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A sediment agglutination on females of the free-living marine nematode *Desmodora schulzi**

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ABSTRACT: Mature females of *Desmodora schulzi* Gerlach carry a massive sediment agglutination on the ventral side of their body. Males and juveniles are devoid of the agglutination. It is suggested that this structure, exhibiting a microbe population in some specimens, is either related to some kind of unknown maternal brood-care or provides the reproductive female with extra food necessary for the generation of the large oocytes.

INTRODUCTION

Nematodes are numerically the most prominent members of the meiofauna in marine sediments, but the ecological significance of many of the common species cannot be assessed because of insurmountable difficulties in cultivating generations of nematodes from mud and sand of the open sea (Warwick, 1981; Heip et al., 1985). Therefore, we must often resort to circumstantial evidence when trying to elucidate the natural history of these nematodes. Here we present observations made on preserved and living specimens of a sand-inhabiting desmodorid species, *Desmodora schulzi* Gerlach, 1950.

Desmodoridae have been found worldwide in euhalinic or polyhalinic habitats, sometimes in large numbers. Many species move very sluggishly. Species tested for their respiration rates showed very low values (see Heip et al., 1985). Only one species, *Desmodora scaldensis* De Man, has been maintained in the laboratory over a long period. This species was kept on a substrate of small pieces of *Laminaria* leaves and required about two years for the completion of one life cycle at 7 °C (Gerlach & Schrage, 1972).

Desmodora schulzi has been redescribed by Vincx (1983). She gave a description of adults and juvenile stages, discussed the taxonomic status and gave a bibliography of distribution records.

MATERIAL AND METHODS

Desmodora schulzi (syn. *Desmodora hirsuta* autores, see Vincx, 1983) was sampled in the North Sea around the island of Helgoland and from beach sand at the island of Sylt, which is the type locality of the species.

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The Helgoland material (50 mature females, 32 males, 31 juveniles) was isolated from 8 samples taken between 1975 and 1977 (February to September); depths about 20 m, coarse and medium sand containing some detritus. The nematodes were extracted by washing and decantation. Aliquots were fixed with formalin (made up with distilled water or sea water) or formalin-propionic acid mixtures; cold and hot fixatives were used. Glycerine was used for mounting.

The Sylt material (55 females and 24 large juveniles were observed for two months or more in 1982 and 1983) was used for live observations under the dissecting microscope. The nematodes were extracted from coarse sand at the base of the beach slope near the Litoral Station of List during the summer. The collection site sometimes contained large numbers of *Desmodora schulzi* (see Blome, 1983, sub nomine *D. hirsuta*). The specimens were kept in covered glass cavity block dishes (Bovery dishes) with sea water and small amounts of their natural sediment (coarse sand containing detritus flakes) at 17 °C in a dark refrigerator. One to twelve specimens were maintained in each dish. Water was changed once a week. Observations were made usually every three days. – An additional sample of 31 females, collected in 1984, was observed sporadically to reduce disturbances.

OBSERVATIONS

Desmodora schulzi is a slender nematode with a body length of about 1.5 mm (Fig. 1). The colour of the body wall is brown as is typical for Desmodoridae. In addition to some strong setae on the cuticle, there are characteristic longitudinal rows of fine hairs, which are about 10–15 µm long (Fig. 3). They are arranged very densely, with one hair per cuticle annule in each row. In the middle of the body there are eight rows, located in submedian and sublateral (or lateromedian) positions. In the male preanal region the subventral hair rows are replaced by a field of small, triangular pegs (Fig. 2); in juveniles

