

First checklist of free-living marine nematodes from the Israeli coast of the Mediterranean

Zoya HARBUZOV^{1,2}, Moshe TOM¹, Roberto DANOVARO³, Cristina GAMBI³, Laura CARUGATI⁴,
 Hadas LUBINEVSKY¹ and Nikolaos LAMPADARIOU⁵

¹National Institute of Oceanography, Department of Biology and Biotechnology, Israel Oceanographic & Limnological Research, Israel. P.O.B 2336, Haifa 3102201, Israel

²Leon H. Charney School of Marine Sciences, Department of Marine Biology, University of Haifa, 199 Aba Koushy Ave., Mount Carmel Haifa 3498838, Israel

³Department of Marine Science, Faculty of Science, Polytechnic University of the Marche, Via Breccia Bianche, 60131 Ancona, Italy

⁴University of Cagliari, Department of Life and Environmental Sciences, Via Università 40, 09124 Cagliari, Sardinia

⁵Hellenic Center for Marine Research (HCMR), Institute of Oceanography, P.O. Box 2214, 71003 Heraklion, Crete, Greece

Corresponding author: Zoya Harbuzov; zoya.garbu@ocean.org.il

Contributing Editor: Joachim LANGENECK

Received: 11 September 2023; Accepted: 12 April 2024; Published online: 03 July 2024

Abstract

This study presents an inventory of free-living marine nematodes from the deep waters of the southeastern part of the Levantine Basin. The meiofauna of this area, particularly the free-living marine nematodes, have been poorly investigated; hence, the present study has regional zoo-geographic importance. To fill this knowledge gap, nematodes were collected from the upper 0-3 cm sediment horizon from a transect located perpendicular to the Israel coast off Tel Aviv, with depths ranging between 76 and 1400 m. Our sampling yielded a diverse assemblage of nematodes representing 65 species belonging to 54 genera and 22 families. About 38% of the species have been previously reported in the Mediterranean; the remaining 62% are reported for the first time. A taxonomic checklist provides information on the worldwide distribution of the encountered species. This checklist provides a baseline for understanding the nematode community in this region and serves as a valuable resource for future studies.

Keywords: Free-living marine nematodes; South-east Mediterranean; meiofauna; Levantine Basin; Israeli Mediterranean waters.

Introduction

Free-living marine nematodes are the most abundant and diverse metazoans found in marine sediments. Their distribution spans from the high-water mark to the deepest oceanic trenches, asserting their dominance in both density and diversity within marine sediment ecosystems (Lambshhead, 2004). Hodda's recent taxonomic review (2022) suggested that the phylum Nematoda consists of 3 classes, 8 subclasses, 12 superorders, 32 orders, 53 suborders, 101 superfamilies, 276 families, 511 subfamilies, 3,030 genera and 28,537 species. Hodda (2022) also reviewed a variety of estimates of the total existing number of nematode species, and the obtained range was between half a million and 10 million species. Although larger individuals exist, the free-living marine nematodes are generally considered to belong to the meiofaunal size group. There is no universally accepted size range for meiofauna, and according to Giere (2009), the accepted range is between an upper limit of 500-1000 µm and a lower limit of 44-63 µm.

The Mediterranean is a semi-enclosed water body characterized by constant temperatures at depths below 300-500 m. In the Eastern Mediterranean, the temperature ranges from 13.6°C to 13.8°C. Salinity levels are very high, ranging from 38.7 to 38.8‰, and the oxygen concentration just above the seafloor in the studied area is >175 µM (Kress *et al.*, 2014), indicating a well-oxygenated near-bottom water layer. In addition, the region is characterized as one of the most oligotrophic areas in the world (Berman-Frank & Rahav, 2012; Moore *et al.*, 2013; Siokou-Frangou *et al.*, 2010).

There are several faunistic species-level nematode checklists from the Mediterranean, mainly from relatively shallow waters (Schuurmans-Stekhoven, 1950; Wieser, 1956; Semprucci *et al.*, 2008; Semprucci, 2013 and Jouili *et al.*, 2018, and see also the literature in Table 2). The majority of them concern coastal European ecosystems. Thus our understanding of the eastern, non-European Mediterranean ecosystems is rather poor (Semprucci & Balsamo, 2012). Regarding the eastern Mediterranean, while several studies of free-living marine nematodes do

exist (e.g. see reviews of Lampadariou & Sevastou, 2022; Sevastou & Lampadariou, 2021 and references therein), nematodes have been identified either to genus or, at best, to putative species (i.e. sp.1, sp.2 etc.) in most of them. To the best of our knowledge, nematodes from the deep Levantine Basin have never been identified to species level.

In the present study, nematodes from the Israeli part of the eastern Mediterranean were studied with the aim of providing a list of the nematode species across a deep-sea transect of the coast of Tel Aviv. A species checklist, together with some additional information on the distribution of the encountered species in other parts of the world, is provided. Such information will expand our knowledge of the biodiversity of nematodes in the Mediterranean and can be used as baseline information in future monitoring surveys.

Materials and Methods

Survey area

The heterogeneous Israeli continental slope comprises a prominently steep northern section incised by several canyons, a comparatively gentler seabed in its southern region, and two gravitational slumps known as Dor and Palmahim (Fig. 1). The relatively flatter bathyal basin extends westward to Crete, and the studied area in the Israeli waters is its shallow east part, with depths ranging between 1000 and 2000 m (Kanari *et al.*, 2020, and references therein). The specimens under scrutiny in this study were sampled from the southern part of the Israeli

Mediterranean coast along a transect perpendicular to the Tel Aviv shoreline, encompassing a depth range of 76-1400 m (Fig. 1 and Table 1).

