NEMATODES FROM SANDY BEACHES OF GUANABARA BAY, RIO DE JANEIRO, BRAZIL

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RESUMO

Este trabalho caracterizou a composição da nematofauna de três praias arenosas localizadas na Baía de Guanabara, Rio de Janeiro, Brasil (22°24' e 22°57'S; 42°33' e 43°19'W). Essas três praias arenosas protegidas (Bica, Bananal and Coqueiros) foram estudadas de Janeiro a Junho de 2001, durante a maré baixa. As amostras foram coletadas usando um cilindro de PVC com $10cm^2$. Os nematódeos foram extraídos utilizando-se a técnica de flotação com açúcar. O sedimento destas praias foi composto, principalmente, de areia, variando de média a muita grossa. No total 6312 indivíduos foram identificados em nível genérico ou, quando possível, em nível de espécie. No total, das três praias, foram encontrados 62 gêneros pertencentes a 25 famílias e distribuídos ao longo de 8 ordens. Chromadoridae foi a família com maior número de gêneros. Todas as famílias encontradas já haviam sido registradas para outras praias, previamente, estudadas. Dentre os gêneros encontrados, quatro deles (*Deontolaimus*, *Dracograllus*, *Phanodermella* and *Subsphaerolaimus*) foram, pela primeira vez, registrados na costa Brasileira. Os números de gêneros presentes nas praias da Baía de Guanabara (31 na Bica, 39 no Bananal e 46 em Coqueiros) são similares a de uma outra praia arenosa brasileira, enquanto que, esses valores mostraram grande variação em relação a outras praias tropicais e não-tropicais no mundo. O primeiro registro de quatro gêneros para a costa brasileira sugere a possibilidade de novas espécies nesta baía, o que reforça a importância do desenvolvimento da taxonomia de nematódeos no Brasil.
Palavras-chave: composição dos nematódeos, praia do Bananal, praia da Bica, praia de Coqueiros, Chromadoridae, *Deontolaimus, Dracograllus, Phanodermella* e *Subsphaerolaimus.*

ABSTRACT

This work assessed the nematode composition in three sandy beaches located at Guanabara Bay, Rio de Janeiro, Brazil (22°24' and 22°57'S; 42°33' and 43°19'W). These microtidal, sheltered sandy beaches (Bica, Bananal and Coqueiros) were surveyed on January and June 2001, during the low tide. Samples were taken using a PVC core of $10cm^2$. Nematodes were extracted using the sugar-flotation methodology. The sediment of these beaches was mainly composed of sand and showed a variation between medium to very coarse sediments. In total 6312 specimens were identified up to the genus level or when possible to species level. At the three beaches, 62 genera were found, belonging to 25 families and distributed along of 8 orders. Chromadoridae was the most abundant family in terms of genera. All the families found have also been recorded from previously studied beaches. Amongst the genera found, four of them (*Deontolaimus*, *Dracograllus*, *Phanodermella* and *Subsphaerolaimus*) were for the first time recorded for Brazilian's coastline. The number of genera occurring on the Guanabara beaches (31 for Bica, 39 for Bananal and 46 for Coqueiros) is more or less similar to another Brazilian sandy beach whereas these values showed higher variation concerning worldwide tropical and non-tropical beaches. The first occurrence of four genera for the Brazilian coastline suggest the possibility to discover new species in this bay, therefore to the need for further development of nematode taxonomy in Brazil.
Keywords: nematode composition, Bananal beach, Bica beach, Coqueiros beach, Chromadoridae, *Deontolaimus*, *Dracograllus*, *Phanodermella* and *Subsphaerolaimus*

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INTRODUCTION

In Brazil, taxonomic studies on marine nematodes began in the mid-20th century when the German nematologist Dr. Sebastian Gerlach was invited by Universidade de São Paulo (Esteves *et al*, 2006). His visit to Brazil resulted in the description of several new and known species of free-living marine nematodes (Gerlach, 1954, 1956a, 1956b, 1957a, 1957b). After it, nematode taxonomic research ceased until the end of the same century when a new group of investigators began to work, principally relating the occurrence of nematodes to ecological aspects (Netto & Gallucci, 2003; Esteves *et al*., 2003; 2004; 2006; Genevois *et al*., 2004; Netto *et al*., 1999; 2005; Rocha *et al*., 2005; Pinto *et al*., 2006). Recently, taxonomic studies of free-living marine nematodes dealt with descriptions of new species from littoral and deep sea areas (Venekey *et al*., 2005; Castro *et al*., 2006; Fonseca *et al*., 2006; Botelho *et al*., 2007). The present work will further contribute to increase our knowledge of nematodes from Brazilian's shoreline. Hence, we aim to provide the first base line survey of nematodes in three sandy beaches located at the Guanabara Bay.

