INFLUENCE OF THE TIDAL AND RAINFALL CYCLES ON THE POPULATION STRUCTURE AND DENSITY OF *Mesacanthion hirsutum* GERLACH (NEMATODA, THORACOSTOMOPSIDAE) ON A TROPICAL SANDY BEACH (TAMANDARÉ BAY, PERNAMBUCO, BRAZIL)

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ABSTRACT

The population structure (males, females and juveniles) and density of *Mesacanthion hirsutum* Gerlach were studied during the tides (low, flood, high and ebb) of two consecutive tidal cycles in four different months of the year (May, July, September and November). *Mesacanthion hirsutum* density variations showed association with the rainfall cycle, with lower densities during July and September and significantly higher values in May and November. The population structure was constituted mostly by juveniles indicating a continuous reproduction during all the studied period. There were no significant differences between light and dark periods of the day, however, the higher densities detected during the high and ebb tidal stages demonstrate that this species could be dispersing through the water column and/or migrating within the sediment.

RESUMO

A estrutura populacional (machos, fêmeas e juvenis) e densidade de *Mesacanthion hirsutum* Gerlach foram estudadas durante as marés (baixa, enchente, alta e vazante) de dois ciclos de maré consecutivos, em quatro meses diferentes do ano (Maio, Julho, Setembro e Novembro). As variações de densidade de *Mesacanthion hirsutum* mostraram associação com o ciclo de chuvas, com densidades mais baixas durante Julho e Setembro e significativamente maiores em Maio e Novembro. A estrutura populacional constituiu-se em sua maior parte por juvenis indicando uma reprodução continua durante todo o período de estudo. Não foram encontradas diferenças significativas entre os períodos claros e escuros do dia, contudo maiores densidades foram detectadas durante as marés altas e vazantes demonstrando que a espécie pode estar se dispersando através da coluna d'água e/ou migrando dentro do sedimento.

Descriptors: Marine nematodes, Meiobenthos, Intertidal environment, Seasonal variations, Brazil.
Descritores: Nematode marinhos, Meiobentos, Ambiente entremarés, Variações sazonais, Brasil.

INTRODUCTION

The effect of tides on nematodes has been studied and linked to a variety of both biotic and abiotic environmental factors since the middle of the last century (e.g., RENAUD-DEBYSER; SALVAT, 1963; BOADEN; PLATT, 1971) and also more recently (NICHOLAS, 2001; STEYAERT et al., 2001). These studies were mainly concentrated in temperate regions and most of them considered the total nematode community. One of the most direct reactions to tides in intertidal regions is the dispersal of organisms which might be using different substrates, such as leaves, seaweeds, adhesion to transported sediment (GERLACH, 1977), or the water column (BELL; SHERMAN, 1980; HAGERMAN; RIEGER, 1981; SIBERT, 1981) or, otherwise, within the sediment itself (PALMER; GUST, 1985).

On the Brazilian coast the investigations into marine nematodes have consisted mainly of taxonomical lists or descriptions (i.e. GERLACH, 1954, 1956a, 1956b, 1957a, 1957b; ESTEVES, 2004; VENEKEY et al., 2005; CASTRO et al., 2006; FONSECA-GENEVOIS et al. 2009) which are certainly necessary and constitute essential first steps to the knowledge of this group on such an extensive coastline. Ecological studies on nematodes at low taxonomical level have just been begun with works such as those of NETTO and GALLUCCI (2003), FONSECA-GENEVOIS et al. (2004), DA ROCHA et al. (2006) and FONSECA-GENEVOIS et al. (2006). Also recently, were published the first studies concerning the population structure of *Oncholaimus*

cobbi Kreis, *Comesoma arenae* Gerlach and *Daptonema oxycerca* DE MAN by ESTEVES et al. (2003), ESTEVES et al. (2004) and MARIA et al. (2008), respectively.

Mesacanthion hirsutum was described as a new species by Gerlach in (1953) for the Mediterranean Sea, later being found in the Red Sea (GERLACH, 1964; GERLACH, 1967) and the Exe estuary (WARWICK, 1971). Even though this species was discovered more than 50 years ago, nothing is yet known about its population structure. The objectives of the present study were to register the first record of this species on the Brazilian coast and to describe its population structure (males, females and juveniles) and density variations, considering also the influence of the tidal cycle during four different months of the year.