Sediment grain size declines gradually from 7 to 5 μm along the 100 to 1900 m depth gradient (Lubinevsky *et al.*, 2017).

Sampling and sorting

Meiofauna samples were acquired by sub-sampling from 0.25 m² box corer (BX-650, Ocean instruments, San Diego, CA) samples, employing a Plexiglas tube with an inner diameter of 9.4 cm. The upper 0-3 cm sediment layer was taken from each Plexiglas tube and preserved onboard in 99% ethanol while applying mild mixing to facilitate the ethanol penetration. The sampling cruise took place during the autumn of 2018 aboard the R/V “Bat Galim”, operated by the Israel Oceanographic and Limnological Research (IOLR). Meiofaunal nematode specimens were separated from the ethanol-preserved sediments according to Harbuzov *et al.* (2022) following Heip *et al.* (1985) and Danovaro (2010), which included two major stages: sieving and density gradient centrifugation. This method revealed a specimen size range of 20-500 μm .

The selection procedure involved randomly choosing ~10 nematode individuals from each sample, combining the liquid containing the entire pool of sampled organisms, and then extracting the specimens using a pipette, ensuring a balanced representation across different stations. No permanent slides were prepared, and identification was conducted from individuals immediately placed in glycerol.

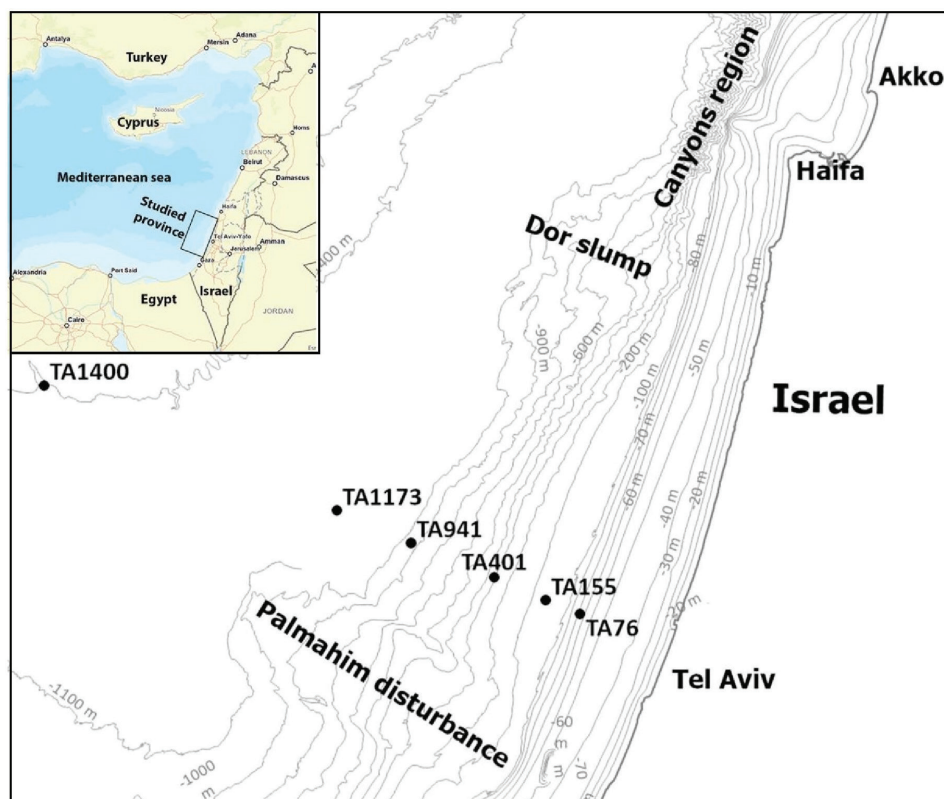


Fig. 1: Sampling sites map. TA – Tel Aviv transect; the studied sites are labeled by black dots. The numbers to the right of the station designations depict depth in meters. Palmahim and Dor are two gravitational sediment slumps.

Table 1. Geographical coordinates and depths of six sites sampled along the coast of Israel for studying marine nematodes

No.	Site name	Depth [m]	Longitude	Latitude
1	TA1400	1400	33.891	32.501
2	TA1173	1173	34.310	32.322
3	TA941	941	34.415	32.277
4	TA401	401	34.534	32.226
5	TA155	155	34.607	32.194
6	TA76	76	34.657	32.174

Morphological identification

The identification process involved utilizing the pictorial keys of Platt and Warwick (1983, 1988) and Warwick *et al.* (1998), as well as the work of Schuurmans-Stekhoven (1950) from the Mediterranean and the NeMys database accessible at Nemys eds. (2023), which contains the up-to-date taxonomic literature on free-living marine nematodes. All observations were conducted under a Nomarski interference contrast microscope employing a $\times 100$ magnification.

Results

In total, 182 specimens belonging to 22 families, 54 genera and 65 species were identified. In some cases (25 out of 65), species identification was not possible, and species were ascribed as putative species or morphospecies (i.e. sp.1, sp.2 etc.). Of the 40 named species, 15 (38%) have been previously reported from the Mediterranean. Table 2 displays a detailed list of all species together with additional information on their distribution, synonyms, original description and other sources of references from the Mediterranean (e.g. Schuurmans-Stekhoven, 1950; Wieser, 1956; Semprucci *et al.*, 2008; Semprucci, 2013; Jouili *et al.*, 2018).

