DIVERSITY OF NEMATODA IN A CARIBBEAN ATOLL: BANCO CHINCHORRO, MEXICO

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ABSTRACT

Free-living marine nematode assemblages were studied at four sites in Banco Chinchorro, Caribbean Sea, Mexico: Cayo Norte, Cayo Lobos, Isla Che, and Cayo Centro. Three orders, 21 families, 65 genera, and 98 species represented the nematode fauna. The order Chromadorida was the best represented with nine families, and 56 species, followed by Enoplida (nine families, 22 species), and Monhysterida (three families, 16 species). Desmodoridae had the highest number of species (31). The highest nematode density (1.83×10^5 nematodes m^{-3}) was found at Cayo Centro, followed by Cayo Norte (1.77×10^5 nematodes m^{-3}). Lowest nematode density was found at Isla Che (3.18×10^4 nematodes m^{-3}). Cayo Norte had also the highest number of species (47), with a diversity of $H' = 5.03$ bits ind^{-1} and an evenness value of 0.91; Cayo Lobos and Cayo Centro had a similar number of species (41 and 40, respectively) and a similar diversity ($H' = 4.76$ bits ind^{-1} and $H' = 4.67$ bits ind^{-1}). Isla Che presented the lowest number of species (14) and diversity ($H' = 3.55$ bits ind^{-1}). At Cayo Lobos, an inner station, nematodes had small and annulated bodies with many somatic setae, typical of sandy environments with high energy. At the family level, the nematode fauna at Banco Chinchorro is similar to other assemblages found in the Caribbean. All species registered in this study add new evidence of their geographic range in the western Caribbean. The nematode fauna surveyed represent possibly up to 69% of new species. Nematoda diversity values found at Banco Chinchorro were higher than those known in similar environments.

The marine nematodes of the northwestern tropical Atlantic are poorly known. In the Gulf of Mexico, Castillo and Lambshead (1992) revised the genus *Elzalia* and described three new species. Castillo and Decraemer (1993) described *Cheironchus paravorax* and re-described *Cheironchus vorax* from the Sonda de Campeche. In the same area, 117 nematode species were identified relating their distribution with the concentration of total hydrocarbons in sediments (de Jesús-Navarrete, 1993a). Among the few previous studies in the Caribbean region, some taxonomic aspects of the nematofauna from Cuba were investigated by Botosoneau (1970) and Andrassy (1973). Wagenaar Hummerlinck (1977) studied the meiofauna from Martinique, and Renaud-Mornant and Gourbault (1981) determined the composition and abundance of the nematode fauna of Guadeloupe Island. Guadeloupe's meiofauna distribution and environmental relationships were described later on by Boucher and Gourbault (1990). New species belonging to the Epsilonematidae and Desmodoridae were described by Decraemer and Gourbault (1986, 1987), Gourbault and Decraemer, (1986, 1987, 1988) and Gourbault and Vincx (1990). The nematode assemblages of deep environments of Venezuela and Puerto Rico were studied by Tietjen (1984, 1989).

In the Mexican Caribbean, the composition and distribution of nematodes in the Laguna de Buenavista were studied by de Jesús-Navarrete (1993b). The nematode fauna associated with the urban zone of Chetumal Bay was described by de Jesús-Navarrete and Herrera-Gómez (1999). However, information on the nematode distribution, composition, and abundance from the reef zones of Quintana Roo were previously unavailable.

The main goal of this paper is to provide new information about the Nematoda composition in reef areas of the Mexican Caribbean.

Materials and Methods

During June 1996, sediments were collected at four sites of the biosphere reserve Banco Chinchorro. Two samples outside the reef lagoon: Cayo Norte (18°43′44′′N, 87°21′38′′W), and Isla Che (18°29′59′′N, 87°26′16′′W) and two samples inside the reef lagoon: Cayo Centro (18°34′25′′N, 87°19′00′′W) and Cayo Lobos (18°23′48′′N, 87°22′15′′W; Fig. 1). Samples were collected using SCUBA and skin diving. The depth in Cayo Norte and Isla Che was 20 m, and in Cayo Centro and Cayo Lobos it was 3.5 m. Outside stations had sand bottoms; within the reef lagoon the sediment was medium sand with seagrass meadows and reef patches.

