



On the function of the ultimate legs of *Cryptops* and *Theatops* (Chilopoda, Scolopendromorpha)

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Abstract

Statements in the literature suggest that the scolopendromorph centipedes *Cryptops*, *Theatops* and *Plutonium* use their ultimate legs to capture prey. It has been suggested that when the ultimate legs of *Cryptops* are flexed the tibial and tarsal saw teeth are opposed, however, this is not so. There are relatively few observations of prey capture by *Cryptops* and none involve the ultimate legs. It is suggested that the ultimate legs are defensive; trapping some part of a potential predator and then being autotomised as the centipede makes good its escape. Although they may be involved in holding predators, this may not be the primary use of the saw teeth. In some New Zealand species the tibial saw teeth in males are arranged in several rows whereas in females there is a single row of teeth. The saw teeth may, therefore function in sexual recognition. Saw teeth may also function in species recognition before pairing takes place. That the ultimate legs of *Theatops* are involved in prey capture seems doubtful. Observations of the movements of the ultimate legs in living specimens and, particularly, on feeding are required.

Key words

Chilopoda, Scolopendromorpha, *Cryptops*, *Theatops*, ultimate legs, prey capture

Introduction

Verhoeff (1902-25) suggested that the ultimate legs of *Cryptops* may be used to capture prey and Bücherl (1971) stated that “The specimens of *Scolopendra* and *Otostigmus*, *Cryptops* and others attack their prey with the last prehensorial anal legs, then the head is rapidly curved behind and the venom claws deeply and firmly buried in the body of the prey.” There are scattered statements in the literature also suggesting that the ultimate legs of the cryptopid genus *Cryptops* and the plutoniumine genera *Theatops*

and *Plutonium* are involved in the capture of prey. The evidence for these assertions is here examined and it is concluded that there is presently no evidence to support these statements.

The function of the ultimate legs in *Cryptops*

When flexed, the tibia and tarsus 1 and 2 of the ultimate legs of *Cryptops* species (family Cryptopidae) become arranged in the form of a triangle (Figs 1 & 2). Verhoeff (1902-25) likened this flexure to the closing of a penknife describing the process in considerable detail. The tibia and tarsus 1 each have a ventral row of saw teeth between which, according to Verhoeff, prey or an "organ" may be held. Moreover, the spine-like setae on the inner surfaces of the prefemur and femur, he maintained, further assisted in maintaining the grip of the legs. Dobroruka (1961), and Bücherl, (1971) similarly regarded the flexure of the tibia and tarsus of *Cryptops* as a device to capture prey. Lawrence (1953) added that the legs may also be partly defensive. He pointed out that they are joined to the body by a weak articulation and are easily broken off. Eason (1964) followed Verhoeff, stating that "serrate combs (the rows of saw teeth) on the ventral margins of the tibia and tarsus which are opposed when the tarsus is flexed form an ideal arrangement for grasping prey, which can be held even more firmly by flexing the other joints and bringing into play the spinous setae which cover the prefemur and femur ventrally."

Verhoeff (1940) noted that when numerous *Cryptops* are preserved together the ultimate legs of some specimens become attached to other specimens. He suggested that this clasping ability enabled the centipedes to cling to floating debris thus allowing distribution to islands by rafting, this despite the fact that the legs were often detached.

The flexed tibia and tarsus of the ultimate legs of *Cryptops* may well form an ideal arrangement for grasping prey but I am unaware of any observations of their use in doing so. The only observation of their use as prehensile organs is that of Verhoeff (1902-25) who placed an *Anthomyia* near a *Cryptops hortensis* (Donovan, 1810) which trapped the fly's wing with one of its ultimate legs and a hind leg with the other. Feeding, however, was not observed. This, Verhoeff ascribed to the centipede being disturbed by the light. The fly was released having lost some legs, one of which continued to be held in the ultimate leg of the centipede for some twenty minutes.