As depicted in Table 2, the various families elucidated specific depth distributions. Two families, Aegialoalaimidae and Rhabdolaimidae, were completely absent from the shallow 76-401 m depth range. Chromadoridae, Comesomatidae, and Xyalidae were encountered, with some exceptions, across the entire transect, indicating a wide depth distribution ranging from the shelf down to the bathyal basin. Selachinematidae, Phanodermatidae, Desmodoridae, Desmoscolecidae, Diplopeltidae, Ceraimonematidae, Microlaimidae and Tarvaiidae were absent between the 941 and 1400 m depth range. Diplopeltidae, Phanodermatidae and Selachinematidae were found only at the shallowest 76 m station. Finally, species from the Rhabdolaimidae were found only at the deepest 1440 m station.

Discussion

Twenty-five species out of the 65 identified ones could not be conclusively attributed to known species. This limitation predominantly arose from the absence of adult males, which play a pivotal role in precise taxonomic identification. Juveniles and females often lack the requisite diagnostic features for accurate classification. Furthermore, suboptimal preservation conditions contributed to the challenge by compromising the visibility of the small morphological features essential for species-level identification. This may have been due to the choice of ethanol as a preservation medium, but this was necessary since our initial sampling strategy aimed at combining both morphological identifications and molecular techniques. The preservation method proposed by Yoder (2006), utilizing dimethyl sulfoxide-disodium EDTA in saturated NaCl and abbreviated DESS, was recently applied successfully in our laboratory and provided promising results and is thus recommended when both morphological identifications and molecular techniques are needed.

The 65 different species identified out of 182 individuals confirm previous reports of a rather high species diversity of nematodes in general (Appeltans *et al.*, 2012; Hodda, 2022) and in the deep sea in particular (e.g. Lamshead & Boucher, 2003). It should be mentioned, however, that nematode species-level data, particularly from the deep sea, are generally scarce since most studies are either conducted at the genus level or based on a separation into putative species. Lamshead (1993) provided a comparison of nematode alpha diversity from worldwide deep-sea studies. He reported numbers ranging between 81 and 316 species, although in most of the studies mentioned, a much higher sampling effort was applied. In a more recent compilation derived from various literature sources, Miljutin *et al.* (2010) provided a comprehensive summary of deep-sea nematode species. Their findings revealed considerable variability in nematode species numbers, ranging from 1 to 6 to as high as 175 species, contingent upon the specific geographic region. Notably, instances of lower species counts were predominantly associated with taxonomically focused

Table 2. List of Nematoda species found in the studied area of the Israeli coast. V - presence and (—) - absence of species. All the synonyms were taken from the World Register of Marine Species (WoRMS), and the notes refer to the original description of the species in the Mediterranean

Taxonomy	Depth [m]				Geographical distribution	Synonymized names	Notes*
	76	155	401	941			
Nematoda							
Order Chromadorida							
Chromadoridae Filipjev, 1917							
<i>Acantholaimus</i> sp.1	—	v	v	—	—	v	
<i>Chromadorella duopapillata</i> Platt, 1973	v	v	—	—	v	—	A1, A5, A12, A15
Adriatic Sea, North Atlantic Ocean							
<i>Endeolophos</i> sp.1	v	—	—	—	—	—	
<i>Actinonema pachydermatum</i> Cobb, 1920	—	v	—	—	—	v	A1, A2, A3, A5, A12
Adriatic Sea, Belgium, Gulf of Mexico, Mediterranean Sea, North Atlantic Ocean, North Sea							
<i>Actinonema amphidiscatum</i> (Schuurmans Stekhoven & Adam, 1931) Wieser, 1954							
<i>Actinonema fragile</i> (Allgén, 1929) Wieser, 1954							
<i>Adeuchromadora megamphida</i> Boucher & Bovée, 1972							
<i>Euchromadora fragilis</i> Allgén, 1933							
<i>Pareuchromadora amphidiscata</i> Allgén, 1940							
<i>Pareuchromadora amphidiscata</i> Schuurmans Stekhoven & Adam, 1931							
<i>Pareuchromadora fragilis</i> (Allgén, 1934)							
<i>Spiliphora fragilis</i> Allgén, 1929							
<i>Spilophora fragilis</i> Allgén, 1929							
<i>Hypodontolaimus schuurmansstehoveni</i> Gerlach, 1951	—	—	—	—	—	v	
North Atlantic Ocean, North Sea							
<i>Dichromadora geophila</i> (de Man, 1876) Kreis, 1929	v	—	—	—	—	—	A6
<i>Chromadora canadensis</i> Cobb, 1914							
<i>Hypodontolaimus geophilus</i> de Man, 1876							
<i>Spiliphora canadensis</i> Cobb, 1914							
<i>Spiliphora spectabilis</i> Allgén, 1929							
<i>Spilophora canadensis</i> Cobb, 1914							
<i>Spilophora geophila</i> de Man, 1876							
<i>Spilophora spectabilis</i> Allgén, 1929							