Material and Methods

The sampling station (08º45'58''S, 35º05'96''W) is located on Tamandaré Bay, about 110 km south of Recife, Pernambuco, Brazil (Fig. 1). This sandy beach is characterized by quartz sediments varying from fine to medium grain size and the adjacent subtidal area presents coral reef formations lying parallel to the coast (MAIDA; FERREIRA, 1997). According to MCLACHLAN'S (1980) criteria the study area might be classified as a sheltered beach. The tidal amplitude in the area is of about 2.5 m and the cycle is semidiurnal. The climate is hot and humid, of type Aws, according to the Köppen system. The region, in accordance with the last 50-year average, presents two seasons: a dry season extending from September to February and a rainy season from March to August, with half of the annual rainfall occurring between May and July (SEMA - Science, Technology and Environment Department of Pernambuco State). The daylight period in the area is of around 12-13 hours/day.

The samples were always collected in the upper intertidal zone, at hourly intervals, for 24h, in four different months of 1991: May, July, September and November. At each sampling six meiofauna replicate cores were collected using a PVC tube (2.5 cm of inner diameter and 10 cm deep) and fixed immediately in 4% formaldehyde solution. In the laboratory, the samples were treated using the routine methods for meiofauna (humid sieving and manual centrifugation) suggested by ELMGREN (1973) and the nematodes sorted using Dollfus plates and a stereoscopic microscope. The individuals of *M. hirsutum* were removed manually using a needle, and permanent slides were made as described by COBB (1917) and DE GRISSE (1969). The animals were identified as males, females and juveniles. The mean density for each tide (low, flood, high and ebb) was calculated using the density values obtained during each tide peak and at preceding and subsequent times.

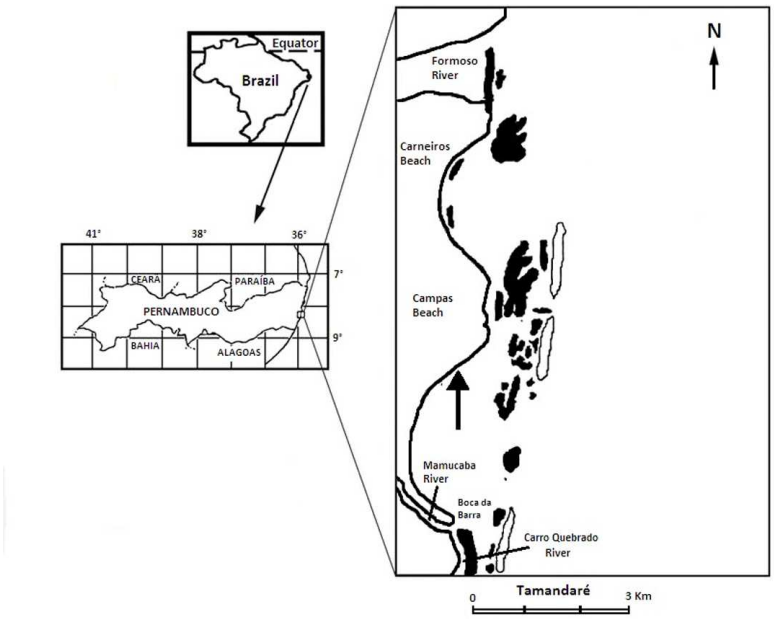

Fig. 1. Map of the sampling site.

Differences in the population densities between months, tides and light/dark periods of the day were tested by multifactorial analysis of variance (ANOVA) using STATISTICA 5.5 on the data transformed to ln(x+1). Before the ANOVA the homogeneity of variances was verified using Sen & Puri's non-parametric test. Post-hoc comparisons were undertaken using the Tukey HSD-test.

The male/female ratio was calculated for each month and tide in order to test the deviations from an expected chi-square distribution.

RESULTS

The meiofauna in Tamandaré was composed by 10 groups (Turbellaria, Gastrotricha, Tardigrada, Nematoda, Polychaeta, Oligochaeta, Bivalvia, Copepoda Harpacticoida, Ostracoda and Acari) from which Nematoda represented 45% of the total density considering all the samples together (Fonseca-Genevois et al., unpublished data). The nematode community, present in all the months sampled, consisted of 48 genera, 5.2% of the individuals of which were of *Mesacanthion*. In Tamandaré this genus was monospecific, the single species being identified as *Mesacanthion hirsutum* Gerlach.