Duplicate sediment samples were collected using a PVC corer with a 5 cm internal diameter; the corer was introduced in the sediment bottom to a depth of 10 cm. Meiofauna were fixed with hot (60°C) formaldehyde 10% solution. Meiofauna were extracted for elutriation, nematodes were separated manually from the rest of the meiofauna, mounted on glass slides and species were identified with a Zeiss microscope (100×). Keys of Tarjan (1980), Platt and Warwick (1983) were used to make genera determinations. Bibliographic references with species descriptions before 1973 can be found in Gerlach and Riemann (1973). Specimens were deposited at the Collection of Aquatic Nematodes of El Colegio de la Frontera Sur-Unidad Chetumal (ECO-CH-N).

Nematode density was calculated as a function of a cylindrical section (0.007 m^2 area, 0.10 m height) and standardized to nematodes m^{-3}. Abundance was analyzed using a simple dominance index. Shannon's diversity index (H′), and the evenness (E) were calculated for each station (Pielou, 1975). A cluster analysis (Bray-Curtis dissimilitude index) was performed with the transformed Ln (x + 1) abundance data, using the ANACOM computer program (de la Cruz, 1994).

Results

The local nematode fauna were represented by three orders, 21 families, 65 genera, and 98 species. The order Chromadorida was the best represented, with nine families and 56 species, followed by Enoplida (nine families, 22 species) and Monhysterida (three families, 16 species). Desmodoridae had the greatest number of species (31; see Table 1).

Out of all the organisms collected, up to 30.6% correspond to species described from other regions of the world. The remaining ones are possibly new species. All species are new records for Mexico and the first records for Banco Chinchorro.

Paracomesoma inequale was the most common species (7.16%) followed by *Meyersia major* (5.43%), *Spirinia hamata* (3.70%), *Odontophora* sp. (3.45%), and *Rinchonema hirsutum* (3.21%). Together, these five species represented up to 23% of total nematode numerical abundance. *Enoplus communis* represented 2.71%, whereas *Euchromadora vulgaris*, S*tylotheristhus* sp. and *Tarvaia* sp. represented 2.46%, respectively.

Cayo Norte showed a greater number of species (47), a diversity of H′= 5.03 bits ind^{-1} and evenness of E = 0.91; Cayo Lobos and Cayo Centro had similar species number (41 and 40 respectively) and a similar diversity. The lowest species number (14), diversity, and evenness were found at Isla Che (Fig. 2).

The greatest density (1.83×10^5 nematodes m^{-3}) was found at Cayo Centro; Cayo Norte had 1.77×10^5 nematodes m^{-3}. The lowest density was registered at Isla Che (3.18×10^4 nematodes m^{-3}) whereas Cayo Lobos had a density of 1.24×10^5 nematodes m^{-3}.

Cluster analysis revealed the presence of three groups; a group with similar characteristics represented by Cayo Lobos and Cayo Centro, corresponding to the inner lagoon

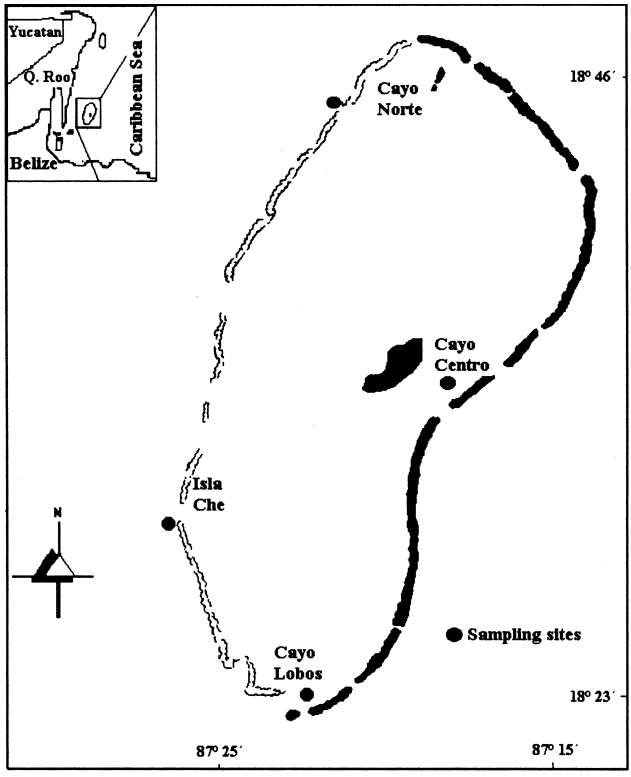

Figure 1. Location of the study area.

stations; and two separate sites, Cayo Norte and Isla Che, representing the outer stations (Fig. 3).

In general, nematodes from the reef lagoon were small, with annulated cuticles and abundant somatic setae, mainly in Cayo Lobos, which is a high-energy place. In Cayo Norte nematodes were larger than at the inner stations.