Continued

Taxonomy	Depth [m]					Geographical distribution	Synonymized names	Notes*
	76	155	401	941	1173			
Ethmolaimidae Filipjev & Schuurmans Stekhoven, 1941								
<i>Filitonchus filiformis</i> Warwick, 1971	v	—	—	—	—	Belgium, North Atlantic Ocean, North Sea		A9, A12, A15
<i>Comesa vitia</i> Warwick, 1971	—	—	—	v	v	Barents Sea		
<i>Neotonchus punctatus</i> Cobb, 1933	—	—	—	v	—	Adriatic Sea		A17
Selachinematidae Cobb, 1915								
<i>Choanolaimus psammophilus</i> de Man, 1880	v	—	—	—	—	North Atlantic Ocean, North Sea		
<i>Gammanema femnicum</i> Gerlach, 1953	v	—	—	—	—	White Sea		
Cyatholaimidae Filipjev, 1918								
<i>Paralongicyatholaimus minutus</i> Warwick, 1971	—	v	—	—	—	North Atlantic Ocean, North Sea		
<i>Maryllynia complexa</i> (Warwick, 1971) Hopper, 1972	—	v	—	—	—	Adriatic Sea, Mediterranean Sea, North Atlantic Ocean, North Sea	<i>Longicyatholaimus complexus</i> Warwick, 1971 <i>Maryllynia complexus</i> (Warwick, 1971) Hopper, 1972	A8, A17
<i>Paracanthonchus longicaudatus</i> Warwick, 1971	—	v	—	—	—	Barents Sea, North Atlantic Ocean, North Sea		
<i>Metacyatholaimus</i> sp.1	—	—	v	—	—	—		
<i>Paracyatholaimus</i> sp.1	v	—	—	—	—	v		
<i>Pomponema</i> sp.1	—	v	—	—	—	—		
Order Monhysterida								
Sphaerolaimidae Filipjev, 1918								
<i>Sphaerolaimus hirsutus</i> Bastian, 1865	—	—	v	—	—	Belgium, North Atlantic Ocean, North Sea		A5

Continued

Taxonomy	Depth [m]					Geographical distribution	Synonymized names	Notes*
	76	155	401	941	1173			
<i>Sphaerolaimus macrocirculus</i> Filipjev, 1918	—	—	—	v	—	—	Adriatic Sea, Black Sea, Mediterranean Sea, North Atlantic Ocean	A5, A10, A12
<i>Doliolaimus agilis</i> Lorenzen, 1966	—	—	—	—	—	v	North Atlantic Ocean, North Sea	
Xyalidae Chitwood, 1951								
<i>Daptonema invagiferoum</i> Platt, 1973	v	—	—	—	v	v	North Atlantic Ocean, North Sea	<i>Daptonema invagiferoum</i> Platt, 1973 <i>Theristus invagiferoum</i> Platt, 1973
<i>Daptonema setifer</i> Gerlach, 1952	v	v	—	—	v	—	Mediterranean Sea, North Atlantic Ocean, North Sea	<i>Theristus setifer</i> Gerlach, 1952 <i>Trichotheristus setifer</i> Gerlach, 1952
<i>Elzalia</i> sp.1	v	v	—	—	—	—	—	
<i>Retrotheristus breviseta</i> Juario, 1974	v	—	—	—	v	v	North Sea (the German Bight)	<i>Paramonhystra breviseta</i> Juario, 1974
<i>Scaptrella</i> sp.1	—	—	—	—	—	v	—	
<i>Amphimonhystrilla megastoma</i> Timm, 1961	—	—	—	—	v	v	Bay of Bengal	
<i>Omicronema</i> sp.1	—	—	—	v	—	—	—	
<i>Paramonhystra</i> sp.1	v	—	—	—	—	—	—	
Monhystridae de Man, 1876								
<i>Thalassomonhystra parva</i> Bastian, 1865	—	v	—	—	v	—	Adriatic Sea, Belgium, Black Sea, France, Gulf of Mexico, Mediterranean Sea, North Atlantic Ocean, North Sea, Red Sea	<i>Monhystra heteroparva</i> Micoletzky, 1924 <i>Monhystra kossnensis</i> Paramonov, 1929 <i>Monhystra parva</i> (Bastian, 1865) Butschli, 1874 <i>Monhystra parva meridiana</i> Micoletzky, 1922 <i>Tachyhodites parvus</i> Bastian, 1865
<i>Thalassomonhystra venusta</i> Lorenzen, 1979	—	v	—	—	—	—	North Atlantic Ocean, North Sea	<i>Monhystra venusta</i> Lorenzen, 1979
Linhomoeidae Filipjev, 1922								
<i>Linhomoeus elongatus</i> Bastian, 1865	—	v	—	—	—	—	France, New Zealand, North Atlantic Ocean, North Sea	<i>Eulinhomoeus elongatus</i> Bastian, 1865

Continued

Taxonomy	Depth [m]					Geographical distribution	Synonymized names	Notes*
	76	155	401	941	1173			
<i>Terschellingia longicaudata</i> de Man, 1907	—	—	v	—	—	Adriatic Sea, Baltic Sea, Barents Sea, Belgium, Gulf of Mexico, Japan, Mediterranean Sea, New Zealand, North Atlantic Ocean, North Sea	<i>Terschellingia antonovi</i> Filipjev, 1922 <i>Terschellingia gerlachi</i> Inglis, 1968 <i>Terschellingia heteroseta</i> Schuurmans-Stekhoven, 1950 <i>Terschellingia longispiculata</i> Wieser & Hopper, 1967 <i>Terschellingia supplementa</i> Tchesunov, 1978	A1, A8, A10, A11, A12, A14, A15, A16, A17
<i>Metalinhomoeus filicaudatus</i> Allg�en, 1930	v	—	—	—	—	North Atlantic Ocean, North Sea	<i>Linhomoeus (Metalinhomoeus) filicaudatus</i> Allg�en	
<i>Paralinhomoeus</i> sp.1	—	—	—	—	—	v		
Order Plectida								
Aegialoaimidae Lorenzen, 1981								
<i>Aegialoaimus</i> sp.1	—	—	—	v	—	—		
Ceramionematidae Cobb, 1933								
<i>Metadasynemella</i> sp.1	v	v	—	—	—	—		
<i>Psilonema</i> sp.1	v	v	—	—	—	—		
Tarvaidae Lorenzen, 1981								
<i>Tarvaia angusta</i> Gerlach, 1953	—	v	—	—	—	—	Mediterranean Sea, North Atlantic Ocean, North Sea	A8, A12
Order Enoplida								
Enchelidiidae Filipjev, 1918								
<i>Pareurystomina vaughtae</i> Keppner, 1989	—	—	—	—	v	—	St. Andrew Bay, Gulf of Mexico, Mexican Bay	
<i>Belbolla longispiculata</i> Nasira, Shahina & Shamim, 2014	v	—	—	—	—	—	Indus River	
<i>Pareurystomina scilloniensis</i> Warwick, 1977	v	—	—	—	—	—	North Atlantic Ocean	
Phanodermatidae Filipjev, 1927								