Observations on feeding in *Cryptops* are rare indeed. Verhoeff (1902-25) recorded *Cryptops hortensis* as killing flies, young *Pieris* caterpillars and small opilionids, presumably with the forcipules, but they were not eaten. Anon (Keay, 1993), observed *Cryptops anomalans* Newport, 1844, feeding on earthworms, an earwig (*Forficula auricularia*), the centipedes *Henia vesuviana* (Newport, 1854), *Stigmatogaster subterranea* (Shaw, 1789) and *Geophilus flavus* (De Geer, 1778), the millipede *Cylindroiulus caeruleocinctus* (Leach, 1815) and Diplura. He noted that in most cases the prey is grasped in the forcipules and devoured whilst still struggling. The observations were made in laboratory conditions under red light (Keay, personal communication). More recently

Keay (personal communication) recorded *C. anomalans* eating a dipluran, the entire insect being fed into the oral cavity head first. He has never seen the terminal legs of *Cryptops* used to capture prey but adds that the death reflex of, particularly the tibia and tarsus would indicate strong grasping ability. He adds that the terminal legs seem to be used in a sensory capacity when the animal reverses out of tight situations.

The ultimate legs of *Cryptops* are readily autotomised and care has to be taken when collecting these animals not to hold them: they are missing in many specimens in collections. This property is hardly to be expected of an organ used to catch prey. It seems much more likely that they are defensive, trapping some part of a potential predator, being autotomised and remaining attached to the predator as the centipede escapes. Verhoeff's (1902-25) observations on *C. hortensis* and *Anthomyia* would seem accord with this. Likewise, Greg Edgecombe (personal communication) has observed and has photos of an interaction between *Scolopendra oraniensis* Lucas, 1846 and *Cryptops trisulcatus* Brolemann, 1902 in Sicily. When the *Cryptops* was removed from the attacking *Scolopendra* one of its ultimate legs remained attached to the legs of the predator.

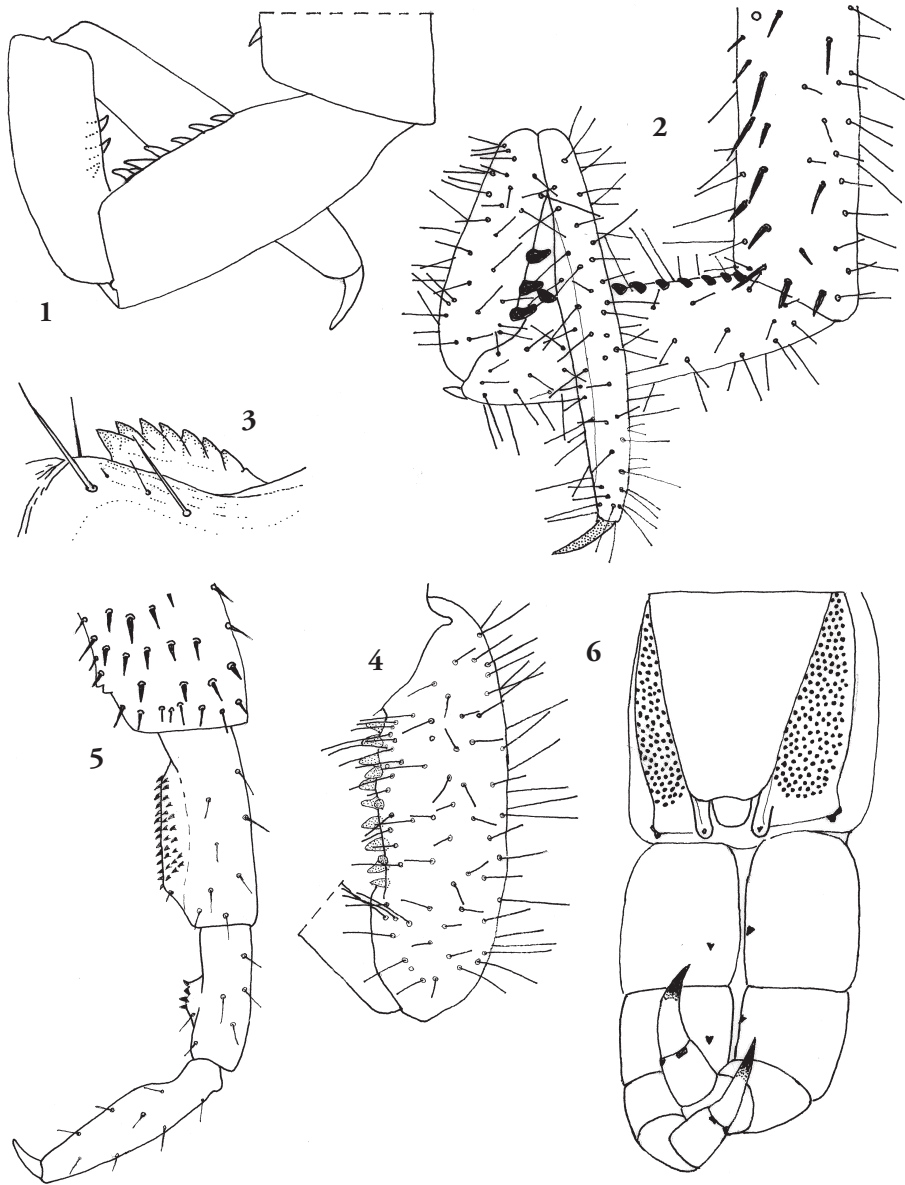
The function of the tibial and tarsal saw teeth in *Cryptops*

