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The MANUELA database: an integrated database on meiobenthos from European marine waters

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Abstract

An integrated database on meiofauna was developed with the funding of the European Union Network of Excellence on Marine Biodiversity and Ecosystem Functioning (MarBEF). The general aim of the project was to integrate the available information on the structure, dynamics and functional role of marine meiofauna, and in particular nematodes and harpacticoid copepods, into a single database to perform joint analyses. Data collection started in December 2005 and lasted for fifteen months. 83 datasets have been captured. The collected data ranged from the deep-sea to the coastal zone and from the Arctic to the Antarctic, with a focus on the North-East Atlantic region and the North Sea. Meiofaunal data were available for almost 1300 stations, representing some 140 000 distribution records. After a thorough quality control and standardisation, all the received data were uploaded into a value added database using relational database management technology. The integrated database has built-in functionalities, such as sub-selection of datasets based on spatial and/or temporal boundaries, exclusion of rare taxa and combination of data on user-defined taxonomic levels. The database also allows the calculation of a variety of diversity indices. Finally, data can be exported to a commonly used data format in statistical analysis software. The advantages of an integrated database include standardisation of species lists, data quality control and bringing together large amounts of information varying over space and time. This allows the users to test hypotheses using data that could never have been collected by the individual scientists involved, thereby greatly increasing the strength of the obtained results and interpretation. Crucial to the success of compiling an integrated database is the data sharing attitude of the contributing scientists and a firm, underpinning data policy.

Keywords: meiofauna, Harpacticoida, Nematoda, data management, data rescue

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Introduction

Traditionally, marine researchers collect data in their own field of expertise, often with a confined temporal and spatial range. These data are then normally used in a rather limited context (Floen et al. 1993, Costello & Vanden Berghe 2006). Yearly, large sums of taxpayers' money are spent to finance these collections of scientific data (Zeller et al. 2005). In the old days however – before the computer and internet era – all this collected information was written down in notebooks or on sheets of paper, making it sometimes hard to retrace certain information. Sourcing information was especially hard if the data had not been analysed and published in primary literature and there was a high risk that the underlying data and the sampling design could be lost from scientific memory by disappearing into ever growing paper archives (Zeller et al. 2005). But now, since the advent of wide-spread access to computers and the World Wide Web, finding, exchanging and saving information or data for future use has become a lot easier. However, despite all these (electronic) possibilities to safeguard information, too many good datasets are still being lost. Data are lost either through a lack of adequate management (failing back-ups or no back-ups at all) or the data just 'disappear' at the end of a project, when the people actively involved in the data collection and analysis change jobs and disperse (Vanden Berghe 2006). In this light, the importance of data rescue, archiving and dataset description in a data centre can not be underestimated. Data and the associated metadata are at the foundation of science as they give information answering the five principle questions: what, where, when, who and how (Costello & Vanden Berghe 2006)? There are however more advantages to sound data management. By bringing together several datasets into one integrated database, new analyses on unprecedented spatial and temporal scales can be carried out, thereby yielding new scientific insights. In the absence of large, integrated databases and informatics-supported analyses, the global nature of e.g. profound changes in the ecosystem would not have been recognised (Costello & Vanden Berghe 2006) and large-scale distribution patterns in e.g. meiobenthic communities would still be unknown.

The development of an integrated database on meiofauna was funded within the EU-FP6 Marine Biodiversity and Ecosystem Functioning Network of Excellence (MarBEF). The pan-European MarBEF network – established in 2004 – comprises more than 700 marine scientists from 91 institutes and 24 countries throughout Europe. MarBEF aims to integrate interdisciplinary marine biodiversity research and at disseminating knowledge on marine biodiversity. MANUELA – **M**eiobenthic **a**nd **N**ematode biodiversity: **U**nravelling **E**cological and **L**atitudinal **A**spects – was one of the 18 small research projects that were implemented within MarBEF. MANUELA aimed to: (1) integrate the scattered information on the dynamics and the functional role of meiofauna – with an emphasis on nematodes and copepods – into one single database so that (2) joint analyses could be performed.

