Cah. Biol. Mar. (2008) 49 : 295-297

Direct evidence of predation in deep-sea nematodes: the case of *Pontonema* sp.

Gustavo FONSECA and Fabiane GALLUCCI
Alfred Wegener Institute for Polar and Marine Research, Am Handelshafen 12, 27570 Bremerhaven, Germany.
Tel.: +49 47148312045; Fax: +49 47148311776. Email: Gustavo.Fonseca@awi.de

Abstract: Shallow-water studies showed that adults of Oncholaimidae, including *Pontonema*, are facultative predators, while younger juveniles feed mainly on dissolved organic matter and decaying organisms. We examined the gut contents of 12 *Pontonema* specimens, four adults and eight juveniles, from the Arctic deep sea (1300-2500 m). An average of 4.25 nematode preys per individual was found, together with spicules, organic matter and sediment. Particularly in three juveniles, 15, 13 and 10 preys, mainly juveniles of *Thalassomonhystera*, were found. These observations give evidence that feeding strategy within a genus may differ among environments and that previous laboratory experiments have underestimated their predation rates.

Résumé : *La prédation chez les nématodes en milieu profond : le cas de* Pontanema *sp.* Les études en milieu côtier ont montré que les adultes de la famille des Onchalaimidae, y compris le genre *Pontonema*, sont des prédateurs facultatifs, alors que les individus plus jeunes se nourrissent prinicipalement de matière organique dissoute et d'organismes en décomposition. Les contenus stomacaux de 12 individus du genre *Pontonema*, 4 adultes et 8 juvéniles, du benthos arctique profond (1300-2500 m). Une moyenne de 4,25 nématodes proies par individu a été trouvée, ainsi que des spicules, de la matière organique et du sédiment. Chez 3 juvéniles en particulier, 15, 13 et 10 proies, principalement des juvéniles du genre *Thalassomonhystera*, ont été trouvées. Ces observations mettent en évidence que la stratégie d'alimentation au sein d'un genre peut varier en fonction des milieux et que les expériences effectuées en laboratoire ont sous-estimé leur taux de prédation.

Keywords: Nematode feeding ecology • Free-living marine nematodes • Facultative predator • Oncholaimidae

Introduction

Very little is known about the feeding ecology of marine nematodes (Jensen, 1987; Moens et al., 2004). Most of our knowledge is derived from the morphology of the buccal cavity of adult organisms (Wieser, 1953), or is based on laboratory observations (Moens & Vincx, 1997). Direct evidence of their feeding behaviour *in situ* (Kennedy, 1994) or analyses of gut contents remain scarce (Jensen, 1992). Moreover, most of the studies were done on estuarine organisms and little is known about nematodes from other marine environments (Jensen, 1992). It is plausible that the same genus may use different feeding strategies when inhabiting a eutrophic estuary or a nutrient poor deep-sea floor, and consequently occupy varying trophic levels in the different ecosystems. Therefore, if the role of marine

Reçu le 22 avril 2008 ; accepté après révision le 31 juillet 2008.
Received 22 April 2008; accepted in revised form 31 July 2008.

nematode species in the food web is to be fully understood, it is necessary to understand the feeding ecology of each developmental stage under different environmental conditions (Yeates, 1987).

In shallow water environments, oncholaimids and particularly the genus *Pontonema* are attracted to decaying plants and animals (Lorenzen et al. 1987 and references therein). Actually, the predatory behaviour of this group was not apparent in field studies (Jennings & Colam, 1970; Jensen, 1987). However, experiments demonstrated that oncholaimids later stage juveniles and adults may be predaceous, while younger juveniles feed mainly on dissolved organic matter, including exudates of bacteria and algae (Heip et al., 1978; Moens & Vincx, 1997; Moens et al., 1999 & 2000). In fact, younger juveniles died on starvation when supplied with only nematodes (Heip et al., 1978; Moens et al., 1999).