MATERIAL & METHODS

Guanabara Bay is a Brazilian's ecosystem located at the shoreline of Rio de Janeiro between the parallel 22°24' and 22°57'S and meridian 42°33' and 43°19'W having 384 km^2 of surface area (Figure 1). This bay has undergone great anthropogenic impact since Brazil's colonization. Human interference led to alterations of landscapes and diverse biological, physical and chemical features (Amador, 1997).

At that bay three microtidal, sheltered sandy beaches were surveyed in January and June 2001 during the low tide: Bica and Bananal beaches are located at the largest island (Ilha do Governador) in the middle of the bay and Coqueiros beach is located at a small island in the interior of the bay (Figure 1).

At each beach, one transect perpendicular to the water line was marked and two stations were sampled in the intertidal zone. At each station triplicate meiofauna samples were taken using a 30cm long PVC core with an inner diameter of 4.8cm (sampling a surface area of 10cm^2) and divided into three layers of 10cm (denominated a, b and c) and immediately fixed with 4% formaldehyde. One additional sample was taken to analyse the granulometric features through the sieving methodology (Buchanan, 1984).

In the laboratory, nematode specimens were extracted using the sugar-flotation method (Esteves & Silva, 1998). The upper limit was defined as a mesh sieve of 500µm and the lower limit as a mesh size of 62µm. The nematodes retained on the 62µm sieve were counted and, at least, 100 nematodes were picked out randomly using a stereomicroscope, transferred from a solution of 5 parts of glycerin, 5 parts of ethanol and 90 parts of distilled water (Platt & Warwick, 1983). The nematodes were mounted on glass slides and identified up to genus level using the pictorial keys of Platt & Warwick (1983; 1988), Warwick *et al* (1998) or, if possible, up to species level through the Nemys database (Steyaert et al., 2005). For classification, we followed De Ley & Blaxter (2003) up to superfamily level and Lorenzen (1994) up to genus level. Sediment fractions were defined according to the Wentworth scale.

RESULTS

The sediment of the three beaches was mainly composed of sand and revealed a variation between medium to very coarse sediments (Table 1). At Bananal beach the median grain size ranged from 400µm to 940µm; at Bica Beach from 570µm to 2844µm; and Coqueiros beach from 1174µm to 2213µm (Table 1).

At the three beaches 62 genera were found, belonging to 25 families, distributed along of 8 orders. The family Chromadoridae was represented by the largest number of genera (9) (Table 2).

In total 6312 specimens were identified up to the genus level or when possible to species level, except for some individuals of Dorylaimida, which unfortunately could not be identified up to genus because only juveniles and females were found in the samples.

At Bananal Beach, a total of 1802 nematode specimens were identified. They belong to 22 families and 39 genera, besides of Dorylaimida order. The family Chromadoridae, with 27% of relative abundance, was the dominant family and Epsilonematidae (14%) was the co-dominant family (Figure 2, Table 3). Chromadoridae, Desmodoridae and Oncholaimidae had the highest number of genera (4) (Table 3).

At Bica Beach, a total of 1849 specimens were identified. They belonged to 20 families and 35 genera. Draconematidae, with 24% of the relative abundance, was the dominant family and Desmodoridae (22%) was the co-dominant family (Figure 3, Table 3). Chromadoridae showed the highest number of genera (5) (Table 3).

At Coqueiros Beach, a total of 2261 specimens were identified. They belonged to 22 families and 46 genera, besides of Dorylaimida order. The Draconematidae with 33% of the relative abundance was the dominant family, followed by Desmodoridae (12%) (Figure 4, Table 3). Chromadoridae demonstrated the highest number of genera (7) (Table 3).

