

## A self-made taxonomic character in whip scorpions (Arachnida, Uropygi: Thelyphonida)

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### ABSTRACT

The nature of incisions on tarsal articles of the female tactile leg has been studied in *Typopeltis crucifer* Pocock, 1904. Such structures have been described from various species of the genus *Typopeltis*, but they must be considered as secondary. They are not present in freshly moulted females, nor do they occur in all females. A reinvestigation of the mating behaviour of *Typopeltis crucifer* shows that they may be inflicted by the chelicerae of the male during courtship. For this reason their distribution is irregular, and scanning electron microscopy reveals injuries of the cuticle.

### INTRODUCTION

Some Asian whip scorpions are characterized by specific morphological differentiations on the tarsal articles of the female tactile leg. These are used to distinguish species or characterise different genera, for example the South East Asian genus *Thelyphonus* (Kraepelin, 1899). In the East Asian genus *Typopeltis* tarsal notches were first noted by Pocock (1894), and subsequently they have been interpreted as tarsal differentiations such as in *Thelyphonus*. Nevertheless, the comparative study of whip scorpions casts some doubt on this interpretation, and a critical reinvestigation in the occurrence and importance of these structures became necessary.

### MATERIAL AND METHODS

A large number of female specimens of *Typopeltis crucifer* Pocock, 1894 preserved in the Zoological Museum of Humboldt University Berlin were checked for the occurrence of tarsal modifications. This material was collected by Sauter in Taiwan in 1904. Living material of the same species was obtained on the island of Iriomote in 1995 and 1996. In order to review

the mating behaviour, females were brought together with males in a special arena, the bottom of which was covered with soil, litter, and stones.

Specimens used for scanning electron microscopy were fixed in phosphate buffered 12.5 % glutaraldehyde (pH 7.4), rinsed in buffer, subsequently dehydrated in ethanol, and sputtered with gold. Studies were carried out with a Cambridge Stereoscan Mark II.

## RESULTS

The study of a larger number of *Typopeltis crucifer* females revealed that notches on the articles of the tactile leg appear at random, and are not symmetrical (Fig. 1). They are most frequently found on the last but one article, but they may also be present on the terminal article or at more proximal articles.

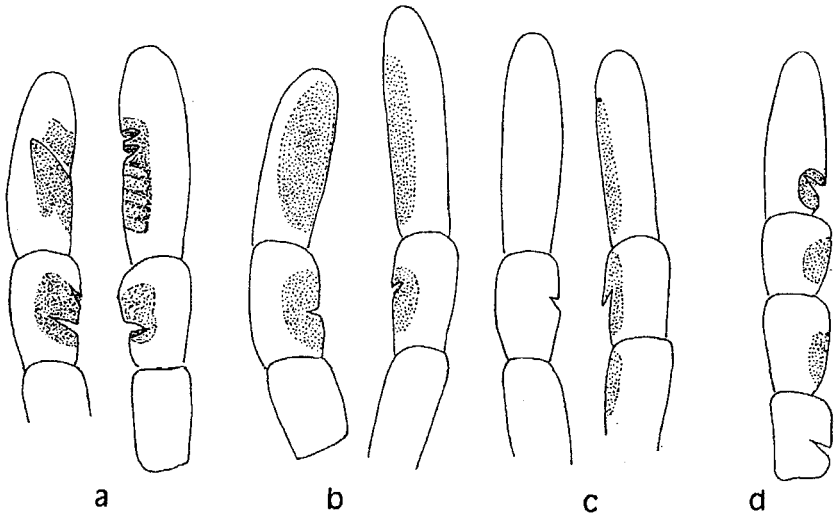


Fig. 1 Tarsal modifications on the tarsi of female tactile legs from different specimens of *Typopeltis crucifer* (a-c distal articles of left and right side), and *Teltus vanoorti* (d).

Under the scanning electron microscope it is apparent that the modifications consist of a clearly ruptured surface (Fig. 2), almost vertical to the normal cuticular surface of the tarsal articles. This gives the impression that the notches are by no means original structures of the tarsal articles, but incisions caused by some sharp instrument. Examination of living specimens shows that freshly moulted females lack any tarsal notches on the tactile leg.

For this reason the mating behaviour was reviewed. Courtship of *Typopeltis* usually starts with the male raising its whip into an upright position. The whip may be then put into an oscillating vibration, as displayed

in the film of *Mastigoproctus brasilianus* (Weygoldt, 1974). Such air borne vibratory signals may easily be recorded by the giant trichobothria on the tibia of the tactile leg (Haupt 1996). The male slowly approaches the female and synchronously grasps the female's tactile legs with his pedipalpal chelae. He then places the female's tactile leg tarsi in-between his chelicerae. During this process the male may cut the female's tarsal articles in one or more places, especially if the correct positioning of the females tarsi cannot be achieved immediately. Mating begins with the partners facing each other, the male then climbs obliquely over the female and moves in front of her. The following procession, during which the female holds the opisthosoma of the male with her pedipalps, may continue for hours. During this whole time the female's tarsal articles are held by the chelicerae of the male. Sometimes, the male slightly chews on the tarsal articles, and this is a second occasion when incisions into one or the other tarsal article may be inflicted.

For this simple reason, the modifications are neither symmetrical nor regular: the sharp edges of male chelicerae cut accidentally into the cuticle.

## DISCUSSION

Because of their irregular and asymmetrical occurrence, tarsal modifications, as described by Schwangart (1906) in *Typopeltis crucifer*, must immediately cast some doubt on their taxonomic importance. This problem was recognized by Schwangart himself, when he wrote: 'Es treten somit bei *T. crucifer* an der Tarsengeißel Kerben inkonstant auf. - Irgendwelchen Vermutungen darf aber erst dann Raum gegeben werden, wenn wir mit der Organisation und der speziellen Funktion des Organs des Weibchens bekannt geworden sind.' Nevertheless, Schwangart used this very inconsistent character to distinguish a new subspecies: *Typopeltis crucifer kochi*.

Although the mating behaviour of *Typopeltis crucifer* has previously been studied by Weygoldt (1978), the chewing effect has not been previously described. The reason may simply be that this effect does not occur in every mating process. Consequently, one can also find pregnant females lacking any incisions on tactile leg tarsi.

On the other hand, the occurrence of such inflictions, which may be considered as occasional mating marks, is not limited to *Typopeltis crucifer* (Pocock, 1894), but they have been mentioned for *T. dalyi* (Pocock, 1900), and they are also present in the recently discovered female of *Teltus vanoorti* (Fig. 1d), a species of whip scorpions living on the island of Hainan in Southern China. Although the mating behaviour of these species is still unknown, it can be supposed that these occasional mating marks have the same origin as in *Typopeltis crucifer*.



Fig. 2 Scanning electron microscopic view of a tarsal injury from the tactile leg of a *Typopeltis crucifer* female.

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