Materials and Methods

We observed the gut contents of 12 *Pontonema* specimens, three males, one female and eight early stage juveniles, from an undescribed species from three Arctic deep-sea sites (1300, 2000 and 2500 m water depth; coordinates 78°-79°N, 4°-6°E). The samples were taken with a multiple-corer and fixed in formaldehyde 4%. Nematodes were extracted with Ludox (1.18), sorted under a stereo microscope, transferred to anhydrous glycerol and mounted on permanent slides. Measurements of body length (L) were made using an image analyser (AnalySIS 3.0).

Results

The genus *Pontonema* was represented by a single species and corresponded to less than one percent of the local nematode assemblage. Analyses of the guts showed that sediment and organic matter were usually present in all individuals. On average, 4.25 (range 0 - 15) nematode preys per individual were observed. Inside one of the males (L = 1780-2360 µm), we observed only one unidentified nematode prey. In the female (L = 2910 µm), one unidentified nematode, three *Thalassomonhystera*, a pair of spicules (most probably belonging to *T. cuspidospiculum* (Allgén, 1932) Jacobs, 1987) and parts of diatoms were encountered. The highest number of prey was observed in three early stage juveniles (no reproductive system apparent; L = 890-1230 µm). One juvenile had 14 *Thalassomonhystera* and one juvenile Aegialoalaimidae. Another juvenile presented 10 juvenile *Thalassomonhystera* and three pairs of spicules, and a third had ingested two *Thalassomonhystera*, two Aegialoalaimidae and six unidentified nematodes. The prey had on average 10 µm of maximum width. The genus *Thalassomonhystera* is one of the most abundant in this area, principally represented by *T. molloyensis* Tchesunov & Miljutina, 2005 (Gallucci et al., 2008). Unfortunately, precise identification was not possible, because prey was partially digested and early juvenile stages (J1 and J2) of *T. molloyensis* have not been described.

Discussion

The presence of nematode preys and other food items in the intestine of deep-sea *Pontonema* juveniles provides evidence of facultative predatory behaviour in the early developmental stages. Early stage juveniles of *Pontonema* may be facultative predators in deep-sea sediments but not in shallow water systems (Heip et al., 1978, Moens et al., 1999) probably as a consequence of the quantity and quality of potential food sources available in the environment. Although nematodes are high-quality food items (Danovaro et al., 1994), predation might be an expensive feeding strategy, because it involves foraging and energetic short attacks (Moens & Vincx, 1997). Thus, in shallow-water environments with a large array of potential food sources in addition to nematodes, facultative predators may choose other highly energetic food items. However, in the Arctic, deep sea sediments are nutrient poor and organic matter arrives in pulses from previous summer blooms and/or by lateral transport from adjacent continental slopes. Under these conditions, predation may be a good alternative strategy for adults and juveniles of oncholaimids. Anatomically, the juveniles of *Pontonema* already have stoma structures suitable for predation and are therefore capable of predation. Usually the inner content of the prey is sucked, but as observed in the present specimens, small prey can be completely ingested.

Our observations from three deep-sea sites showed that *Pontonema* ingested mainly members of the genus *Thalassomonhystera*, suggesting a selective predatory behaviour. Laboratory studies have suggested selective predation in marine nematodes (Moens et al., 2000; Gallucci et al., 2005). Since deep-sea monhysterids are among the smallest nematodes in deep-sea sediments, selective feeding might indeed be a function of the size of the prey (i.e. smaller prey might be easier to predate). However, it might also result from its numerical dominance among other species of nematodes.

An average predation rate of 4 and 2 nematodes per day has been estimated for the voracious *Enoploides longispiculosus* Vitiello, 1970 and for the oncholaimid *Adoncholaimus fuscus* Bastian, 1865, respectively (Moens et al., 2000). Nevertheless, the presence of 10, 13 and 15 specimens and/or spicules in the intestine of *Pontonema*

juveniles provides new insight into oncholamids' predation rates. It is known from *Pontonema vulgare* Bastian, 1865 that the time for complete digestion varies with the quantity of food ingested, but generally nothing recognizable remains in the intestinal lumen 12 hours after ingestion (Jennings & Colam, 1970). Previous laboratory experiments might have underestimated predation rates. This behaviour might also be related to the scarcity of food items in the deep sea; once a predator encounters a patch of prey, it may ingest as much as possible and, as observed for *P. vulgare,* it may store the food in the form of glycogen and fat (Jennings & Colam, 1970).

