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THE DIET OF THE CAVE SPIDER *META MENARDI* (LATREILLE 1804) (ARANEAE, TETRAGNATHIDAE)

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ABSTRACT. This study investigated the range and number of prey consumed by a population of *M. menardi* in an abandoned mine drainage adit at Mary Tavy, on the edge of Dartmoor (Devon, UK). The adit was visited each week from October 1997 to November 1998 and any spider found feeding was interrupted and its prey removed and preserved in alcohol. Over the 13 months a total of 69 prey were recovered representing 18 taxa. While a number of flying insects used the adit as a refuge in which to over winter they formed a small percentage of the total prey consumed. Most of the prey were members of the soil or litter fauna (myriapods and slugs) that were observed walking over the surface of the adit walls.

Keywords: *Meta menardi*, prey, myriapods, slugs, litter fauna

Meta menardi (Latreille 1804) is a well known member of the twilight zone community in subterranean systems. This zone is located just beyond the entrance and provides an environment buffered from the extremes of the outside world while still receiving light from the external environment. As such, this zone forms a series of small habitat islands on the fringes of subterranean systems. While this habitat is connected to the external environment, the dark entrance zone acts as a significant barrier to many invertebrates, thus the diversity of potential prey in the twilight zone is low by comparison with the outside. Predators that occupy this zone are isolated from the surrounding habitats and thus have access to a limited range of potential prey. Yet as populations of *M. Menardi* can be large (in excess of a 100 individuals, pers. obs.), it is clear that an abundance of prey must be available in order to sustain populations of this size.

A number of invertebrates have been previously recorded as prey of *M. menardi*. Yoshida & Shinkai (1993) recorded Diplopoda, Diptera, Formicidae and Vespidae from a population living between boulders in Japan, while both Eckert & Moritz (1992) and Chapman (1993) recorded myriapods, Coleoptera and isopods as prey from populations in Germany and the UK respectively. Previous studies by the author recorded 2 species of diplopods, 1 isopod, carabid beetles, spiders of the genus *Meta*, plus slugs and oligochaetes (Smithers 1996). Studies of a cellar population in Germany revealed; 9 spp. Coleoptera, 2 spp. Isopoda, 3 spp. Araneae, 2 spp. Diptera, 1 spp. Gastropoda, 2 spp. 1 spp. Opiliones, Chilopoda, 1 spp. Nematophora, 1 spp. Hymenoptera and 1 spp. Pseudoscorpiones (Pötzsch 1966).

While previous work has shown that *M. menardi* consumes a wide range of prey there has not been a systematic study of the relative abundance of these prey in the diet of this species or an investigation of any seasonal variation. This study was designed to investigate the diet of *M. menardi*, and to determine any seasonal or life stage variations in the prey consumed.

METHODS

The work was conducted in an abandoned mine drainage adit on the edge of Dartmoor, Devon, UK (SX 513787). A man-made tunnel was chosen due to its linear nature which meant that all members of the population were accessible for observations. The adit was situated in a steep bank, the top of which was covered with deciduous woodland. The site was visited each week from October 1997–November 1998 (no data was gathered between December 97–January 98). At each visit the population was examined for spiders with prey in their web or mouthparts. When spiders with prey were disturbed the spider

Table 1.—The abundance of prey groups recovered from different life stages of *Meta menardi*.

Prey taxon	Immature	Female	Male	Total	% of total
Unidentified prey items	1	2		3	4
Diptera, Nematocera	2	1		2	3
Diptera, Culicidae	1			1	1
Diptera, *Eristalis* sp.			1	1	1
Coleoptera, Carabidae	2	3		5	7
Trichoptera unidentified	5	4		9	13
Trichoptera, *Stenophylax permistus*		1		1	1
Trichoptera, pupae		1		1	1
Neuroptera, Sisyridae		1		1	1
Lepidoptera, *Scoliopteryx libatrix*		1		1	1
Araneae, imm *Meta menardi*	1	1	1	2	3
Araneae, *Meta merianae*		2	1	3	4
Myriopoda, unidentified Diplopoda			1	1	1
Myriopoda, Julidae	5	5		10	14
Myriopoda, *Cylindroiulus punctatus*	1	2		3	4
Myriopoda, *Nanagona polydesmoides*	4	3		7	10
Myriopoda, Chilopoda Geophilomorpha	3			3	4
Gastropoda (Slugs)	1	12		13	19
Total number of prey recorded	26	39	4	69	

would retreat to the top of the web leaving the prey hanging by a silken thread. Any prey discovered were removed and taken back to the laboratory were they were preserved in 70% alcohol, then identified to the lowest taxonomic unit possible. The prey recovered were always wrapped in silk and in an advanced state of digestion. The exoskeleton of the arthropods were broken open and fragmented while the molluscs were usually digested from one end, occasionally leaving a head or rear intact. All of the spiders sampled were assigned to one of three life stage groups, females, males or immatures. Voucher specimens of *M. menardi* collected at the study site have been lodged in the invertebrate collection at the University of Plymouth.