DISCUSSION

Several studies relate nematode dominance with type of sediment found present at the sampling location. Beaches composed of fine to medium sand have a trend to show dominance of Xyalidae (Calles *et al*., 2005; Gourbault & Warwick, 1994; Gheskiere *et al.*, 2004; Hourston *et a*l., 2005; Moreno *et al*., 2006; Nicholas & Hodda, 1999), whereas beaches with sediment varying from medium to very coarse sand are often less predictable in terms of dominance, since Chromadoridae or Linhomoeidae can both be dominant (Sharma & Webster, 1983; Urban-Maligna *et al*., 2004). This study showed a variation of dominant families that can be attributed to the different sediments found on these beaches.

Draconematidae and Desmodoridae were the dominant families at Bica and Coqueiros beaches. These families are known to occur in environments bearing coarse sand and a high contribution of gravel, such as beaches and coralline substrates. (Heip *et a*l., 1985; Netto *et a*l., 1999; Raes, 2006; Urban-Maligna *et al*., 2004). At Bananal beach, Chromadoridae and Epsilonematidae were the dominant families. Sediments composed of medium sand and high contribution of gravel showed dominance of Chromadoridae and co-dominance of Desmodoridae (Deudero & Vincx, 2000; Tietjen, 1969, 1977, 1980; Ward, 1975). The dominance of Epsilonematidae was reported to occur on a sandy beach characterized by medium sand by Bezerra (2001).

All the families found in this study have also been recorded from previously studied beaches in the literature. Seven of the sixty-two recorded genera have not been registered of worldwide sandy beaches before. These are *Deontolaimus*, *Desmodorella*, *Kosswigonema*, *Nygmatonchus*, *Odontophoroides*, *Phanoderma*, *Phanodermella*. Amongst the sixty-two genera found, four of them are for the first time recorded from Brazilian's coastline (Vennekey, personal communication). They are *Deontolaimus*, *Dracograllus*, *Phanodermella* and *Subsphaerolaimus*. The lack of records of these genera in previous Brazilian's surveys does not mean that they are not present in these areas; part could be due to lack of updated literature or keys or to incorrect identifications. For example, the genus *Dracograllus* is not included in the world widely used pictorial keys of Platt & Warwick (1983; 1988) and Warwick *et al*. (1998) and consequently some draconematid specimens could be identified as *Draconema* instead of *Dracograllus*. Nevertheless, these two genera differ by the absence of large annules in the enlarged region of the pharynx in the case of *Dracograllus*. *Desmodorella* is another genus documented which should be interpreted with caution. *Desmodorella* was regarded as a subgenus of *Desmodora* (Gerlach, 1963) until Verschelde *et al.* (1998) recognized it as a valid genus, based on the presence of large mustispiral fovea, longitudinal rows of spines, spicules with tiny capitulum and without velum.

The number of genera occurring on the Guanabara beaches (31 for Bica beach, 39 for Bananal beach and 46 for Coqueiros beach) is more or less similar to those obtained by Bezerra (2001) i.e. 39 genera of a tropical sandy beach located in a polluted region of the north-eastern shoreline of Brazil. However, the number of genera was either less or higher than at other tropical beaches. At a beach of Guadeloupe, an island located between the Atlantic Ocean and the Caribbean Sea, 61 genera were recorded (Gourbault & Warwick, 1994) while at two Ecuadorian beaches Salina (sheltered) and San Pedro de Manglaralto (exposed) respectively, 29 genera and 28 genera were found (Calles *et al*., 2005). Concerning non-tropical beaches, the number of genera is often higher, though cases of less and equivalently number of genera were also recorded. For example, Gheskiere *et al*. (2004) registered 65 genera at an ultra-dissipative beach of De Panne, at the Belgian coast. Nicholas & Hodda (1999) registered 48 genera at the exposed beach Dolphin at Australia; Gheskiere *et al*. (2005) found in two very exposed beaches in Italy and Poland 49 and 46 genera, respectively. Hourston et al (2005) inventoried 61 genera for temperate Australian sandy beaches. At Canadian Pacific beaches, 55 genera were found at Belcarra Park but only 24 genera were recorded at Iona Island (Sharma & Webster, 1983). Further, Moreno *et al*. (2006) registered 16 genera for Collungo beach, an exposed Italian beach.

It is important to point out that the comparisons made above should be interpreted carefully. The different morphodynamic features of those beaches should be taken into account as well as the absence of standardization in sampling of those different beaches and the different methodologies utilized for the nematode extraction. Each author adopted a different sampling strategy. For example, Gheskiere *et al* (2004) established three transects perpendicular to the water line resulting in nine stations from the upper tide level to the low tide level and each single sample was taken using a corer of 15cm deep. Moreno *et al* (2006) limited their nematode assemblage to the samples of the swash zone and only sampled the deeper layer (5-10cm); Hourston *et al* (2005) studied three different habitats ranging from a zone covered by dense sea grass to a zone completely exposed to wave activities which supports no attached vegetation along the Australian's coast.