The density of *M. hirsutum* did not vary significantly as between the light and dark periods of the day ($p = 0.78$) but did vary significantly among the four months sampled ($p < 0.01$) with significantly higher densities in November than in May, July or September (Fig. 2). Statistical differences were also found when densities were compared as between tides ($p < 0.01$). Although differences can be found in relation to the densities, absences were observed throughout the study period regardless of the month or tide.

The population of *M. hirsutum* was composed mainly of juvenile animals that were dominant during July, September and November. The females, exclusively non-ovigerous, were dominant in May when males were not observed (Table 1). The male/female ratios (Table 01) varied significantly between months ($\chi^2 = 81.491$; $p < 0.05$) but did not between tides ($\chi^2 = 0.791$; $p > 0.05$).

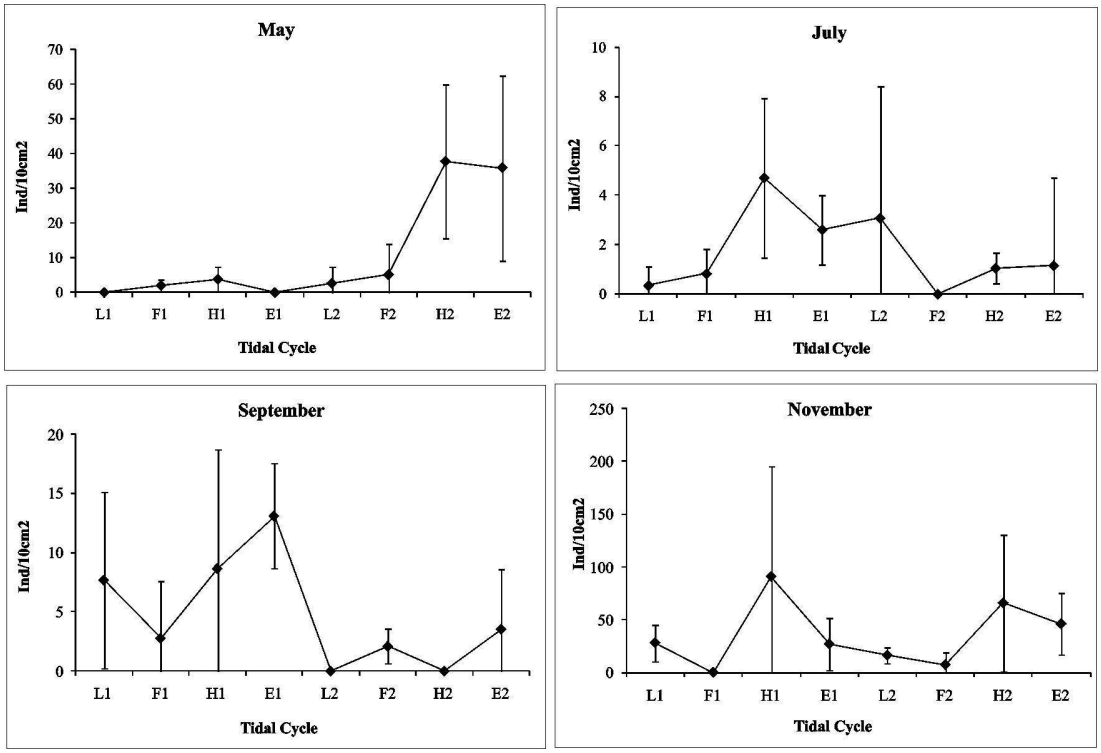

Fig. 2. Total density (ind/10cm^2) of *Mesacanthion hirsutum* during two consecutive tidal cycles (1 and 2) in four different months (L = low tide; F = flood tide; H = high tide; E = Ebb tide).

Table 1. Mean densities (ind/10cm^2) of males, females and juveniles of *Mesacanthion hirsutum* during two consecutive tidal cycles (1 and 2) during four different months (L = low tide; F = flood tide; H = high tide; E = ebb tide).