Although our study is limited to a small number of specimens, it indicates that feeding behaviour within a genus may vary among environments and consequently caution is needed when inferring feeding ecology for marine nematodes.

Acknowledgments

G.F. is sponsored by CNPq (200852/2005-1) and F.G. is supported by the Helmholtz Association. We are grateful to Jean Lee Wan for improving the English and two anonymous referees for commenting on the manuscript. This is publication awi-n17278 of the Alfred Wegener Institute for polar and marine research.

References

Danovaro R., Dell'Anno A., Martorano D., Parodi P., Marrale N.D. & Fabiano M. 1994. Seasonal variation in the biochemical composition of deep-sea nematodes: bioenergetics and methodological considerations. *Marine Ecology Progress Series*, **179**: 273-283.

Gallucci F., Steyaert M. & Moens T. 2005. Can field distributions of marine predacious nematodes be explained by sediments constrains on their foraging success? *Marine Ecology Progress Series,* **304**: 167-178.

Gallucci F., Fonseca G. & Soltwedel T. 2008. Effects of megafauna exclusion on nematodes assemblages at a deep-sea site. *Deep-sea Research I,* **55**: 332-349.

Heip C., Smol N. & Absilis V. 1978. Influence of temperature on the reproductive potential of *Oncholaimus oxyuris* (Nematoda: Oncholaimidae). *Marine Biology,* **45**: 255-260.

Jennings J.B. & Colam J.B. 1970. Gut structure, digestive physiology and food storage in *Pontonema vulgaris* (Nematoda: Enoplida). *Journal of Zoology,* **161**: 211-221.

Jensen P. 1987. Feeding ecology of free-living aquatic nematodes. *Marine Ecology Progress Series,* **35**: 187-196.

Jensen P. 1992. Predatory nematodes from the deep-sea: description of species from Norwegian Sea, diversity of feeding types and geographical distribution. *Cahiers de Biologie Marine,* **33**: 1-23.

Kennedy A.D. 1994. Predation within meiofaunal communities - description and results of a rapid-freezing method of investigation. *Marine Ecology Progress Series,* **114**: 71-79.

Lorenzen S., Prein M. & Valentin C. 1987. Mass aggregations of free-living marine nematode *Pontonema vulgare* (Oncholaimidae) in organically polluted fjords. *Marine Ecology Progress Series,* **37**: 27-34.

Moens T., Verbeeck L. & Vincx M. 1999. Feeding biology of a predatory and facultatively predatory nematode (*Enoploides longispiculosus* and *Adoncholaimus fuscus*). *Marine Biology,* **134**: 585-593.

Moens T., Herman P., Verbeeck L., Steyaert M. & Vincx M. 2000. Predation and prey selectivity in two predacious estuarine nematode species. *Marine Ecology Progress Series,* **205**: 185-193.

Moens T., Yeates G.W. & De Ley P. 2004. Use of carbon and energy sources by nematodes. *Nematology Monographs and Perspectives,* **2**: 529–545.

Moens T. & Vincx M. 1997. Observation of feeding ecology of estuarine nematodes. *Journal of the Marine Biological Association of the United Kingdom,* **77**: 211-227.

Wieser W. 1953. Die Beziehung zwischen Mundhöhlengstalt, Ernährungsweise und Vorkommen bei freilebenden marinen Nematoden. *Arkiv für Zoologie,* **4**: 439-484.

Yeates G.W. 1987. Nematode feeding and activity: the importance of developmental stages. *Biology and Fertility of Soils,* **3**: 143-146.