Discussion

The study of the nematode fauna in America and the Caribbean has been related to shallow, calcareous environments similar to Banco Chinchorro. The presence of *Rynchonema hirsutum*, *Viscosia papillata*, *Halichoanolaimus duodecimpapillatus, Euchromadora vulgaris*, and *Spilophorella paradoxa* has been recorded on the east coast of Florida (Hopper, 1961, 1963; Wieser and Hopper, 1967) and all were found in Chinchorro. Keppner (1988, 1992) described *Bathylaimus longicorpus* and *Odontophora carrolli* from estuarine sediments of the northwest coast of Florida. The occurrence of this species at Banco Chinchorro constituted a range extension in their geographical distribution and suggests a wide tolerance capacity to different salinities for these two species.

In Guadeloupe, Boucher and Gourbault (1990) noted the occurrence of *Nannolaimus fusus*; Gourbault and Vincx (1990) described *Croconema otti*. In Banco Chinchorro these species were found at a depth of 6 m; whereas, in Guadeloupe they were found dwelling

Table 1. Free-living nematodes from Banco Chinchorro, total number of individuals at 0.00078 m^{-3}.

Species	Cayo Norte	Cayo Lobos	Isla Che	Cayo Centro
Enoplida				
Enchelidiidae				
Belbolla sp.		2	1	
Calyptronema sp.	1			
Eurystomina sp.			1	
Polygastrophora sp.	1			
Enoplidae				
Enoplus communis (Bastian, 1865)	2	7	2	
Ironidae				
Thalassironus sp.	1		2	
Leptosomatidae				
Cylicolaimus sp.	1			
Thoracostoma sp.	3			
Oncholaimidae				
Metoncholaimus sp		8		
Meyersia major (Hopper, 1967)	6	9	1	6
Oncholaimus sp.	1			
Viscosia papillata (Chitwood, 1961)		1	1	
Viscosia sp			2	
Oxystominidae			2	
O*xystomina* sp.				1
Thoracostomopsidae				
Enoplolaimus sp.	2			
Epacanthion sp.	1			
Mesacanthion sp. 1	1			
Mesacanthion sp. 2	1	1	1	
Trypiloidiidae				
Bathylaimus longicorpus (Keppner, 1988)	4			
Tripyloides marinus (Butschli, 1874)	5			
Trefusiidae				
Cytolaimium sp.	1			
Rhabdocoma sp.				1
Chromadorida				
Comesomatidae				
Dorylaimopsis sp.			3	
Paracomesoma inaequale (Jensen and Gerlach, 1977)	5			1
Paracomesoma sp.	2			24
Sabatieria sp. 1				2
Sabatieria sp. 2				2
Setosabatieria sp.	2			
Vasostoma sp.	6	1		
Cyatholaimidae				
Longicyatholaimus sp.	1	1		
Marylynna sp.	1			1
Paracyatholaimus sp.				3
Pomponema		1	1	5

Table 1. Continued.

Species	Cayo Norte	Cayo Lobos	Isla Che	Cayo Centro
Praeacanthonchus sp.		1		
Chromadoridae				
Dichromadora geophila (de Man, 1876)		3		2
Euchromadora vulgaris (Bastian, 1865)		10		
Parapinnanema sp.	1			1
Ptycholaimellus jacobi (Jensen and Nehering, 1992)	4			7
Spilophorella paradoxa (de Man, 1888)	2			
Desmodoridae				
Acanthopharynx sp.	2	1		1
Chromaspirina pellucida (Cobb, 1920)		1		4
Desmodora brevicollis (Cobb, 1920)		1		1
Desmodora (*Croconema*) sp. 1		2		
Desmodora (*Croconema*) *cincta* (Gerlach, 1963)	6			1
Desmodora sanguinea (Southern, 1914)		1		
Desmodora sp. 1	2			
Eubostrichus parasitiferus (Chitwood, 1936)		1		5
Eubostrichus porosum (Hopper and Cefalu, 1973)		5		2
Leptonemella granulosa (Boucher, 1975)	2			1
Leptonemalla sp.		2		2
Metachromadora (Chromadoropsis) sp. 1	3	1		
Metachromadora (Chromadoropsis) sp. 2	4			
Paradesmodora sp. 1		2		
Paradesmodora sp. 2		2		
Pseudochromadora sp.		1		
Robbea caelestis (Gerlach, 1956)				1
Spirinia hamata (Wieser and Hopper, 1967)	15			
Spirinia sp. 1	1			6
Spirinia sp. 2	1			7
Spirinia sp. 3		6		
Spirinia sp. 4				4
Onyx sp. 1				2
Desmoscolecidae				
Desmoscolex sp.	1			
Tricoma hopperi (Timm, 1970)		1		
Ethmolaimidae				
Filitonchus sp. 1		2		
Gomphionchus sp.	1			6
Nannolaimus fusus (Gerlach, 1956)	5			1
Neotonchoides cuanensis (Platt, 1982)		1		5
Leptolaimidae				
Leptolaimus sp.	1	1		

Table 1. Continued.