	L1	F1	H1	E1	L2	F2	H2	E2
May								
Males	0	0	0	0	2.68	5.12	21.75	30.15
Females	0	2.00	2.97	0	0	0	15.96	5.7
Juveniles	0	0	0.80	0	2.68	5.12	37.71	35.85
July								
Males	0	0.32	0.96	0.61	1.23	0	0.18	0.35
Females	0	0.51	3.27	1.99	0.61	0	0.87	0.81
Juveniles	0.35	0.83	4.70	2.60	3.07	0	1.05	1.16
September								
Males	0	0.20	0	0	0	0	0	2.35
Females	0	2.58	8.65	10.16	0	2.09	0	1.17
Juveniles	7.66	2.78	8.65	12.09	0	2.09	0	3.52
November								
Males	1.81	0	19.77	4.49	1.85	0.43	1.85	6.4
Females	2.19	0	32.86	10.96	4.73	1.73	10.01	6.4
Juveniles	24.13	0	38.29	11.67	9.76	5.13	54.16	33.18

DISCUSSION

The species *Mesacanthion hirsutum* seems to have a preference for the dry season as the average densities, already low in May (10.89 ind/10cm^2), were even lower in July (1.72ind/10cm^2) and increased in September (4.72ins/10cm^2) and November (35.23ind/10cm^2).

Data on the temporal variation of marine nematodes are scarce in tropical regions but the few existing studies suggest a variation of this group mainly associated with the rainfall cycle, with lower densities occurring during the rainy season (INGOLE; PARULEKAR, 1998; PATTNAIK; RAO, 1990). The data concerning Nematoda in the same study area confirmed this pattern (SOUZA-SANTOS et al, 2003). Although the Nematoda group seems to be associated with the rainfall cycle, ESTEVES et al. (2003), ESTEVES et al. (2004) and MARIA et al. (2008) studying *Oncholaimus cobbi*, *Comesoma arenae* and *Daptonema oxycerca*, respectively, on a tropical tidal flat (Coroa Grande, Rio de Janeiro - Brazil), found that each species behaved differently. *Oncholaimus cobbi* was more abundant during the warmer and rainy season while *C. arenae* and *D. oxycerca* preferred the colder and dry months. Thus nematode species can have different reactions to the seasonal variations even in tropical areas where climatic changes are not well defined, indicating the importance of studies at low taxonomic level to detect such patterns.

Concerning the tidal cycle, a preference of *M. hirsutum* for the high and ebb tides was observed during this study. This behavior was more obvious in November when the densities were as much as three times higher during these tides than during the flow tides. NICHOLAS and HODDA (1999) found on an Australian temperate sandy beach that when the sea was calm the nematode fauna remained stable for at least 24h (two tidal cycles) during all tide levels and changed only slowly with the passage of time. This fact is certainly not the case with *M. hirsutum*, whose densities can even quadruplicate from one tide to the next. These great density variations can probably be linked to the dispersion and/or migration of the animals within the sediment or through the water column. Nematode migration to deeper sediment layers during high tides has already been reported by many authors (e.g., MCINTYRE; MURISON, 1973; PLATT, 1977); however, STEYAERT et al. (2001) found in a temperate estuary that some species have the opposite behavior, increasing their densities in the upper layers of the sediment during the submersion periods (high tides).

The population composition of *M. hirsutum* consisting mainly of juveniles (dominant during July, September and November) as well as their continuous presence suggests that this species reproduces continuously. HEIP et al. (1982) have stated that most marine nematode species have many more than one or two generations in the course of a year and in many cases the reproduction is continuous. The fact that all females were non-ovigerous suggests that the ovigerous stage of females is very short or that the preference at this life stage is for deeper sediment layers (below 10cm) which were not sampled in this study. Certainly the complete life cycle could be more easily studied in the laboratory but the predator/omnivorous feeding habits as well as the intertidal habitat of this nematode species make it

difficult to maintain it in culture (MOENS; VINCX, 1998).

The results obtained by the use of the sampling design of the present study enable us to conclude that *M.hirsutum* might have continuous reproduction and higher densities in the dry season, the period of the year during which the tidal effect is more pronounced. The differences in the population densities and/or structure of nematode species influenced by either seasonal or tidal variations evidence the pressing need for studies at lower taxonomical level in tropical regions.

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