Continued

Taxonomy	Depth [m]						Geographical distribution	Synonymized names	Notes*
	76	155	401	941	1173	1400			
<i>Crenopharynx</i> sp.1	v	—	—	—	—	—	-		
Ironidae de Man, 1876									
<i>Dolicholaimus</i> sp.1	v	—	—	—	v	—	-		
Oxystominae Chitwood, 1935									
<i>Halalaimus</i> sp.1	—	—	v	—	—	v	-		
<i>Oxystomina asetosa</i> (Southern, 1914) Filipjev, 1921	—	v	—	—	—	—	Adriatic Sea, North Atlantic Ocean		A12, A17
Rhabdolaimidae Chitwood, 1951									
<i>Syringolaimus</i> sp.1	—	—	—	—	—	v	-		
Oncholaimidae Filipjev, 1916									
<i>Viscosia abyssorum</i> (Allgén, 1933) Wieser, 1953	v	v	v	—	—	—	Adriatic Sea, North Atlantic Ocean, North Sea, South Atlantic Ocean	<i>Oncholaimus abyssorum</i> Allgén, 1933	A15, A17
<i>Viscosia viscosa</i> (Bastian, 1865) de Man, 1890	—	—	—	v	—	—	Adriatic Sea, Baltic Sea, Belgium, France, North Atlantic Ocean, North Sea	<i>Monocholaimus viscosus</i> Allgén, 1930 <i>Oncholaimus viscosus</i> Bastian, 1865 <i>Viscosia viscosa</i> Bastian, 1865	A17
Order Desmodorida									
Desmodoridae Filipjev, 1922									
<i>Desmodora pontica</i> Filipjev, 1922	v	v	—	—	—	—	Adriatic Sea, Belgium, Black Sea, Mediterranean Sea, North Atlantic Ocean, North Sea		A1, A8, A12, A14, A17
<i>Desmodora communis</i> (Bütschli, 1874) De Man, 1889	v	v	—	—	—	—	Belgium, France, North Atlantic Ocean, North Sea	<i>Desmodora gracilis</i> Kreis, 1928 <i>Desmodora leucocephala</i> Schulz, 1932 <i>Desmodora problematica</i> Allgén, 1929 <i>Desmodora serpentulus</i> de Man, 1889 <i>Desmodora serpentulus suecica</i> Allgén, 1929 <i>Spiliphora communis</i> Bütschli, 1874 <i>Spiliphora communis</i> Bütschli, 1874	

Continued

Taxonomy	Depth [m]						Geographical distribution	Synonymized names	Notes*
	76	155	401	941	1173	1400			
<i>Desmodora</i> sp.1	v	v	—	—	—	—	—		
<i>Desmodora</i> sp.2	v	v	—	—	—	—	—		
<i>Metachromadora</i> sp.1	v	—	—	—	—	—	—		
<i>Pseudonchus</i> sp.1	—	v	—	—	—	—	—		
Microalaimidae Micoletzky, 1922									
<i>Microalaimus tenuispiculum</i> de Man, 1922	—	v	—	—	—	—	Baltic Sea, North Atlantic Ocean, North Sea, South Pacific Ocean, Southern Ocean	<i>Molgalaimus demani</i> Jensen, 1978	
<i>Microalaimus robustidens</i> Schuurmans Stekhoven & De Coninck, 1933	v	—	—	—	—	—	Belgium, Netherlands, North Atlantic Ocean, North Sea		
Order Desmoscolecida									
Desmoscolecidae Shipley, 1896									
<i>Desmoscolex</i> sp.1	—	v	—	—	—	—	—		
<i>Tricoma</i> sp.1	v	—	—	—	—	—	—		
Order Araeolaimida									
Diplopeltidae Filipjev, 1918									
<i>Neodiplopeltula barentsi</i> (Steiner, 1916) Holovachov & Boström, 2018							New Zealand	<i>Dipeltis barentsi</i> Steiner, 1916 <i>Diplopeltis asymmetricus</i> Allgén, 1935 <i>Diplopeltis barentsi</i> Steiner, 1916 <i>Diplopeltis ovalis</i> Ditlevsen, 1928 <i>Diplopeltula cuspidibojia</i> Leduc, 2017 <i>Neodiplopeltula asymmetrica</i> (Allgén, 1935) Holovachov & Boström, 2018 <i>Neodiplopeltula cuspidibojia</i> (Leduc, 2017) Holovachov & Boström, 2018 <i>Neodiplopeltula ovalis</i> (Ditlevsen, 1928) Holovachov & Boström, 2018	
Comesomatidae Filipjev, 1918									