The two first authors used sieves of mesh size of 38µm as lower limit whereas the last authors employed a mesh size of 63µm similar to the present study. The latter method results apparently in a lack of very small nematodes. Consequently to compare the number of genera found in this study with other studies using different methodologies may be producing unrealistic assumptions.

The first occurrence of four genera for the Brazilian coastline seems to suggest the possibility to discover new species in the Guanabara Bay and thus to the need for further development of nematode taxonomy in Brazil.

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Table 1: Granulometric characteristics of the three beaches studied (mean ± standard deviation).

		Bananal Beach	Bica Beach	Coqueiros Beach
January	% of gravel	3,2±2,5	8,9±5,9	15,8±9,6
	% of sand	96,4±2,7	90,7±5,9	83,9±9,6
	% of silt and clay	0,4±0,3	0,4±0,3	0,4±0,1
	mean grain size (µm)	624±242	1255±486	1569±358
June	% of gravel	5,4±6,3	14,1±16,1	16,4±13,3
	% of sand	92,9±7,6	86,2±15,1	83,3±13,5
	% of silt and clay	1,6±1,9	0,3±0,4	0,3±0,3
	mean grain size (µm)	632±190	1404±861	1487±419

Table 2: Nematode classification and genera found along of the three beaches studied at Guanabara Bay. (+: indicates presence at each beach).

Taxa	Bananal Beach	Bica Beach	Coqueiros Beach
Classe Enoplea Inglis, 1983			
Subclass Enoplia Pearse, 1942			
Order Enoplida Filipjev, 1929			
Suborder Enoplina Chitwood and Chitwood, 1937			
Superfamily Enoploidea Dujardin, 1845			
Family Enoplidae Dujardin, 1845			
Enoplus Dujardin, 1845			+
Family Thoracostomopsidae Filipjev, 1927			
Enoploides Ssaweljev, 1912	+	+	
Trileptium Cobb, 1933	+	+	+
Family Anoplostomatidae Gerlach and Riemann, 1974			
Anoplostoma Bütschli, 1874	+	+	+
Family Phanodermatidae Filipjev, 1927			
Phanoderma Bastian, 1865		+	
Phanodermatidae morphotype 1			+
Phanodermella Kreis, 1928			+
Suborder Ironina Siddiqi, 1983			
Superfamily Ironoidea de Man, 1876			
Family Ironidae de Man, 1876			
Trissonchulus Cobb, 1920	+		+
Family Oxstomatidae Chitwood, 1935			
Oxystomina Filipjev, 1921		+	+
Thalassoalaimus de Man, 1893	+		
Suborder Oncholaimina de Coninck, 1965			
Superfamily Oncholaimoidea Filipjev, 1916			
Family Oncholaimidae Filipjev, 1916			
Metaparoncholaimus de Conninck & Stekhoven, 1933			+
Metoncholaimus Filipjev, 1918	+	+	
Oncholaimus oxyuris Ditlevsen, 1911	+	+	+
Oncholaimidae morphotype 1	+		+
Viscosia de Man, 1890	+		+
Family Enchelidiidae Filipjev, 1918			
Eurystomina Filipjev, 1921	+	+	+
Suborder Trefusiina Lorenzen, 1981			
Superfamily Trefusoidea Gerlach, 1966			
Family Trefusiidae Gerlach, 1966			
Trefusia de Man, 1893	+		+
Subclass Dorylaimia Inglis, 1983			
Order Dorylaimida Pearse, 1942	+		+
Class Chromadorea Inglis, 1983			
SubClass Chromadoria Pearse, 1942			
Order Chromadorida Chitwood, 1933			
Suborder Chromadorina Filipjev, 1929			
Superfamily Chromadoroidea Filipjev, 1917			
Family Chromadoridae Filipjev, 1917			
Actinonema Cobb, 1920	+		
Chromadora Bastian, 1865		+	+
Chromadorita Filipjev, 1922	+	+	+
Euchromadora de Man, 1886		+	
Neochromadora Micoletzky, 1924		+	+
Nygmatonchus Cobb, 1933	+	+	+
Prochromadorella Micoletzky, 1924			+
Rhips Cobb, 1920			+
Spilophorella Filipjev, 1917	+		+