Species	Cayo Norte	Cayo Lobos	Isla Che	Cayo Centro
Selachinematidae				
Cheironchus vorax (Cobb, 1917)	2			
Halichoanolaimus duodecimpapillatus (Timm, 1952)	2		1	
Latronema sp. 1	1			
Richtersia coomansi (Soetaert et Vincx, 1987)				1
Synonchiella sp.				1
Tarvaiidae				
Tarvaia sp.	10			
Microlaimidae				
Microlaimus sp. 1		1		
Microlaimus sp. 2		1		
Monhysterida				
Axonolaimidae				
Odontophora carrolli (Keppner, 1988)	4			
Odontophora sp. 1	12	1		1
Linhomoeidae				
Desmolaimus sp.				3
Didelta maculatum (Cobb, 1920)		1	5	
Didelta sp.		1		
Eleutherolaimus sp.	1	1		
Monhystera sp.				11
Paramonohystera sp.	2			
Paralinhomoeus sp.		1		4
Terschellingia communis (de Man, 1888)		1		1
Terschellingia longicaudata (de Man, 1907)		1		5
Xyalidae				
Rhynchonema hirsutum (Hoper, 1961)	5	8		
Daptonema sp.		3		
Steineria sp.				1
Stylotheristus sp.				10
Theristus sp.		1		1
Unidentified 1				1
Unidentified 2			1	
Unidentified 3			3	
Unidentified 4				1
Species number	47	41	14	40

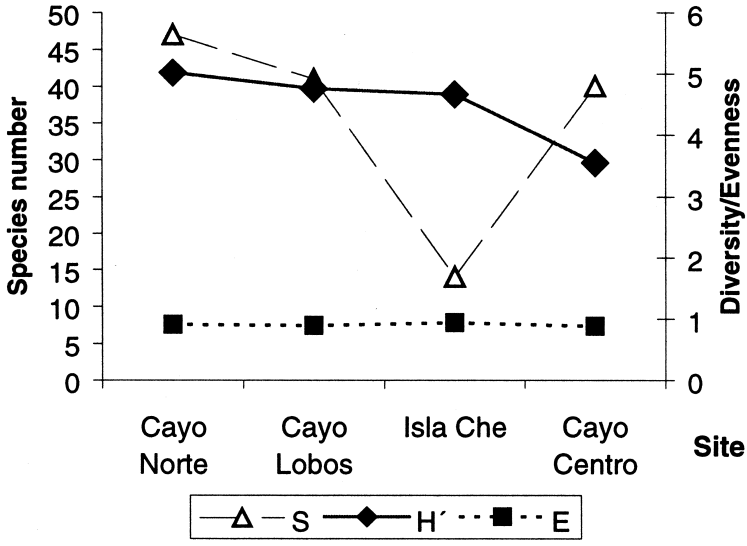

Figure 2. Species number, diversity and evenness of nematode assemblages at Banco Chinchorro, Quintana Roo, Mexico.

in the littoral area. The finding of both species allows a range extension in their distribution toward the western Caribbean.

Other species have been found in different areas of America and Europe. *Enoplus communis* and *Eubostrichus parasitiferus* were reported in North Carolina (Chitwood, 1934); whereas, *Tricoma hopperi* was found previously in Bermuda (Timm, 1970). *Richtersia coomansi* was collected in the Mediterranean (Soetaert and Vincx, 1987); and *Croconema cincta* was described in Jamaica (Cobb, 1920) and in Brazil (Gerlach, 1963).

Some species considered to be cosmopolitan forms were found in this survey: *Dichromadora geophila, Enoplus communis, Spilophorella paradoxa, Terschellingia longicaudata,* and *Tripyloides marinus*. These species are common in almost all seas of the world, mainly in shallow coastal areas (Jensen, 1984).