The general aim of developing an integrated meiofaunal database was to bring together a large amount of meiofauna-related datasets and to serve as the first large-scale information source on meiofauna and in particular on its nematode and copepod components. Compiling and integrating these datasets has given the scientists involved in the MANUELA project the opportunity to perform novel large-scale analyses of the nematode and copepod communities on a pan-European and even larger scale. The meiobenthos research community has been able to address six major topics: (1) large scale patterns in meiobenthic diversity and community composition, (2) the universal response of meiobenthos to disturbance, (3) patterns in marine nematode morphometry, (4) patterns in deep-sea nematode communities, (5) prediction of nematode biodiversity by using artificial neural networks and (6) large scale patterns in harpacticoid copepod community composition and diversity.

This paper describes the data management aspects such as data capture, data integration, standardisation and quality control, data policy, database architecture and the associated exploration and analysis tools of the project. The results of the joint analyses will be published elsewhere.

Datasets

Data collection for the MANUELA research project covered a period of fifteen months, from December 2005 until February 2007. During this period, twelve European institutes delivered 83 datasets to the MarBEF – MANUELA data management team (table 1). The datasets contained data and information on the spatial distribution of meiofauna acquired from a large number of small- to medium-scale studies. These studies involved a variety of benthic habitats, ranging from shallow waters to the deep-sea, inter- and subtidal estuarine and marine environments, and had a sediment range from pure silts over fine-sandy to gravely bottoms. Although the data covered a very wide geographical range – from the Arctic to the Antarctic – the focus was on European marine and estuarine habitats. As most of the benthic research is currently carried out at a rather small number of institutes, it was relatively easy to collect available meiofaunal datasets containing information on distribution patterns and covering a wide geographical and bathymetrical range.

Within the received datasets, three major types could be distinguished: (1) datasets derived from experimental studies, (2) deep-sea datasets (> 200 m sampling depth) and (3) coastal and estuarine datasets. Eleven datasets resulted from experimental designs, in which all the meiobenthos was collected in the field and then incorporated in laboratory microcosm setups. All experiments were designed to test the effects of physical or biological disturbance or pollution on meiofaunal communities. The field samples were all collected along the English (10 experiments) or Norwegian (1 experiment) coasts. For convenience, these datasets were split up into a field and an experimental sub-dataset, facilitating in- or exclusion of the experimental information in the analyses, depending on the research question. The 16 datasets in the deep-sea category comprised samples collected below 200 meters depth, encompassing both the continental slope and the bathyal/abyssal zones. The deepest sample was collected at 8380 meters. We used this classification, as deep-sea meiobenthologists commonly sample the meiobenthos along both the continental slope and the deep-sea to analyse data along a depth gradient. The majority of the datasets (56) however resulted from sampling campaigns in coastal areas and estuaries, ranging from the intertidal zone to a depth of 200 m.

Metadata

Upon arrival in the data centre, each component dataset was archived and described in detail. Describing these datasets in a standardised way made it possible to create a searchable metadata inventory, thus making it fairly easy to look up certain information and to share it with other people. This metadata – or data about the data – describes all the useful information on the dataset, e.g. where the data came from, how they were collected, who has played a role in the collection and the management of the data, where the data are stored now and in what format and under what conditions they are available. All metadata descriptions of the MANUELA datasets have been made publicly available through the MarBEF website (www.marbef.org/data/dataset.php) in order that: (1) other MANUELA partners can easily keep track of the delivered datasets and define possible gaps in the delivered information and (2) duplication of research by other scientists can be avoided. To keep track of the datasets and to fully document them, we made use of the 'Integrated Marine Information System' (IMIS) (Cattrijsse et al. 2006).

For a comprehensive overview, correct citation and short description of each dataset, we refer to Appendix I.