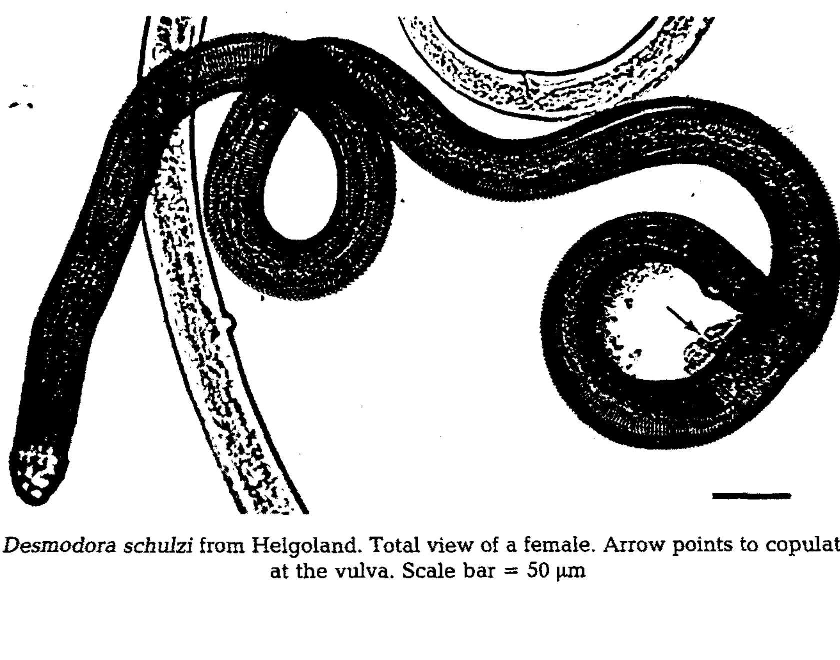

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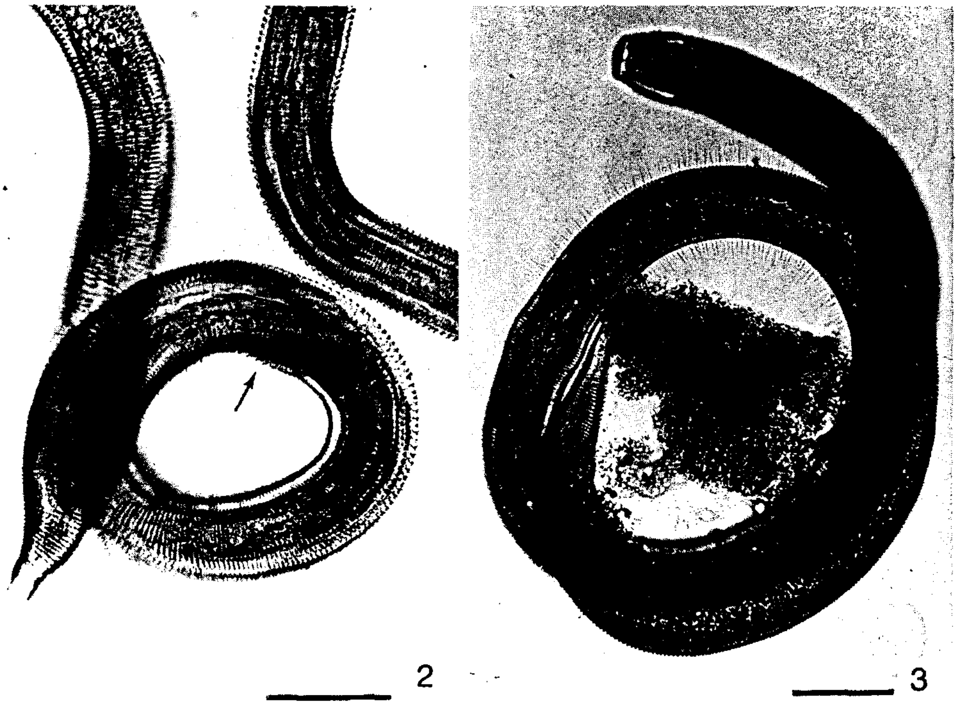
Fig. 1. *Desmodora schulzi* from Helgoland. Total view of a female. Arrow points to copulation plug at the vulva. Scale bar = 50 µm