Table 2: continued

Taxa	Bananal Beach	Bica Beach	Coqueiros Beach
Family Cyatholaimidae Filipjev, 1929			
Acanthonchus Cobb, 1920	+		+
Cyatholaimidae morphotype 1			+
Longicyatholaimus Micoletzky, 1924		+	+
Marylynnia Hopper, 1977		+	+
Paracanthonchus Micoletzky, 1924	+	+	+
Paracyatholaimus Micoletzky, 1922	+		+
Family Selachnematidae Cobb, 1915			
Choanolaimus de Man, 1880	+		
Halichoanolaimus de Man, 1886		+	
Kosswigonema Gerlach, 1964	+	+	
Order Desmodorida De Connick, 1965			
Suborder Desmodorina De Connick, 1965			
Superfamily Desmodoroidea Filipjev, 1922			
Family Desmodoridae Filipjev, 1922			
Chromaspirina Filipjev, 1918	+	+	+
Desmodora de Man, 1889	+		+
Desmodorella Cobb, 1933			+
Metachromadora Filipjev, 1918	+	+	+
Molgolaimus Ditlevsen, 1921	+	+	+
Family Epsilonematidae Steiner, 1927			
Epsilonema espeeli Verschelde & Vincx, 1994	+	+	+
Metepsilonema Steiner, 1927		+	+
Perepsilonema Lorenzen, 1973			+
Family Draconematidae Filipjev, 1918			
Dracograllus Allen & Noffsinger, 1978	+	+	+
Superfamily Microlaimoidea Micoletzky, 1922			
Family Microlaimidae Micoletzky, 1922			
Microlaimus de Man, 1980	+	+	+
Order Monhysterida Filipjev, 1929			
Suborder Monhysterina De Coninck & Stekhoven, 1933			
Superfamily Sphaerolaimoidea Filipjev, 1918			
Family Xyalidae Chitwood, 1951			
Steineria Micoletzky, 1922	+		
Theristus Bastian, 1865	+	+	+
Family Sphaerolaimidae Filipjev, 1918			
Subsphaerolaimus Lorenzen, 1978	+	+	+
Suborder Linhomoeina Andrássy, 1974			
Superfamiliy Siphonolaimoidea Filipjev, 1918			
Family Linhomoeidae Filipjev, 1922			
Eleutherolaimus Filipjev, 1922		+	
Linhomoeus Bastian, 1865	+	+	
Terschellingia de Man, 1888			+
Order Araeolaimida De Coninck and Stekhoven, 1933			
Superfamiliy Axonolaimoidea Filipjev, 1918			
Family Axonolaimidae Filipjev, 1918			
Ascolaimus Ditlevsen, 1919		+	
Axonolaimus de Man, 1889	+	+	+
Odontophoroides Boucher & Helléouët, 1977			+
Family Comesomatidae Filipjev, 1918			
Sabatieria celtica Southern, 1914	+		+
Family Diplopeltidae Filipjev, 1918			
Araeolaimus de Man, 1888	+	+	
Southerniella Allgén, 1932	+	+	+
Order Plectida Malakhov, 1982			
Superfamily Leptolaimoidea Örley, 1880			
Family Leptolaimidae Örley, 1880			
Deontolaimus de Man, 1880			+

Table 2: continued

Taxa	Bananal Beach	Bica Beach	Coqueiros Beach
Leptolaimidae morphotype 1	+		
Onchium Cobb, 1920	+		+
Superfamily Haliplectoidea Chitwood, 1951			
Family Haliplectidae Chitwood, 1951			
Haliplectus Cobb, 1913	+		
Ordem Rhabditida Chitwood, 1933			
Suborder Rhabditina Chitwood, 1933			
Superfamily Rhabditoidea Örley, 1880			
Family Rhabditidae Örley, 1880			
Rhabditis Dujardin, 1845	+		

Table 3: Relative abundance of the families and number of genera, occurring in each Family, found at the three beaches. *not including relative abundance of Order Dorylaimida.