Continued

Taxonomy	Depth [m]						Geographical distribution	Synonymized names	Notes*
	76	155	401	941	1173	1400			
<i>Dorylaimopsis longispicula</i> Fu, Leduc, Rao & Cai, 2019	—	—	v	v	v	—	South China Sea		
<i>Laimella longicauda</i> Cobb, 1920	—	—	v	v	—	—	Gulf of Mexico, North Atlantic Ocean		
<i>Sabatieria armata</i> Gerlach, 1952	v	v	—	—	v	—	Mediterranean Sea, North Atlantic Ocean, North Sea		A8, A12
<i>Sabatieria</i> sp.1	—	—	v	—	—	—	—		
<i>Setosabatieria hilarula</i> de Man, 1922	—	—	—	—	—	—	Adriatic Sea, France, Gulf of Mexico, North Atlantic Ocean, North Sea	<i>Comesoma jubata</i> Cobb N.A., 1898 <i>Comesoma jubatum</i> Cobb, 1898 <i>Sabatieria chitwoodi</i> Wieser, 1954 <i>Sabatieria hilarula</i> (Chitwood, 1951) de Man, 1922 <i>Sabatieria jubata</i> (Cobb, 1898) <i>Sabatieria scotlandia</i> Inglis, 1961 <i>Setosabatieria chitwoodi</i> (Wieser, 1954) Platt, 1985	A1, A12, A15, A17
<i>Setosabatieria</i> sp.1	—	—	v	—	—	—	—		

*Notes

- A1 Ape *et al.*, 2016.
- A2 Boucher & de Bovée, 1971.
- A3 Coomans, 1989.
- A4 De Coninck & Schuurmans Stekhoven, 1933.
- A5 De Smet *et al.*, 2001.
- A6 Gerlach, 1951.
- A7 Gerlach, 1952.
- A8 Gerlach & Riemann, 1973.
- A9 Gheskiere, 2000.
- A10 Jouli *et al.*, 2018.
- A11 Mahmoudi *et al.*, 2008.
- A12 Semprucci *et al.*, 2008.
- A13 Schuurmans Stekhoven, 1943.
- A14 Schuurmans Stekhoven, 1950.
- A15 Semprucci, 2013.
- A16 Thiermann *et al.*, 1994.
- A17 Traversi & Vidakovic, 1997.

publications. Among the regions reported by Miljutin *et al.* (2010), the Mediterranean appears to be among the areas with the most reported species (e.g. 175 species in the Mediterranean vs. 131 in the NE Atlantic and 130 in the CE Pacific). Other more recent deep-sea studies from the Mediterranean where species-level identifications were employed reported similarly high numbers. For example, in the central Mediterranean, Danovaro *et al.* (2013) reported 320 species from 5084 individuals, while Danovaro *et al.* (2009) reported 15 to 82 species from >3000 individuals. Similarly, Gambi *et al.* (2014) reported 182 species from 3562 individuals from the central and western Mediterranean. In the eastern Mediterranean, Lampadariou *et al.* (2013) reported 143 species from >4000 individuals; although this study dealt with chemosynthetic environments, it did include one control station.

As mentioned above, due to the scarcity of species-level identification, a comparison of data and species lists is rather difficult. Nevertheless, 15 of the 40 named species found in the present study have been reported in the Mediterranean (e.g. Nemys *eds.*, 2023; Schuurmans Stekhoven, 1950; Semprucci *et al.*, 2008; Wieser, 1956) while the remaining 25 are reported for the first time. It is expected that with increasing sampling efforts, many new records or new species will be found. In addition, the inclusion of molecular techniques along with morphological data will certainly improve species recognition. In this respect, the present checklist may serve as a starting point for further research on nematodes in this understudied area.

Conclusions

This study reports for the first time a partial inventory of free-living marine nematodes from the deep waters of the south-eastern part of the Levantine Basin. The families and genera found in this study are typical of deep-sea sediments. Approximately 38% of the species have been previously reported in the Mediterranean; the remaining 62% were mainly known from the Northwestern Europe and the North Atlantic, the two regions where most marine nematodes have been described. This emphasizes the value of this checklist as a baseline for future studies and the need for a larger sampling effort in this region where our current knowledge of the distribution and the biodiversity of marine nematodes is limited.

Acknowledgements

We would like to express our gratitude to the crew of R/V “Bat Galim” for their help during sampling. We also thank Roberto Danovaro, Cristina Gambi, and Laura Carugati for hosting Zoya Harbuzov at their laboratory for two months and introducing her to the morphological identification of nematodes. The study was partially supported by grants 216-17-011 and 220-17-004 from the Israeli Ministry of Energy to Hadas Lubinevsky and Moshe Tom. The morphological identifications were completed

at the Institute of Oceanography of the Hellenic Center for Marine Research in Heraklion, Crete, and were financed by a two-month visit funded by the EU COST program “Short term scientific mission - Action number: CA15219-45333” to Zoya Harbuzov.