At the family level, the nematode fauna at Banco Chinchorro are similar to other assemblages found in the Caribbean. At Guadeloupe Island, Boucher and Gourbault (1990) observed that nematodes in calcareous sediments were dominated by Desmodoridae (33%) and Xyalidae (21.5 %); other families present were Chromadoridae, Cyatholaimidae, Ethmolaimidae, Linhomoeidae, Comesomatidae, Selachinematidae, and Microlaimidae. This same general pattern was observed at Banco Chinchorro where Desmodoridae and Comesomatidae were dominant. A similar composition was reported also by Tietjen (1991) in tropical calcareous sediments from Australia, where Chromadoridae represented 15.6%, Desmodoridae 12.7%, Comesomatidae 11.6%, Xyalidae 11.5%, Linhomoeidae 7.5%, Cyatholaimidae 6.5%, and Oncholaimidae 6.6%.

Relatively high density values of nematodes have been reported in estuaries, when compared with marine environments, maximum values have been reported in muddy systems and salt marshes. These figures range from 1.5×10^6 (Jensen, 1984) to 20×10^6 m^{-2} (Platt and Warwick 1983). In marine environments Boucher and Gourbault (1990) found a mean density of $1.9 \times 10^6 \pm 6.5 \times 10^5$ m^{-2} at Guadeloupe Island. At Davies Reef, Australia, Alongi (1986) reported a nematode density varying from 3.5×10^5 to $2.26 \times$

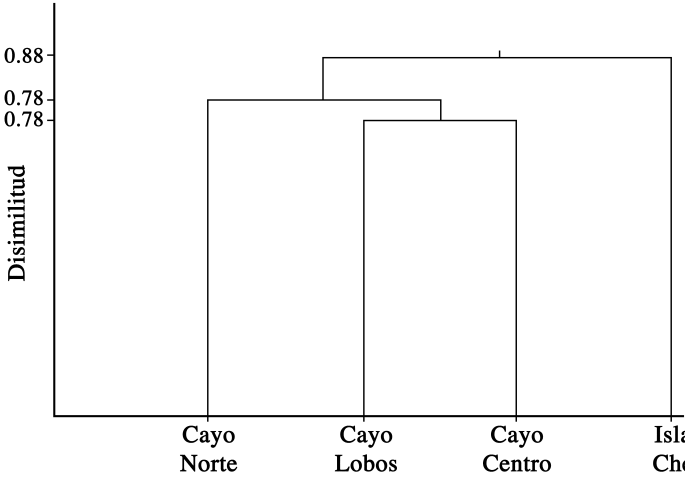

Figure 3. Dendrogram resulting from Bray-Curtis index for nematodes at Banco Chinchorro.

10^6 nematodes m^{-2}. Even when our density values were not comparable directly (nematodes m^{-3}), they show the same order of magnitude.

Nematode diversity pattern in temperate and tropical sediments show a range between $H' = 1.2$ and $H' = 5.5$ bits ind^{-1} (Boucher, 1990). Diversity values found at Banco Chinchorro were superior when compared with similar environments. Tietjen (1991) reported diversity values from $H' = 3.35$ to $H' = 4.08$ bits ind^{-1} in coarse calcareous sand, whereas Alongi (1986) found a diversity of $H' = 1.65$ bits ind^{-1} in fine sand and $H' = 1.62$ bits ind^{-1} in coarse sand. In the Indo-Pacific, Gourbault et al. (1995) reported a diversity of $H' = 3.06$ bits ind^{-1} in coarse sand. The differences with Banco Chinchorro could be related to a higher homogeneity in the nematode distribution, which is evident by the high evenness index values or by a higher habitat complexity that is represented by very poor sorted sediments (de Jesús-Navarrete, this volume).

Cluster analysis evidenced differences between the composition of nematodes in the reef lagoon and outer stations. However, it must be considered that we have sampled only four stations in an extensive area (550 km^2), and more data are needed in order to confirm this difference.

Lambshead (1993) mentions that nearly 1×10^8 species of nematodes are known. However, only 4500 of the known marine nematodes have been described in temperate zones (Platt and Warwick, 1983). Relatively few species have been described from tropical areas, which are expected to be highly speciose; there is a clear asymmetry in the knowledge of nematodes among the different marine latitudes of the world. Knowledge of tropical faunas must be stressed in order to have a better idea of the diversity distribution of this group in the marine realm. The virtual absence of information on the distribution of the species also represents a major problem which enormously affects the interpretations on the nematode biogeography (Boucher and Lambshead, 1994). With only a few species known, and the lack of information in tropical areas such as the western Caribbean, it is impossible to understand the global nematode distribution and biodiversity.

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