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Economic importance of millipedes on Santo Antao (Cape Verde) using the example of *Spinotarsus caboverdus* PIERRARD.

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Abstract

Representatives of the sub-class of the diplopods as plant pests were first verified in 1970. So far, the presence of *Spinotarsus caboverdus* is limited to the islands of Santo Antao and Sao Vicente. There it is subject to an internal quarantine in order to counteract the danger that the pest could spread to other regions in the country through the transport of agricultural products.

The species is infamous as a pest that befalls many plants important for the alimentation of the inhabitants. All chemical and biological combat measures so far have not lead to any considerable success and thus brought the cultivation of individual cultures like the potato, for example, to a standstill. Obviously the measures applied so far failed because the habit and the behaviour of the animals protect them from direct contact with the pesticide. Therefore, new approaches for a combat strategy can only be effective if they are accompanied by the explanation of concrete biological facts regarding this pest.

S. caboverdus very quickly learnt to use the ecological conditions of the island to its advantage and thus managed to spread quickly and with a high population density across the island since its first detection. Their preferred places of habitat are fields with leaf deposits on the floor (e.g. banana leaves) and especially rocks, under which the animals like to hide during the day in order to protect themselves from drying out. The highest population density among millipedes in the course of the year can be observed during the time the mangoes mature. Damages to the cultured plants and their fruits can be observed all the year round, though.

With the aid of a laboratory cultivation, we want to answer specific questions about the pest's development and reproduction.

In our considerations regarding a combating strategy, we prefer natural control mechanisms, as the successful settlement of a useful organism with a lasting efficiency has ecological as well as economical priority for a poor country like Cape Verde.

Introduction

Millipedes (Diplopoda) belong to the order of Myriapoda. They only have one pair of antennae and are trachea breathers like insects (Tracheata). The millipedes' rump consists of a varying number of double segments that almost all feature two pairs of walking legs. Most diplopods are surface-dwellers and live off all kinds of vegetal waste materials.

Generally one can discern that the millipedes' most preferred surroundings are localities with mighty leaf flushings on the floor and moisture-retaining undergrowth with mildly diffuse light.

A series of diplopods were displaced by people for reasons of trading. We can definitely assume that for the genus *S. caboverdus* that was brought to Cape Verde from the African continent this way and also became indigenous there.

S. caboverdus belongs to the family of Odontopygidae (genus Spirostreptida). This family is widely spread across tropical Africa with the exception of Madagascar (Neves, 1993).

The mountainous character of the island of Santo Antao with its humid microclimate is especially suited for the preservation of the species during the dry season. The fact that this parasite was initially ignored along with its high adaptability to the new surroundings has led to substantial damages to the cultivation areas for the past 30 years.

Materials and methods

S. caboverdus was brought from Santo Antao to Berlin, in the base of collaboration of the German and Capverdean authorities. The animals were put into the insectarium with temperature of 22- 26°C and 12 h illumination. The relative humidity varied between 30% and 50%.

The animals are kept in smaller and larger groups in terrariums with special mineral and organic substrate under as natural conditions as possible or tested in small terrariums with regards to their reaction to specific conditions. They will be offered pieces of potato or sweet potato but also pieces of apple and carrot as food.

We have first results and observations about the millipedes' reproduction process and development cycle, as there are still very substantial deficiency in knowledge here.

Present importance of *S. caboverdus*

The relatively small but due to mass presence still dangerous species *S. caboverdus* often infests the most varied cultivated plants like potato and sweet potato tubers (table 1), pumpkins, tomatoes, cassavas, melons, germinating beans and germinating corn.

Table 1 Extent of damages to potatoes and sweet potatoes through *S. caboverdus* (Neves, 1998).

Species	Date	Number of tubers/plant (average)	Number of <i>S. caboverdus</i> /plant (average)	Undamaged tubers %	Tubers with surface damage %
Désirée (potato)	14.02.86	6.7	21.0	17.8	67.9
	20.02.86	7.6	23.0	21.0	74.2
	04.03.86	7.4	54.0	15.2	74.2
	11.03.86	7.7	48.1	2.9	70.6
	18.03.86	7.5	14.5	3.9	73.7
	31.03.86	5.9	13.2	13.2	67.7
	08.04.86	4.5	9.2	2.4	55.1
Tchontcha (sweet potato)	23.05.86	5.0	18.2	2.4	97.6
	02.06.86	5.1	9.4	2.4	97.6
	12.06.86	4.4	20.7	0	100

The species also prefers fruits like papayas, mangoes, bananas and pineapple and does heavy damage to them (fig. 1). The millipedes destroy fruits by drilling into these as soon as they fall on the ground, eating away at them and also favour secondary infections.