References

- Ape, F., Arigò, C., Gristina, M., Genovese, L., Di Franco, A. *et al.*, 2016. Meiofaunal diversity and nematode assemblages in two submarine caves of a Mediterranean marine protected area. *Mediterranean Marine Science*, 17 (1), 202-215.
- Appeltans, W., Ahyong, S.T., Anderson, G., Angel, M.V., Artois, T. *et al.*, 2012. The magnitude of global marine species diversity. *Current Biology*, 22 (23), 2189-2202.
- Berman-Frank, I., Rahav, E., 2012. Dinitrogen fixation as a source for new production in the Mediterranean Sea: a review. p. 199-226. In: *Life in the Mediterranean Sea: a Look at Habitat Changes*. Stambler, N., (Ed.). Nova Science Publishers, New York.
- Boucher, G., de Bovée, F., 1971. *Trochamus carinatus* gen. et sp. n. et *Adeuchromadora megamphida* gen. et sp. n. Chromadoridae Nematoda à dix soies céphaliques de la vase terrigène côtière de Banyuls-sur-Mer. *Vie Milieu*, 22 (2), 231-242.
- Coomans, A.V., 1989. Overzicht van de vrijlevende nematofauna van België (Nematoda). p. 43-56. In: *Proceedings of the Symposium “Invertebrates of Belgium”*, Brussel, 25-26 November 1988. Koninklijk Belgisch Instituut voor Natuurwetenschappen, Brussel.
- Danovaro, R. (Ed.), 2010. *Methods for the study of deep-sea sediments, their functioning and biodiversity*. CRC Press, Taylor and Francis Group, 458 pp.
- Danovaro, R., Bianchelli, S., Gambi, C., Mea, M., Zeppilli, D., 2009. α -, β -, γ -, δ - and ϵ -diversity of deep-sea nematodes in canyons and open slopes of Northeast Atlantic and Mediterranean margins. *Marine Ecology Progress Series*, 396, 197-209.
- Danovaro, R., Carugati, L., Corinaldesi, C., Gambi, C., Guilini, K. *et al.*, 2013. Multiple spatial scale analyses provide new clues on patterns and drivers of deep-sea nematode diversity. *Deep Sea Research Part II: Topical Studies in Oceanography*, 92, 97-106.
- De Coninck, L.A., Schuurmans Stekhoven, J.H., Jr. 1933. *The free-living marine nemas of the Belgian Coast. II With general remarks on the structure and the system of nemas*. Memoires du Musee Royal d’Histoire Naturelle de Belgique, No. 58, 163 pp.
- De Smet, G., Vincx, M., Vanreusel, A., Vanhove, S., Vanaverbeke, J. *et al.*, 2001. Nematoda - free living. p. 161-174. In: *European register of marine species: a check-list of the marine species in Europe and a bibliography of guides to their identification*. Costello, M.J., Emblow, C., White, R.J. (Eds). Collection Patrimoines Naturels, Paris.
- Gambi, C., Pusceddu, A., Benedetti-Cecchi, L., Danovaro, R., 2014. Species richness, species turnover and functional diversity in nematodes of the deep Mediterranean Sea: searching for drivers at different spatial scales. *Global Ecology and Biogeography*, 23 (1), 24-39.