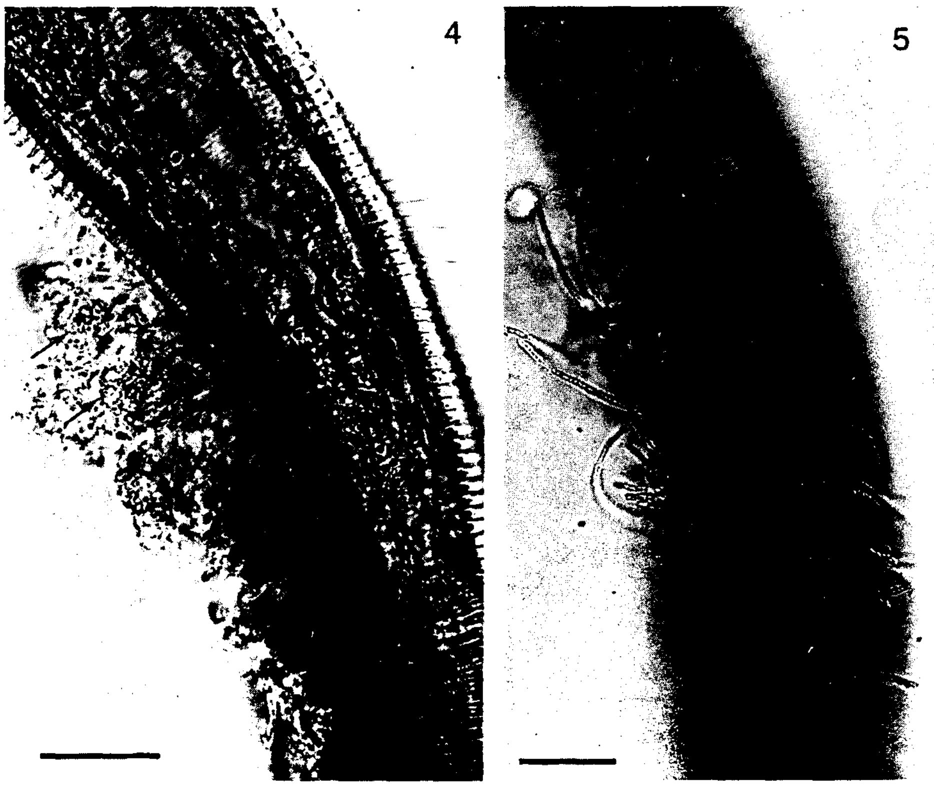
Figs 2 and 3. *Desmodora schulzi* from Helgoland. Fig. 2: Posterior end of a male. Arrow points to preanal pegs. Fig. 3: Total view of a female. Scale bars = 50 µm

the rows of hairs are without modification in the preanal region. However, in all mature females there is a peculiar sediment agglutination ventrally, beginning about two body widths behind the vulva and ending shortly before the anus (Fig. 1). The males and all juvenile stages observed have no sediment agglutinations in the preanal region.

At greater magnification, the sediment particles attached to the females were seen to be glued together by a mucoid substance and in eight cases colonies of microorganisms could be recognized within this substance (Figs 4–6). Thus the agglutinations form a microbial "micro-garden". Colonies of coccoid microorganisms and filamentous, septate forms were observed. Obviously, the preanal sediment agglutinations on *D. schulzi* females provide a favourable substrate for microbial growth.

How are the agglutinations formed and kept in place? There were no special glands detectable in the respective body region that might produce a sticky substance. Presumably, the particles are glued together by the usual caudal gland secretions, which also in other nematodes may produce sediment agglutinations. In these cases, however, the secretions are discharged into the surroundings and are not attached to the body (Riemann & Schrage, 1978). In one preserved female of *D. schulzi* we observed a secretion thread that was discharged from the caudal tip and attached to the sediment agglutination.