RESULTS

A total of 69 prey were recovered representing 17 taxa, only 3 of which proved to be unidentifiable (Table 1). The myriapods were the most abundant prey recovered with 24 individuals, followed by slugs with 13 individuals, Trichoptera with 11, Araneae with 6 and Carabidae with 5. Other prey were recorded in small numbers (Table 1). It is clear that three taxa dominate the prey recovered over the sampling period. These are the myriapods, the gastropod slugs and the Trichoptera. Few prey were recovered from males while females and immature spiders were recorded consuming approximately equal numbers of most prey groups except slugs, which were primarily collected from females (only one slug was not taken from a female) (Table 1).

DISCUSSION

The myriapod prey comprised three main taxa, julid millipedes (some of which could be identified as *Cylindroiulus punctatus*), *Nanagona polydesmoides* and the geophilomorph centipedes. The julids were more abundant in May (4 individuals) and in the autumn (October & November 2 individuals each) but were occasional prey at other times of the year (February & August 1 individual each). The slight increase in numbers captured in the spring and autumn could be explained by a seasonal vertical migrations in the litter/soil undertaken by julids as reported by Geoffroys (1981). While the autumn migration is downward, both the spring and autumn migrations would involve an increase in the activity of individuals. Given the proximity of the adit entrance to the soil litter interface, some individuals becoming active in the spring could reach the surface and follow the rock surface down into the adit entrance. The geophilomorph centipedes also displayed a small autumn peak which could also be explained by seasonal migrations down the soil profile.

Nanagona is also an occasional prey over the spring and summer, which is not surprising as this is a well known troglophile that is commonly encountered in subterranean chambers (Blower 1985; Chapman 1993).

The Trichoptera also displayed seasonal patterns of abundance, being abundant in April / May and again in August where they displayed a distinct peak. This was probably the result of an emergence of adults from either the river outside the adit or the stream within it (a single pupal Trichoptera was recorded, indicating that individuals were emerging within the adit).

The slugs were recovered in small numbers over the late spring through to the autumn in which they displayed a distinct peak. This peak may be a result of their seasonal migration down the soil profile to escape the harsher winter conditions. This would bring them into the mine adit via the micro caverns in the bed rock. Once at a safe depth they are then quiescent for the winter months, thus explaining their absence from the diet of *M. menardi* between December and April. At 19% of the prey captured (Table 1) gastropods are an important element in the diet of *M. menardi*. This is unusual for a spider as a recent review of malocophagy in spiders has shown *M. menardi* to be the only araneomorph spider to include gastropods as a regular part of its diet (Nyffeler & Symondson 2001).

While slugs have been observed crawling into water laden webs of *Argiope bruennichi* (Scopoli 1772) (Quicke 1987), the exact method of prey capture used by *M. menardi* is as yet unknown. The bias in the number of slugs recovered from females (Table 1) hints that this particular prey may require the larger body size exhibited by most females to successfully capture this prey. A similar bias has also been observed in some carabid beetles (Nyffeler & Symondson 2001). Further work is required to determine the exact nature of the prey capture method for this species.

The remaining prey were captured in low numbers through out the year. A number of flying insects such as the hover fly *Eristalis tanax*, the Golden caddis fly *Stenophylax permistus*, the herald moth *Scoliopteryx libatrix*, and mosquitoes of the genus *Culex* commonly use underground chambers as over-wintering sites (Chapman 1993). These can aggregate in large numbers on the walls of underground chambers but, despite their presence in the adit these species were not common elements of *M. menardi*'s prey spectrum. This may be a reflection of their behavior, as they fly into the chamber and quickly settle on the walls where they become immobile until the following spring (pers. obs.). Unless they land in a web they are unlikely to attract a spider's attention.

Carabidae were recorded in the spring with a single record from the autumn. These are active predators that had probably strayed into the adit via the entrance from the woodland floor above. The spiders *Metellina meriane* (Scopoli 1763) and *M. menardi* were occasional prey over the spring and autumn, hinting that for any individual moving around within the chamber can be hazardous.

Predators that occupy the twilight zone have access to a range of potential prey which can be divided into three groups: organisms that move into the subterranean system from the external environment to seek shelter or over winter; those that move down the litter/soil profile and into the chambers via the micro and meso cavern network that connects the macro chambers with the overlying soil system; and members of the deep cave fauna that may stray into this zone. It appears that *M. menardi* has specialized in capturing members of the soil/litter fauna that stray in to underground chambers, but will respond opportunistically to any additional prey that walk over the inner surface of the underground chamber.

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