- Gerlach, S.A., 1951. Nematoden aus der Familie der Chromadoridae von den deutschen Küsten. *Kieler Meeresforsch.*, 8 (1), 106-132.
- Gerlach, S.A., 1952. Nematoden aus dem Küstengrundwasser. *Abhandlungen der mathematisch-naturwissenschaftlichen Klasse. Verlag der Akademie der Wissenschaften und der Literatur in Mainz*, 6, 315-372.
- Gerlach, S.A., Riemann, F., 1973. The Bremerhaven Checklist of Aquatic Nematodes. *Veröffentlichungen des Instituts für Meeresforschung in Bremerhaven*, 4 (1), 1-404.
- Gheschiere, T., 2000. *Structurele diversiteit van nematodengemeenschappen van de Bligh Bank, Zuidelijke Bocht van de Noordzee*. MSc Thesis. Universiteit Gent, Belgium, 91 pp.
- Giere, O., 2009. Meiobenthology – The Microscopic Motile Fauna of Aquatic Sediments, 2nd edn. Springer, Berlin, Heidelberg, pp 527.
- Harbuzov, Z., Farberova, V., Tom, M., Pallavicini, A., Stanković, D. *et al.*, 2022. Amplicon sequence variant-based meiofaunal community composition revealed by DADA2 tool is compatible with species composition. *Marine Genomics*, 65, 100980.
- Heip, C., Vincx, M., Vranken, G., 1985. The ecology of marine nematodes. *Oceanography and Marine Biology: An Annual Review*, 23, 399-489.
- Hodda, M., 2022. Phylum Nematoda: trends in species descriptions, the documentation of diversity, systematics, and the species concept. *Zootaxa*, 5114, 290-317.
- Jouili, S., Semprucci, F., Nasri, A., Saidi, I., Mahmoudi, E. *et al.*, 2018. Inventory of the free-living marine nematode species from el Bibane Lagoon, Tunisia. *Arxius de Miscellània Zoològica*, 16, 1-19.
- Kanari, M., Tibor, G., Hall, J. K., Ketter, T., Lang, G. *et al.*, 2020. Sediment transport mechanisms revealed by quantitative analyses of seafloor morphology: New evidence from multibeam bathymetry of the Israel exclusive economic zone. *Marine and Petroleum Geology*, 114, 104224.
- Kress, N., Gertman, I., Herut, B., 2014. Temporal evolution of physical and chemical characteristics of the water column in the Easternmost Levantine basin, Eastern Mediterranean Sea from 2002 to 2010. *Journal of Marine Systems*, 135, 6-13.
- Lambshhead, P.J.D., 1993. Recent developments in marine benthic biodiversity research. *Océanis*, 19, 5-24.
- Lambshhead, P.J.D., Boucher, G., 2003. Marine nematode deep-sea biodiversity – hyperdiverse or hype? *Journal of Biogeography*, 30, 475-485.
- Lambshhead, P.J.D., 2004. Marine nematode biodiversity. p. 436-467. In: *Nematology: advances and perspectives. Volume 1: Nematode morphology, physiology, and ecology*. Chen, Z. X., Chen, S. Y., Dickson, D. W. (Eds). Wallingford: CABI Publishing.
- Lampadariou, N., Kalogeropoulou, V., Sevastou, K., Keklikoglou, K., Sarrazin, J., 2013. Influence of chemosynthetic ecosystems on nematode community structure and biomass in the deep eastern Mediterranean Sea. *Biogeosciences*, 10, 5381-5398.
- Lampadariou, N., Sevastou, K., 2022. Deep-sea meiofauna diversity. p. 173-184. In: *Deep-Sea Atlas of the Eastern Mediterranean Sea, IUCN-HCMR DeepEastMed Project*. Otero, M., Mytilineou, C. (Eds). IUCN Gland, Malaga.
- Lubinevsky, H., Hyams-Kaphzan, O., Almogi-Labin, A., Silverman, J., Harlavan, Y. *et al.*, 2017. Deep-sea soft bottom infaunal communities of the Levantine Basin, SE Mediterranean and their shaping factors. *Marine Biology*, 164 (36), 1-12.
- Mahmoudi, E., Essid, N., Beyrem, H., Hedfi, A., Boufahdja, F. *et al.*, 2008. Mussel-farming effects on Mediterranean benthic nematode communities. *Nature Geoscience*, 6, 701-710.
- Miljutin, D.M., Gad, G., Miljutina, M.M., Mokievsky, V.O., Fonseca-Genevois, V. *et al.*, 2010. The state of knowledge on deep-sea nematode taxonomy: how many valid species are known down there? *Marine Biodiversity*, 40, 143-159.
- Moore, C.M., Mills, M.M., Arrigo, K.R., Berman-Frank, I., Bopp, L. *et al.*, 2013. Processes and patterns of oceanic nutrient limitation. *Nature Geoscience*, 6, 701-710.
- Nemys eds., 2023. Nemys: World Database of Nematodes. Accessed at <https://nemys.ugent.be> on 2023-12-24.
- Platt, H.M., Warwick, R.M., 1983. Free-living marine nematodes. Part I. British enoplids. Synopses of the British Fauna (New Series). Vol 28. Cambridge University Press, Cambridge, 307 pp.
- Platt, H.M., Warwick, R.M., 1988. Free-living marine nematodes. Part II. British chromadorids. Synopses of the British Fauna (New Series). Vol 38. Brill, Leiden, 502 pp.
- Schuermans Stekhoven, J.H., Jr. 1943. Freilebende marine Nematoden des Mittelmeeres. IV. Freilebende marine Nematoden der Fischereigründe bei Alexandrien. *Zoologische Jahrbücher (Systematik)*, 76 (4), 323-378.
- Schuermans Stekhoven J.H., Jr. 1950. The free-living marine nemas of the Mediterranean. I. The Bay of Villefranche. *Mémoires Institut Royal des Sciences Naturelles de Belgique*, 2 (37), 1-220.
- Semprucci, F., Sandulli, R., De Zio Grimaldi, S., 2008. Adenophorea nematodi marini. *Biologia Marina Mediterranea*, 15, suppl., 184-209.
- Semprucci, F., Balsamo M., 2012. Key role of free-living nematodes in the marine ecosystem. p. 109-134. In: *Nematodes: morphology, functions and management strategies*. F. Boreri, F., Jordan, A.C. (Eds). Hauppauge, NY: NOVA Science Publishers.
- Semprucci, F., 2013. Marine nematodes from the shallow subtidal coast of the Adriatic Sea: species list and distribution. *International Journal of Biodiversity*, 1-9.
- Sevastou, K., Lampadariou, N., 2021. Benthic meiofauna in the Aegean Sea. In: *The Handbook of Environmental Chemistry*. Springer, Berlin, Heidelberg.
- Siokou-Frangou, I., Christaki, U., Mazzocchi, M.G., Montessor, M., Ribera d'Alcalá, M. *et al.*, 2010. Plankton in the open Mediterranean Sea: a review. *Biogeosciences*, 7 (5), 1543-1586.
- Thiermann, F., Windoffer, R., Giere, O., 1994. Selected meiofauna around shallow water hydrothermal vents off Milos, Greece: ecological and ultrastructural aspects. *Vie Milieu*, 44 (3/4), 215-226.
- Travisi, A., Vidakovic, J., 1997. Nematofauna in the Adriatic Sea: review and check-list of free-living nematode species. *Helgoländer Meeresuntersuchungen*, 51, 503-519.
- Warwick, R.M., Platt, H.M., Somerfield, P.J., 1998. Free-living marine nematodes Part III. Monhysterids. Synopses of

- the British fauna, New Series, 53. ISBN 1-85153-260-9. VII, 296 pp.
- Wieser, W., 1956. Eine Sammlung mariner Nematoden aus Piraeus (Griechenland). *Österreichische Zoologische Zeitschrift*, 6 (3/5), 597-631.
- Yoder, M., Tandingan De Ley, I., Wm King, I., Mundo-Ocampo, M., Mann, J. *et al.*, 2006. DESS: A versatile solution for preserving morphology and extractable DNA of nematodes. *Nematology* 8, 3, 367-376.