	Bananal Beach		Bica Beach		Coqueiros Beach	
Family	Relative abundance	Number of genera	Relative abundance	Number of genera	Relative abundance	Number of genera
Anoplostomatidae	2,02	1	0,91	1	0,02	1
Axonolaimidae	0,01	1	0,25	2	0,01	2
Chromadoridae	27,32	4	4,98	5	9,11	7
Comesomatidae	0,16	1	0	0	5,69	1
Cyatholaimidae	10,59	3	3,79	3	10,61	6
Desmodoridae	13,65	4	21,67	3	12,06	5
Diplopeltidae	0,81	2	4,36	2	0,63	1
Draconematidae	0,24	1	24,05	1	33,10	1
Enchelidiidae	0,45	1	3,76	1	0,41	1
Enoplidae	0	0	0	0	0,01	1
Epsilonematidae	14,23	1	7,26	2	6,17	3
Haliplectidae	0,12	1	0	0	0	0
Ironidae	12,44	1	3,61	1	3,94	1
Leptolaimidae	0,09	3	0,12	1	0,34	2
Linhomoeidae	0	0	0,14	2	0,01	1
Microlaimidae	0,69	1	1,21	1	1,50	1
Oncholaimidae	2,02	4	5,70	2	9,27	4
Oxystominidae	0,03	1	2,85	1	0,30	1
Phanodermatidae	0	0	0,05	1	0,87	3
Rhabditidae	0,05	1	0	0	0	0
Selachinematidae	1,95	2	0,97	2	0	0
Sphaerolaimidae	2,74	1	0,02	1	1,25	1
Thoracostomopsidae	5,43	2	0,59	2	0,05	1
Trefusiidae	0,08	1	0	0	0,67	1
Xyalidae	4,78	2	13,70	1	3,05	1
Total	99,92*	39	100,00	35	99,02*	46