Data availability

All the information stored in the integrated MANUELA database is subject to the rules of the MANUELA declaration of mutual understanding on data sharing. This policy implies that the participating institutes, organisations and/or the collector of the dataset remain owner of their contributed dataset and that the MarBEF data management team has no such rights. Each data provider could determine the conditions under which his dataset can be used by a third party in the freely available metadata (see earlier). A number of release conditions can apply, such as 'release with permission of the appropriate parties', 'not available until published', 'not freely available', 'no release restrictions' or 'freely available after embargo period'. Co-authorship in all scientific documents in which the (non) MANUELA participants use any of the delivered datasets, is an irrevocable right, as is the correct citation of each used dataset. The full data policy is available on http://www.marbef.org/projects/Manuela/documents/MDMU_final.doc.

Standardisation

The central challenge in integrating different datasets is standardisation. Within the MANUELA database, standardisation efforts focussed on: (1) taxonomical names, (2) geographical names, (3) sampling methodology and (4) abiotic variables. In the first phase, all the taxonomic names were matched against the European Register of Marine Species (ERMS). This is an authoritative list of marine taxa occurring in Europe, including the splash zone above the high tide mark and estuarine waters down to 0.5 salinity (Costello et al. 2001). By matching all the received taxon names to this authoritative list, it was possible to correct spelling mistakes, replace frequently used synonyms and come to a consensus on the use of certain taxonomical names. As the Register is supported by the input of a large number of taxonomic experts, the taxonomic quality is also assured. Secondly, all the used geographical names were standardised as much as possible and together with this, all the coordinates were converted into decimal degrees. In the next phase, the sampling techniques used were also studied and – where possible – a standard nomenclature was used (e.g. 'cores sampled by scuba divers', 'scuba diving, manual corer' and 'diver with core' were all renamed to 'diver taken corer') to make the sampling techniques easily searchable. Finally, the nomenclature of the abiotic variables measured concurrently with the meiobenthos sampling was also standardised, but this was not trivial. Although some abiotic measurements had the same parameter name (e.g. 'sorting coefficient'), the definition or the unit of the parameter could differ slightly (e.g. using the 25 to 75 percent interval or the 16 to 84 percent interval). As a result, such measurements had to remain as two distinct variables, making the abiotic parameter list quite extensive. Wherever possible, the measurements were recalculated to the most commonly accepted unit and definition.

Data archaeology & rescue

The MANUELA data management effort also contributed to meiobenthos data archaeology and rescue, as some of the datasets – mainly from theses or older doctorial studies – only existed in paper format. In total, nine datasets representing 8898 distribution records were converted from paper to a digital format. The digitisation and standardisation of historical datasets was quite time consuming, but ultimately very useful as they vastly extended the time frame for which data were available.

Structure of the database

The software for the integrated MANUELA database was written in MSAccess. The relational database comprises fourteen different tables, all linked together by a number of relationships (figure 1).

The starting point was the *metadata table*, in which the received datasets were described in detail and as accurately as possible. Each dataset was given a name and a unique identification number in combination with a two- or three-letter code. This table also included information on the data providing institute and a contact person. The broader geographical range was defined, followed by details on sampling area and equipment used. When different sampling areas and/ or equipment were employed during a single sampling campaign, this was specified for each sample (see below). Other important metadata included mesh size(s) of used sieves, meiofauna extraction procedures and sub-sampling methods. Checkboxes were provided to indicate what kind of information was available in the dataset, including taxon counts, abiotic measures, biometric data, feeding type information and whether the taxa present were identified only to higher taxon levels (meiobenthos) or contained data at a lower taxonomic level (family, genus, species) for Nematoda or Copepoda (table 1).

Sample information has been stored in three different tables. The *stations table* reports on the exact geographical location of the sample, original station code and name and sampling depth. The *samples table* contains information on the sampling date, the surface area sampled, the sampling equipment per sample and replicates. The *slices table* was specifically designed to capture the upper and lower limits of the sampled sediment column, the eventual slicing details and the densities and counts for each slice on a higher taxon level ('nematodes', 'copepods' and 'rest', i.e. all other meiobenthic groups). If the sample was not divided into slices and/or the exact corer depth of the sample was not known, the lower limit of the slice was set to '99'.

