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ENCOUNTERS BETWEEN THE GEOPHILID CENTIPEDE HENIA (CHAETECHELYNE) VESUVIANA NEWPORT AND THE DEVIL'S COACH HORSE BEETLE STAPHYLINUS OLENS (MUELLER)

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Introduction

Henia vesuviana Newport is a large soil-dwelling centipede found south of a line between Bristol and London. Notes on the ecology and feeding preferences of this species have appeared in previous issues of the *Bulletin* (Keay 1984, 1986) but in this article, we would like to describe perhaps the most remarkable aspect of its behaviour, the secretion of defensive glues.

During his studies on *Henia vesuviana*, Andy Keay noticed that forceps used to pick up the centipedes often became stuck together with copious amounts of a milky-white sticky substance which quickly hardened to form a very strong glue. This led us to examine this phenomenon in more detail, in particular whether the secretion of this substance could defend the centipede from attack by other predatory invertebrates. Specimens of *Henia vesuviana* collected from waste ground at Newport, Isle of Wight, were subjected to attacks from the Devil's Coach Horse beetle (*Staphylinus olens* (Mueller)), probably the fiercest invertebrate predator of its size in Britain. A detailed description of the ultrastructure of the secretory glands and the chemical properties of the glue will be presented at the 6th International Congress of Myriapodology in July 1987.

Experimental Results

The progress of encounters between *Henia vesuviana* and *Staphylinus olens* in a small cardboard arena (10 cm x 8 cm x 3.5 cm in height) were recorded with a close-up video camera attached to a recorder with a slow motion replay facility. A typical encounter is described in detail in Table 1.

Table 1: Encounter between a female Henia vesuviana (7.5 cm in length) and a Staphylinus olens (2.5 cm in length) on 11/2/86.

Time (mins. secs)	Actions	
	Beetle placed in box and crawls around for 5 minutes.	
.00	Centipede introduced into box.	
.32	ATTACK 1. Contact between animals. Beetle grasps middle of body of centipede with jaws.	7 second attack
.39	Contact lost. Centipede immediately flees. Mouth-parts and antennae of beetle covered with glue. Beetle starts cleaning activities.	4.50 spent cleaning before next attack
4.12	Contact between animals. Centipede quickly withdraws.	
5.29	ATTACK 2. Contact between animals. Beetle grasps centipede.	20 sec. attack
5.49	Contact lost. Centipede flees. Beetle left with legs and antennae glued together and stuck to the floor of the box.	
17.12	Beetle pulls free of the box floor.	
23.32	All six legs of the beetle free.	54.08 spent cleaning
37.47	Beetle back on its feet.	
41.59	Contact between animals. Beetle turns head but does not attack.	
46.02	Contact between animals. Beetle moves towards centipede but no attack made.	
50.55	Contact between animals. Beetle turns head but does not attack.	
67.57	ATTACK 3. Contact between animals. Beetle bites centipede. Attack not vigorous.	2 sec. attack
67.59	Contact lost. Centipede flees. Beetle starts to clean mouthparts.	
74.22	Contact between animals. Uncertain whether beetle actually attacks but it quickly withdraws again.	
80.00	Experiment ended. Animals removed.	

In this encounter, there were three definite attacks. In the first and second attacks the beetle attempted to overpower the centipede by grasping it with its mandibles and violently rolling over, dragging the centipede with it. The first attack lasted 7 seconds and the mouthparts and antennae of the beetle were slightly affected. The second attack lasted 20 seconds which resulted in the beetle being severely disabled and unable to get back on its feet for 24 minutes. The third attack was not a determined effort and the beetle released the centipede after grasping it for 2 seconds.

The centipede, on being bitten by the beetle, reacted by curling its body and applying the ventral surface to the attacker, thus secreting directly onto it. Once released, the centipede always made a rapid escape away from the beetle. The centipede tried to avoid the risk of attack by rapidly recoiling its body whenever it made contact with the beetle. The body of the centipede was slightly swollen in the regions where it had been bitten but the mandibles of the beetle had not pierced the cuticle and appeared to have done no lasting damage (the centipede is still alive a year later!). During this incident, the centipede secreted 13 mg of glue representing about 8% of its body weight at the beginning of the experiment (Table 2). Encounters between Henia vesuviana and Staphylinus olens were repeated a further six times and in each case, the centipede escaped without fatal injury by virtue of its glue secreting ability.

Table 2: Loss of weight of Henia vesuviana after attacks by Staphylinus olens described in Table 1.

Weight of centipede before encounter	0.163 g
Weight of centipede after encounter	0.150 g
Weight of glue secreted	0.013 g
Percentage weight loss	8%

Discusssion

Staphylinus olens is probably one of the largest and most ferocious invertebrate predators that Henia vesuviana is likely to encounter in nature yet the centipede managed to deter several attacks from the beetle with relatively little damage to itself. Like other geophilid centipedes, Henia vesuviana is a relatively slow moving species (a measured speed of 0.4 cm sec^{-1} compared with 6.6 cm sec^{-1} for Lithobius forficatus), but the sticky secretion is sufficient to temporarily disable Staphylinus olens long enough for the centipede to make an escape. In the encounter described (Table 1), it took the beetle about 32 minutes to get back on its feet after the second attack. There are very few eye-witness reports of predation on centipedes in nature but Eason (1964) suggests that carabid beetles and hunting spiders may eat the smaller species, eggs and immature forms. Ridley (1936) observed a beetle, Harpalus ruficornis, successfully deterred by the defensive secretion of Geophilus electricus and Kirby & Spence (1867) observed the same species deterring a Carabus sp. Vertebrates such as shrews, toads and newts probably predate on centipedes as well.

Although the specimen of Staphylinus olens was severely disabled and repelled by the centipeded, it still attacked again once it had cleaned itself, apparently not having learned from its previous experience. A similar case was reported with carabid beetles which severed the body of julid millipedes with their first bites (Roth & Eisner 1962). The beetles were then repelled by the millipede's secretion, although this never happened until after the infliction of the fatal injury. The experiments were repeated day after day with identical results.

Chemical tests on the glue have shown it to be composed almost entirely of low (12,000) and high (>130,000) molecular weight proteins. When stretched, the glue forms strong fibres which polymerise and become very hard within about 20 seconds of exposure to the air. It sticks to a wide range of surfaces including glass, but does not stick to the cuticle of the centipede. Blower (1955) identified a superficial film of lipoid on the cuticle of geophilids which provides them with some degree of waterproofing and may possibly be the substance which prevents the glue from sticking to the centipede. Each segment of Henia vesuviana contains a large sac which surroungs about 200 small tubular glands which synthesize the glue. Each gland opens to the air via a small pore (diameter c. 5 um) which is sealed by a cuticular cap which is withdrawn to allow the glue to escape. The pores are situated centrally on the ventral surface and are visible to the naked eye as an orange patch. When at rest, the centipede always exposes its ventral surface towards the direction from which it is most likely to be attacked.

Jones et al (1976) reported that the geophilid Strigamia bothriopa, could successfully repel one or two ants with its secretion, but if milked exhaustively could become overrun by a swarm of ants and killed. It is, therefore, an adaptive advantage to be able to conserve these exocrine discharges and thus improve their effectiveness. When Henia vesuviana was prodded with a mounted needle under a binocular microscope, it was observed that glue was secreted only from sternal pore plates on the segments stimulated. Thus, the centipede is able to repel several attacks by only secreting glue at the specific site at which it is being bitten.

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