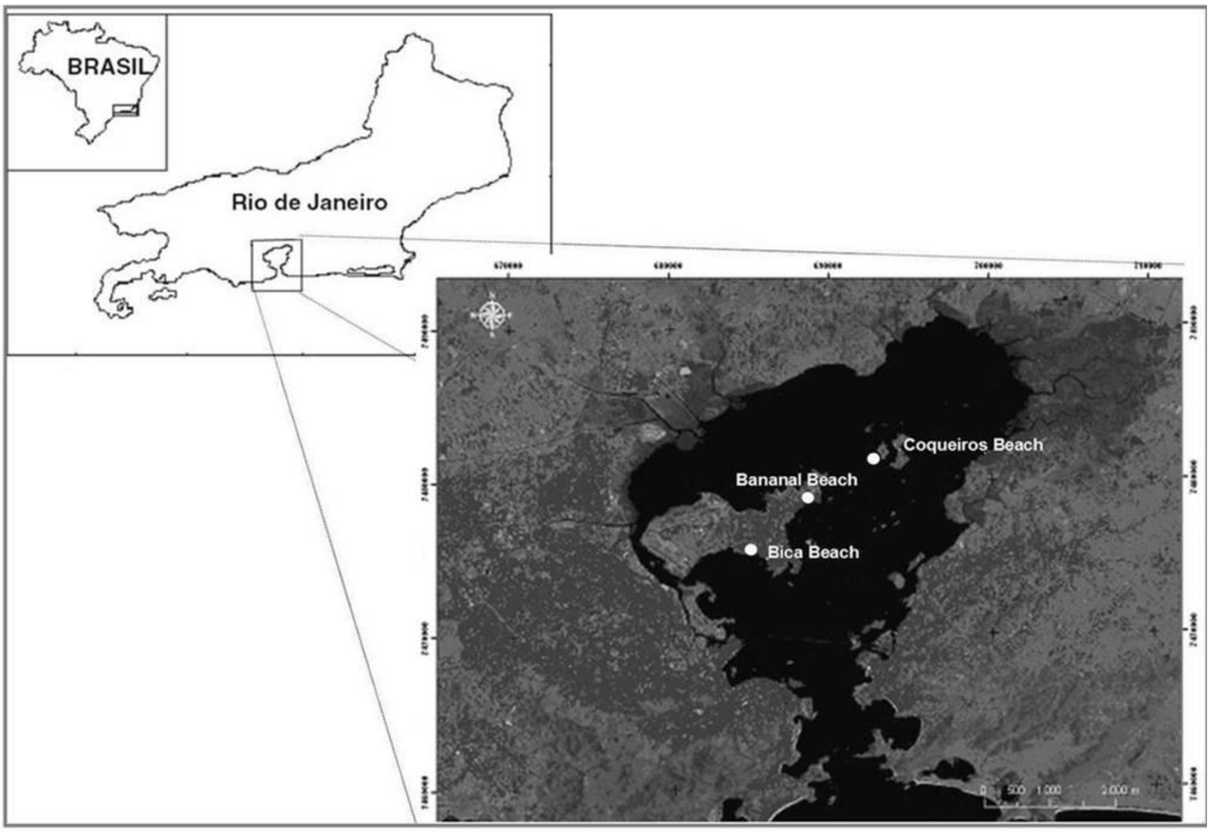

Figure 1: Guanabara Bay LANDSAT TM542 image, obtained by the Remote Sensory Laboratory – UFRJ. Position of the three beaches studied is indicated by a white circle.

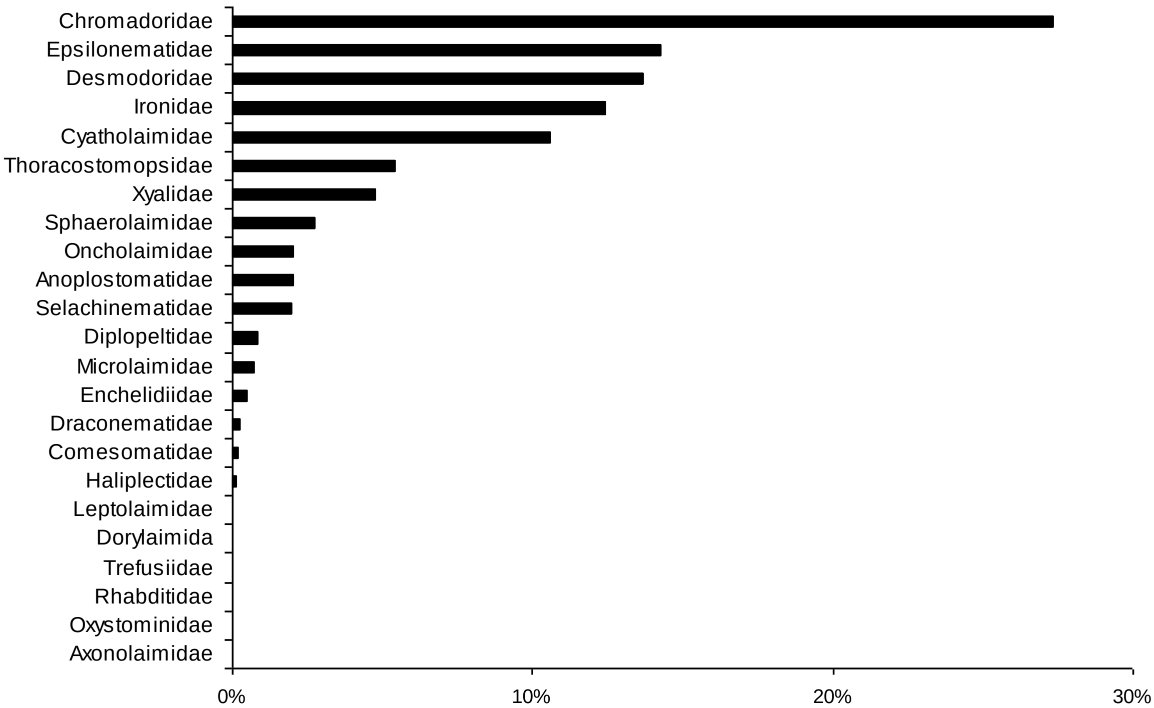

Figure 2: Relative abundance of the families found at Bananal beach.