Figure 1 Accumulation of the adults millipedes at papaya fruit (by A. Mandl)

Despite chemical pest control, the infestation of potatoes still reached an extent of up to 50% (untreated 90%) even after several treatments with chemical preparations (bait with Uden 70 WP) (Neves, 1998).

Therefore we advise against chemical pest control measures, also because of the fact that the high intensity of treatments would harm the environment.

So far, the farmer families on Santo Antao exclusively work on their fields to sustain their own nourishment. However, they should increasingly be persuaded to use the cultivation of fruit and vegetables as a source of income. The failures so far, both with regards to the chemical and biological combat measures against the millipedes, have increased the Farmers' fear of this pest and restricted the cultivation of delicate yet important cultures. Therefore a government programme attempts to reduce the vast cultivation of sugar cane in favour of the cultivation of vegetables. However, this object can only be achieved if a promising strategy can be worked out to combat the millipedes.

In order to derive an effective starting point for a combating method, we have to expand our knowledge about this pest's biology. In addition, one should search for natural enemies and combat-effective cultural measures as well as test new substances to establish an effective overall concept against the millipedes (e.g. *S. caboverdus*).

Biology and damage of the millipedes

There are no definite theories about the evolution of the species *S. caboverdus* in literature. The first results of my examinations are listed below.

The female deposits the oval, whitish eggs individually and scattered on the ground. In relation to the breadth of their bodies, the females of *S. caboverdus* generate relatively large eggs (0.8 mm x 0.6 mm).

The development of the embryo lasts a maximum of 22 days at 20-23°C. At the end of this development section, one can already see the pupoid through the embryonic cuticle

with its structured antennae, leg pairs and body rings. By means of skinning the larva develops into the adult animal (table 2). With each skinning it forms new rump rings with leg pairs from the so-called proliferation zone.

Table 2 Development of larval stage of *S. caboverdus*

Stages	Colour	Length (mm)	Number of segments	Number of ocelli	Duration by 22-23°C (week)	Favourite nourishment
Stage I	white	2	10	none	1	yolk
Stage II to IV	white	2,5 to 6,0	18 to 29	1 to 3	4	dead organic matter
Stage V to last premature stage	white to light-bronze	7,0 to 37	31 to 68	from 10	20	living plant parts

The development of the larva here takes approximately 7 months. The adult animals reach a size of 47 mm with an average of 67 diplosegments.

S. caboverdus is heteroecious like all millipedes, whereby one can hardly discern a difference between males and females. The females have 127 pairs of legs, the males only 125. This is due to the fact that the 1st and 2nd leg pair of the 7th segment are reshaped to gonopodes. This is how one recognizes the males. The encounter of males and females is accidental and can trigger copulation. During copulation, the male animal raps itself spirally around the female in a very specific way. The copulation process can take up to 40 minutes. The studies have shown that the female is capable of copulating several times, also within short intervals.

Under the breeding conditions so far, the adult animals have a life duration of approximately 7 months.

Damages caused more by adult millipedes and older larval stages belong to mechanical damages. They are caused primarily by the eating activity of the animals. It is possible to differentiate hole fed in leaf and bored feed. Bored feed in fruits and roots are created. The damage through gallery bored by animals leads to vegetable tissue losses and also to secondary symptoms by fungal infection.

Conclusion

All examinations of the developmental data so far have shown that the species *S. caboverdus* probably only produces one generation per year. The most sensible stages during the course of development are the egg stage as well as the first three larva stages. In this phase, the integument is only slightly chitinised and very susceptible to dryness. During this phase the animals retreat into the ground. The main damage to the cultivated plants is caused by the juveniles from the stage V and the adult animals.

An approach to combat millipedes therefore only seems to be promising during the initial phase of reproduction.

References

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