The assertion that the rows of saw teeth are opposed when the leg is flexed is incorrect. Flexure of an ultimate leg brings tarsus 2 close to tarsus 1 (Figs 1, 2) but does not bring the saw teeth of the tibia and tarsus 1 into contact. The teeth on tarsus 1 come to lie opposite tarsus 2 rather than opposite the tibial saw teeth. Moreover there are always more tibial than tarsal saw teeth so that some of the former have no opposite number and there is sometimes a considerable disparity in size, the tarsal teeth being larger (Fig. 2). Thus the two rows of teeth are not necessarily opposite each other.

The ventro-distal saw tooth, or teeth sometimes present on the femora in some species (Fig. 1) could not be involved in any gin-trap mechanism. In large specimens of *C. parisi* Brolemann, 1920 the tarsal saw teeth overlap one another and even fuse together (Fig. 3). The saw teeth on tarsus 1 in *Cryptops (Trigonocryptops) roeplainsensis* Edgecombe, 2005 are variably arranged in two rows (Fig. 4) and in large males of the New Zealand species *C. polyodontus* Attems, 1903 and *C. lamprethus* Chamberlin, 1920 there is a considerable number of small teeth arranged in two to four rows on the tibia (Fig. 5). The ultimate legs of *Cryptops inermipes* Pocock, 1888 from Christmas Island lack saw teeth.

Although they do not meet, the saw teeth may well, nevertheless, play a role in trapping part of a would-be predator when the legs are flexed. A small structure would be held between the tarsus 2 and tarsus 1. With a larger object the tarsi would be unable to close to such a degree and the object would be forced against the (usually) backwardly directed tibial saw teeth which would, however, be more efficient if they were forwardly directed.

If the arrangement of the saw teeth suggests that their primary function is not that of locking onto an object then they would be expected have other functions. As noted