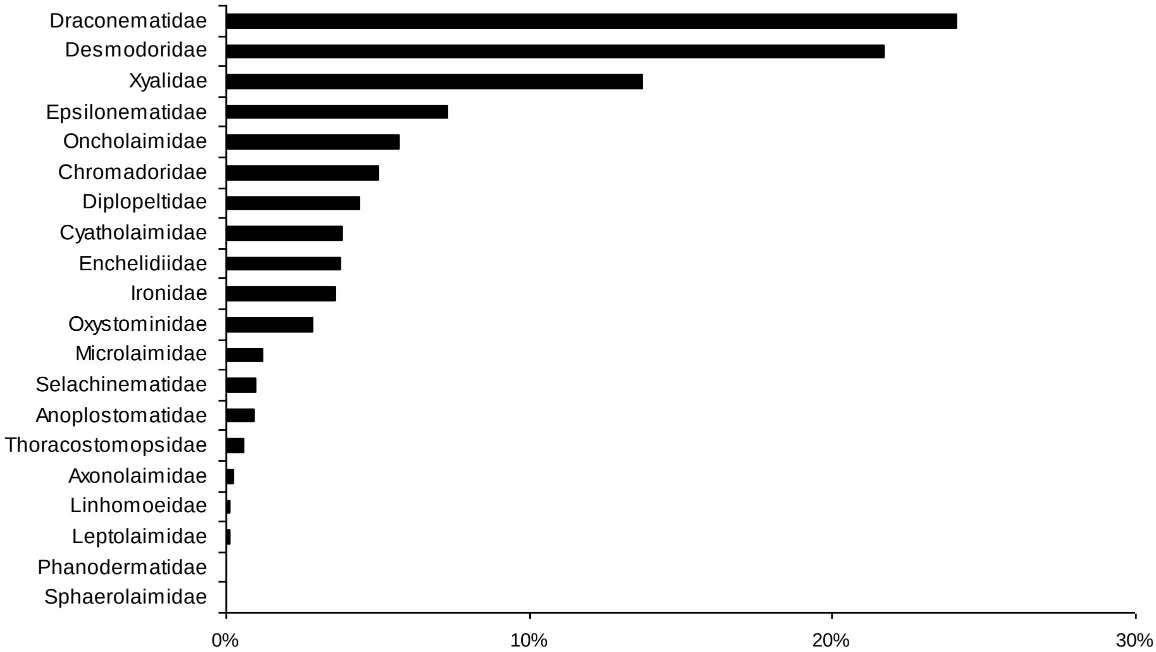

Figure 3: Relative abundance of the families found at Bica beach.

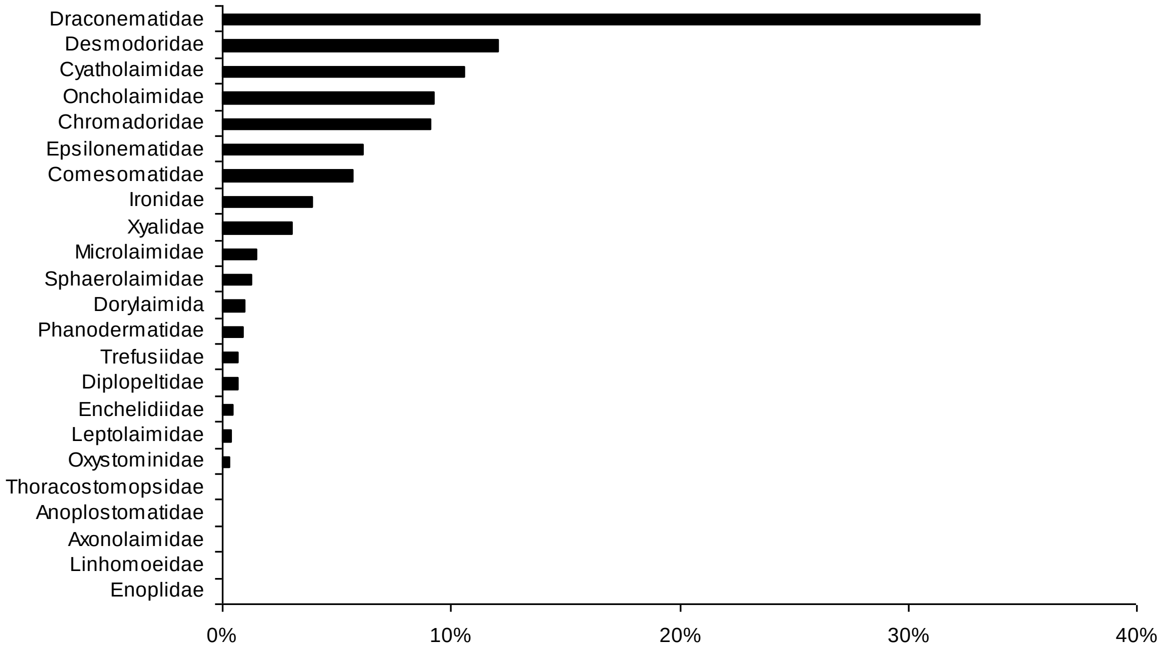

Figure 4: Relative abundance of the families found at Coqueiros beach.