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PHYSICAL METHODS TO COMBAT MASS OCCURRENCES OF *CYLINDROIULUS CAERULEOCINCTUS* (DIPLOPODA: JULIDAE)

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Abstract In the small village of Röns (Austria) three families were confronted with a long lasting major mass occurrence of the snake millipede *Cylindroiulus caeruleocinctus* (Wood). Chemical, biological and physical methods were tested to force back those invaders and to protect the affected people. A three-stage defence-system containing different physical barriers was established to provide long-term protection. The inner circle was built up to prevent the millipedes from entering indoor areas. The middle circle was installed to keep them from climbing up the outer house walls. The outer circle was attached to protect the whole plot against new invaders.

Key words Snake millipedes, swarming behaviour, mechanical methods in pest management, silicate powder.

INTRODUCTION

Millipedes are a group of primeval arthropods characterized by two pairs of legs on most body segments. The biological knowledge about millipedes is rather sparse. On the other hand, their mass occurrences are rather common, and nobody can explain their biological reasons (Passig and Scholz, 2007).

In 2004, the biological advisory service (BAS) of the "inatura – Erlebnis Naturschau Dornbirn" was informed about the mass occurrence of *C. caeruleocinctus* in the village of Röns (Zimmermann, 2014b). Thousands of specimens were climbing up the outer house walls of three detached houses each night during a period of several weeks. Frequently singular millipedes managed to get into the houses, disgusting the tenants massively in their private sphere. This had already been remarked three years before, but in the beginning nobody had an idea of its dimension: the snake millipedes became part of the lives of the affected residents for more than ten years. As there was no chance of getting rid of them rapidly, it was the author´s goal to support the affected families in minimizing the disruptions caused by the invaders and to build up physical barriers to keep them away from more sensitive areas (Zimmermann, 2013).

The author has been asked for advice more than 100 times by people confronted with mass occurrences of *C. caeruleocinctus* and other millipedes in Austria and other European countries during the past ten years. None of these infestations reached the dimension of the one in Röns.

MATERIALS AND METHODS

Annoying Intruders

C. caeruleocinctus is a Julidae-species that is common in many parts of Europe (Bogyó and Korsós, 2010). It was also imported to the U.S.A. and Canada. Being a synanthropic ground dweller in open landscapes it can be found near the boundary of acres, in cemeteries and gardens – mainly under stones

or wooden structures. The diet of this snake millipede contains leaves of several deciduous trees as well as litter of grass plants and moss. Being strictly hygroscopic the specimens show their main activity periods in spring and autumn (Voigtländer, 2005). During the hot summer as well as in winter they hide in deeper zones in the soil. They show a typical diurnal vertical movement pattern, their main activity period being during the night (Haacker, 1967). A few authors describe *C. caeruleocinctus* as a pest feeding on roots of carrots, sweet potatoes and other culture plants (Brunke et al., 2012). Much more relevant is its role as an annoying species, whenever thousands of individuals enter gardens and houses (Scott, 1958).

Evaluation Of The Pest

This mass occurrence of *C. caeruleocinctus* occupied an area of about two hectares of ground. It was completely impossible to count or assess the whole number of individuals. To get a proper reference to the dimension of the infestation, the numbers of individuals climbing up the house walls were counted frequently. This led to the experimental definition, that an amount of 500 or more individuals entering the walls of a house during one hour (at night) three times or more frequently during an activity period marks a major mass occurrence. This definition might also be useful to distinguish between an annoying occurrence and a real pest. Due to the author´s experience, an amount of 500 millipedes and more on the house walls leads to a significantly higher number of individuals trying to get into the houses. On the affected sites in Röns many singular counting (over a period of 7 years) with 2.000 individuals and more, climbing up the walls of each of the affected houses, were documented.

Methodical Attempts To Combat The Pest

At first a local pest controller tried to combat the millipedes using insecticides containing Pyrethrum or Chlorpyrifos, but none of these pesticides could stop these invaders. As a second step, different beneficial organisms like predatory mites (*Hypoaspis miles*) and nematodes (*Steinernema carpocapsae)* were tested to reduce the amount of millipedes (Schulte, 1989). Applied in situ, the mites showed a weak effect for a few days, whereas in laboratory experiments they showed no influence on the millipedes. Nematodes were tested in cooperation with the enema company (Germany), but also showed no effect on *C. caeruleocinctus*. As these chemical and biological methods did not help to reduce the swarming millipedes properly, various physical barriers and traps were tested to keep away these intruders. This led to the plan of an experimental three-stage defence system to force back the invading millipedes (Zimmermann, 2014a).

