate tarsi with ventral submedian spines are unknown in scorpionids, but are characteristic of bothriurids (10 of 11 genera, the separation of which is based to a considerable extent on the spine formula: *Brachistosternus* is the exception, and their tarsal armature appears plesiomorphic). Furthermore, I know of no chactids, iurids, or vaejovids with similar tarsi, and therefore hypothesize that tarsal structure represents a synapomorphy between *Lisposoma* and bothriurids (parsimony indicates that the more general character state is primitive).

HEMISPERMATOPHORE: The hemispermatophores of *Lisposoma* spp. (Lamoral 1979) are unlike those of the scorpionid genera which have been studied [Scorpioninae: *Scorpio* (Vachon 1952a), *Opisthophthalmus* (Lamoral 1979, Francke, pers. obs.), *Heterometrus* (Francke, pers. obs.), and *Pandinus* (Vachon 1952b). Ischnurinae: *Hadogenes* (Francke, pers. obs.), *Liochelis* (Koch 1977), and *Opisthacanthus* (Francke, pers. obs.). Urodacinae: *Urodacus* (Koch 1977, Francke, pers. obs.)] with respect to both pedicel and capsule structure.

In the structure of the pedicel and capsule of the hemispermatophore *Lisposoma* is very similar to bothriurids (Maury 1980); comparison of illustrations of the hemispermatophore of *Lisposoma* spp. (Lamoral 1979) with that of *Timogenes* sp. (Maury and San Martin 1973) reveals very interesting similarities (homologies ?) in the pedicel and capsule, whereas none could be found between *Lisposoma* and scorpionids. Bothriurid hemispermatophores are characterized by a prominent crest or ridge on the distoexternal aspect of the lamina (Maury 1980), a hypothesized autapomorphy for the family. Lamoral (1979) illustrated only the internal and dorsal views of the hemispermatophore of *Lisposoma*, and it is thus impossible to determine at this time whether a crest is present or not.

CONCLUSIONS

I have been unable to find any synapomorphies between *Lisposoma* and other genera of Scorpionidae. The Scorpionoidea (Scorpionidae + Diplocentridae) are characterized by an ovariuterus with numerous diverticula, *Lisposoma* lacks this derived character state and is thus excluded from this superfamily. The loss of retrolateral pedal spurs has occurred independently at least three times among Recent scorpions, and this character provides no indication of the phylogenetic relations of *Lisposoma*. The trichobothrial pattern and the structure of the tarsi, however, represent synapomorphies between *Lisposoma* and the Bothriuridae. Therefore, I hypothesize that *Lisposoma* is indeed a bothriurid and not a scorpionid. Examination of the distoexternal aspect of the lamina of the hemispermatophore of *Lisposoma* for the presence of a crest could provide an independent test of the hypothesis formulated above.

The only taxonomic change proposed here is the transfer of *Lisposoma* from the Scorpionidae to the Bothriuridae. The status of the Lisposominae, as well as the three recognized subfamilies of Bothriuridae, remains uncertain pending the construction of a cladogram expressing phylogenetic relationships within the family.

Finally, the stated objective of this contribution was to test a hypothesis based on zoogeographic considerations: that a bothriurid scorpion should occur in southern Africa. A cladistic analysis of the phylogenetic relations of *Lisposoma* indicates that this is the African bothriurid sought.

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