Figures 1–6. 1. Tibia, tarsus 1, tarsus 2 and part of femur of ultimate leg of *Cryptops doriae* Pocock, 1891, from the Seychelles, after Lewis (2007). 2. Tibia, tarsus 1, tarsus 2 and part of femur of ultimate leg of *Cryptops (Trigonocryptops) camoowealensis* Edgecombe, 2006, from Australia, after Edgecombe (2006). 3. Tarsal saw teeth of *Cryptops parisi* Brolemann, 1920, from France, after Brolemann (1930). 4. Tarsus 1 of ultimate leg of *Cryptops (Trigonocryptops) roeplainsensis* Edgecombe, 2005, from Australia, after Edgecombe (2005). 5. Tibia, tarsus 1, tarsus 2 and part of femur of ultimate leg of *Cryptops polyodontus* Attems, 1903, from New Zealand, after Archey (1924). 6. Ventral view of ultimate segments and legs of *Theatops erythrocephalus* C. L. Koch, 1847, from Camposancos, nr. La Guardia, Pontevedra, Spain.

above, in large males of the New Zealand species *C. polyodontus* and *C. lamprethus*, the tibial teeth are arranged in two to four rows (Fig. 5). Females, on the other hand, possess only one row of teeth of larger size than those of in males. A strongly developed keel on tarsus 1 is also a male secondary sexual character in these species (Archey, 1924). These characters may allow sexual recognition during paring, if this takes place. In addition they may be involved in species discrimination before paring as Lewis (1985) suggested might be the case with the spine distribution on the ultimate legs in some scolopendrids. Mating behaviour has not been observed in cryptopids but in other centipedes, including scolopendrids, the courtship ritual involves mutual tapping or stroking of the ultimate legs by the antennae of the opposite sex [for a recent review see Rosenberg (2009)]. This tapping is likely to be the way in which the partners gather information on spine distribution.

The function of the ultimate legs of *Theatops*

The members of the Scolopocryptopidae (sensu Edgecombe & Koch 2008) subfamily Plutoniuminae, *Theatops*, which occurs in USA, Mexico and southern Europe, and *Plutonium*, which is found in Spain and Italy, are characterised by the possession of ultimate legs described as pincer-like (Fig. 6). Cloudsley-Thompson (1958) stated that in species of *Theatops* the terminal legs with their piercing claws are used for holding food and Manton (1965) suggested that in *Plutonium* the legs formed a stout forcep so that food may be secured both fore and aft (i.e. at the front and rear), for example in deep rock fissures. Strongly thickened pincer-like legs, however, occur in other scolopendromorphs being found also in *Asanada*, *Edentistoma*, *Arthrorhabdus* and *Scolopendropsis* and have four or five separate origins (Edgecombe & Koch 2008). Schileyko (2009) stated that in *Theatops*, *Plutonium* and *Scolopendropsis* the “pincer-shaped” terminal legs, which are adapted for capturing prey, are correlated with a strongly enlarged ultimate segment. He suggested that this may be due to the presence of enlarged muscles necessary to manipulate these appendages as functional forcipules. He also noted that some species of *Cormocephalus* Newport, 1844 show a similar shape of terminal legs but the ultimate segment is never enlarged.

There are, however, no records of feeding in either *Theatops* or *Plutonium*, nor in any other of the scolopendromorphs with pincer-like ultimate legs, and conclusions as to the function of the legs appears to be based on their shape.

In preserved specimens of *Theatops* (Fig. 6) the prefemur and femur are parallel, the tibia, and tarsus 1 and 2 are turned inwards and downwards and are generally crossed. Shelley's (2002) photograph of a living specimen of *Theatops posticus* (Say, 1821) shows the prefemur, femur and tibia parallel and tarsus 1 and 2 curved inwards but not crossed. There can be no doubt that these legs form efficient hooks, which Arkady Schileyko in his review of this paper suggested might possibly be used to pierce soft bodied prey but it is difficult to see how they would form efficient pincers.

That the ultimate legs of *Theatops* (and *Plutonium*) are involved in prey capture seems doubtful. What are needed are observations of the movements of the ultimate legs in living specimens and, particularly, observations on feeding. The pincer-like legs of the African scolopendrid *Asanada socotrana* Pocock, 1899, are probably involved not in the capture of prey but in the distraction of a would-be predator as they are readily autotomised and when detached perform wriggling movements (Lewis 1981).

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