THREE STAGE PHYSICAL DEFENCE SYSTEM

The inner circle of the barrier-system was built up to prevent the diplopods from entering the indoor areas of the houses. To fulfill this purpose, insect screens were installed on windows and doors, several door and window seals were renewed, and other entrance facilities for the millipedes (ventilation slits etc.) were closed with tapes.

The middle circle was established directly on or near the plinths of the house walls to keep the millipedes from climbing up the outer house walls. It also enabled the protection of balconies, verandas, terraces, pergolas and other defined places near the houses. In a small distance from the ground a slippery plastic tape (7 cm high) was fixed with a double-sides adhesive tape to the house wall. Entering millipedes had no chance to pass this slippery barrier. The areas around doors and pathways were additionally protected with trails of silicate powder. To complete the protection masking tapes were applied as adhesive traps on the ground.

The outer circle was installed near the plot boundaries to protect the whole property against migrating millipedes. It was put into practice with a slug fence made of galvanized iron-plate. The vertical parts of this fence were coated with a liquid formulation of silicate powder to build a self-eroding surface. Whenever millipedes tried to climb up this chalky surface, small eroding silicate-crumbs stuck

to their tarsi and made them lose their grip and slip down again (Mucha-Pelzer, 2010). This special surface coating had been developed by the Humboldt-University of Berlin and was tested in situ for the first time in Röns (Mucha-Pelzer et al., 2009). On both sides of this fence sets of barber-traps were posed to control the effect of this barrier.

EXPERIENCES AND DISCUSSION

It proved to be rather helpful to define three different protection areas. Each defence-circle had its specific functions and demands. But all these measures had to fulfill one goal, they had to ameliorate the welfare of the affected tenants.

Normally the interior areas indicate the most delicate space that has to be protected solidly. To achieve this, each single window and door seal had to be proved and – if necessary – renovated. Ventilation slits had to be taped carefully. All windows (and also balcony doors etc.) that might remain open during the nights had to be secured with insect screens. Wherever these inner defence-measures were realized properly, not even single millipedes were able to enter the rooms.

Keeping the house wall more or less free from millipedes is a further important step to keep the tenants calm. The applied plastic tape fulfilled this purpose sufficiently and free from service costs. Its only disadvantage was that it could damage the surface (painting) of the wall, when being peeled off again. Also barriers made of silicate powder showed a rather good performance against the millipedes. Part of the specimens was aware of the silicate trail and turned back. Others, that tried to crawl through the powder, were contaminated massively (Zimmermann and Duelli, 2007). Being animals with many joints and intersegments, the millipedes are predestinated to be controlled with silicate powder: The grains of the powder stuck everywhere on their bodies, destroying the waxy layer of their cuticule and making them unable to move or curl up. Most of the individuals died at least a few hours after being contaminated. But this lethal barrier needed to be maintained permanently: after strong rains or winds the trails had to be cleaned (especially if there were lots of millipede bodies covering the silicate) and new powder had to be applied. The installation of the adhesive traps made from masking tapes was rather tricky, and they had to be renewed very often. As soon as a few millipedes were already sticking to the tapes, the following individuals could cross them in climbing over their bodies.

The outer circle was established to keep migrating millipedes away from the whole plot. The slug fence and its special coating fulfilled this purpose perfectly. But the attempts to quantify this effect with barber-traps had to be cancelled because too many bycatches had been killed. The big disadvantage of this barrier was its permanent need for maintenance. After each grass-mowing, the fence had to be cleaned coated. During winter the fence had to be removed completely and then to be rebuilt in spring.

CONCLUSIONS

The tested set of physical barriers proved to be a proper long-term method to combat swarming and migrating masses of millipedes. The success of these measures is strongly depending on the attitude of the affected tenants, therefore a close contact between them and the pest advisors has to be established. According to the needs of the individual situation, this method can be adapted or only a part of the barriers can be installed. As this system does not help to reduce the stocks of the swarming millipedes (only the silicate powder partly does!), it could be combined with biological methods (nematodes and other beneficial animals) to get a quicker reduction of the problem for the tenants.

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