In the region of the agglutination, beginning two body widths behind the vulva, the regular lateroventral and subventral rows of fine hairs are replaced by a broad field of



Figs 4 and 5. *Desmodora schulzi* from Helgoland. Fig. 4: Preanal sediment agglutination with bacterial clumps (arrows). Fig. 5: Septate filiform microorganisms in the same region, high focus. Scale bars = 20 μm

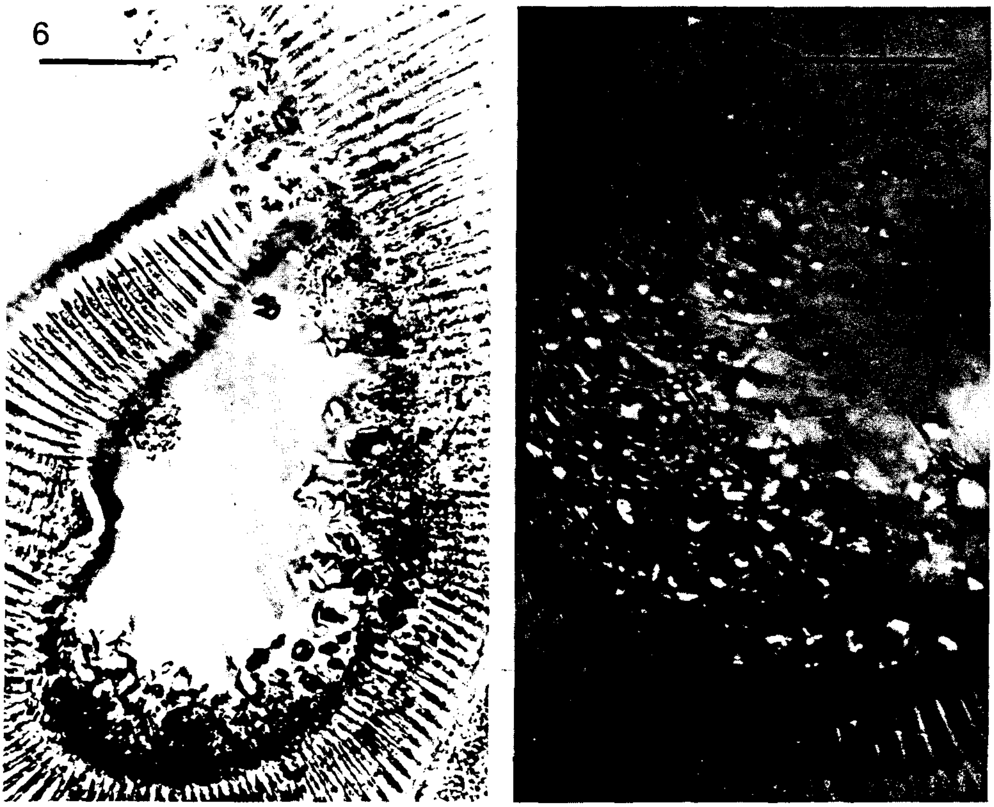
very long and irregularly positioned hairs (Fig. 7). These reach a length of about 25 μm and are approximately twice as long as the hairs in the regular hair rows. The elongate hairs, which are lacking in males and juveniles, form a kind of basket to retain the agglutinations.

A large copulation plug on the vulva (Fig. 1), which indicates insemination (see Vincx, 1983), has been seen in 80 % of the females. Colonies of coccoid bacteria occurred along the outer margin of this secretion in 7 females.

The gut lacked particulate contents in 24 specimens of the Helgoland material; in 5 specimens short sections (up to 100 μm) of the gut were filled with material that consists mainly of pale, granular masses. The globular granules, presumably bacteria, have a diameter of 1 μm.

Living *Desmodora schulzi* females could be maintained in the laboratory for up to 6 months (2 specimens); 10 specimens were kept for 5 months, 14 for 4 months and 33 for 3 months; 22 juveniles collected in the field were kept for 3 months.

Hardly any locomotion was observed; the nematodes were nearly always attached with the tail tip to sand grains or the glass bottom. For periods of several days they were



Figs 6 and 7. *Desmodora schulzi* from Helgoland. Fig. 6: Preanal sediment agglutination with bacterial clump (arrows). Fig. 7: Ventral region of a female with sediment agglutination retained by modified hairs. Scale bars = 20 μm

coiled up into a spiral, only the head showing movements. These periods alternated with periods of activity, when the entire body performed slow undulatory movements. This usually very sluggish behaviour was shown by adult females (all having a sediment agglutination) as well as by juveniles. There was no feeding behaviour observable. In one case a female remained coiled around a large detritus clump for 8 weeks. It resembled the preserved specimen from Helgoland shown in Figure 3, although the detritus clump occupied all the inner space of the body curvature in the living Sylt specimen.

Only two first-stage juveniles appeared in our cultures. One juvenile, about 250 μm long, was first observed in February 1983 and survived for two months. The other, detected in September 1984, was 450 μm long and lived for more than one month. Because of their large size (they are about twice as long as the body widths of the female), we could recognize single oocytes under the dissecting microscope within the gravid females. However, we never observed egg deposition, nor found eggs in the culture dishes.

DISCUSSION

The attachment of a massive sediment agglutination to mature females only, as observed in *Desmodora schulzi*, is a unique condition in marine nematodes known so far.

In our experience, small loosely adhering sediment agglutinations, sometimes with colonies of bacteria, may be found in various members of the orders Monhysterida, Chromadorida and Enoplida. In the order Desmoscolecida (see Decraemer, 1976, 1985) there are regularly arranged rings or protuberances on the cuticle which contain foreign particles. The mode of formation of these agglutinations is unknown. Sometimes, colonies of microbes have been observed attached to the cuticle of desmoscolecids (Riemann, unpubl). During an electron microscopical study, Iken (1979, pers. comm.) found bacteria within the concretion rings of *Desmoscolex* sp. but not in *Tricoma* sp.

In none of the above mentioned examples is the attachment of sediment agglutinations to the cuticle a sexually dimorphic feature, as is the case in *D. schulzi*. It is possible, therefore, that the presence of the agglutination in the species is related to some kind of maternal brood-care which has not yet been observed. Ott (1976) described *D. ovigera*, a species having the eggs attached to the female body, where the development to vermiform embryos takes place. However, this kind of brood-care is obviously absent in *D. schulzi* according to the present observations made on more than 100 females.

Another possible function of the sediment agglutination could be to provide the mature female with an extra amount of food necessary for the generation of the large oocytes. The microbes which have been observed in the agglutinations of eight females are relevant here. The required nutrients may be microbial particular matter or the dissolved products of microbial metabolism (cf. Lopez et al., 1979). A transcuticular uptake of nutrients has been found in some nematode genera and even colloid particles may permeate through the cuticle (Nuß, 1985). Therefore, it is possible that females coiled up in a nearly immobile state, as has been observed for long periods of time, may still be able to incorporate nutrients.

The productivity of *D. schulzi* seems to be extremely low for a non-predatory nematode (cf. Heip et al., 1985). Only two juveniles were born in cultures containing 86 females, 59 of which were kept for three to six months. Gerlach & Schrage (1972) also found low productivity in *D. scaldensis*, with a maximum of 8 eggs laid in a period of about two years. It is possible that the observed low productivity of *Desmodora* is due to a great extent to suboptimal culture conditions. Nevertheless, the results may illustrate the problems involved in assessing the average productivity of nematode populations. Small bacterial feeders may have annual production/biomass ratios of more than 10, and a figure of 30–40 sometimes seems realistic (Heip et al., 1984). However, certain other nematodes are possibly much less productive.

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