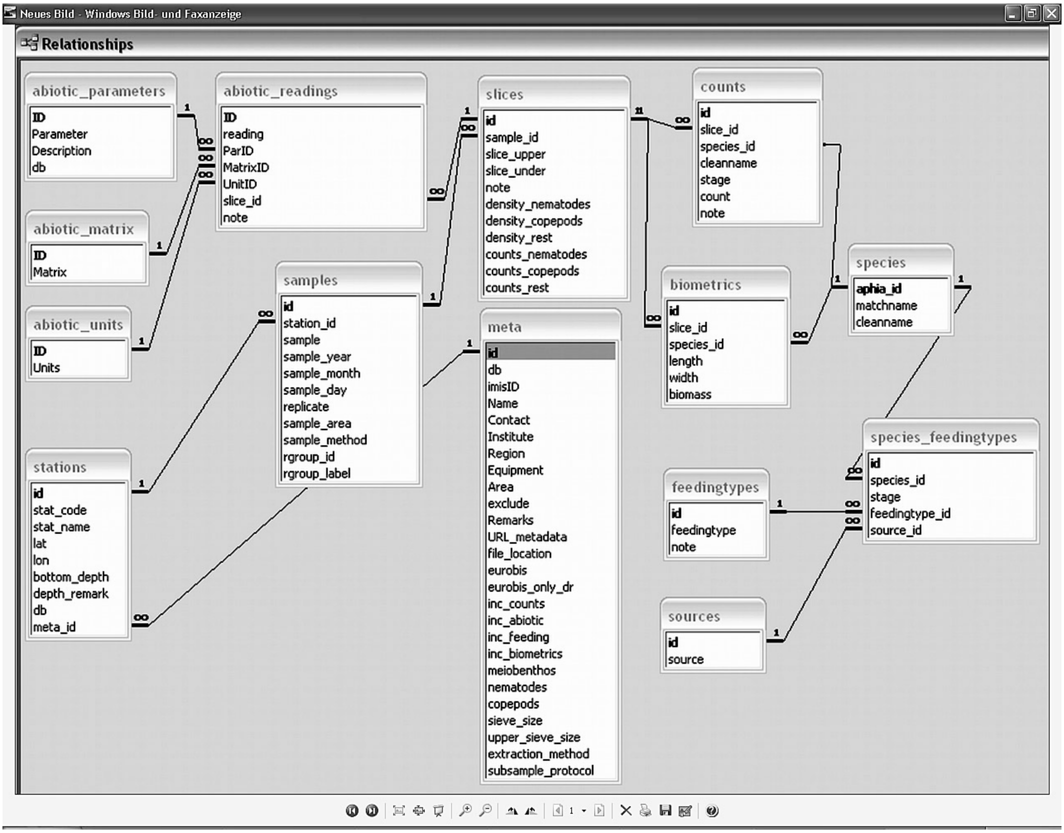

Fig. 1. Relationships within the integrated MANUELA database.

Information on the individual taxa in the dataset has been divided into three major parts: (1) counts of individual taxa per slice *(counts table)*, (2) biometric data per specimen *(biometrics table)* and (3) feeding type information *(feedingtypes table)*. Tables (2) and (3) are taxon-specific for nematodes and copepods.

Abiotic information has been stored in four separate tables: (1) *abiotic parameters* (standard name), (2) *abiotic units* (measuring unit), (3) *abiotic matrix* (water or sediment) and (4) *abiotic readings* (actual measured values). Within these tables, a large amount of valuable information concerning the parameters is stored.

Database tools and utilities

The MANUELA database stores a number of ready-made tools and functions to help the user in analysing the data. These tools and functions were written in Visual Basic for Applications (VBA), as this is the most suitable language for implementation within an MSAccess database. The syntax of VBA is very straightforward and it is in widespread use.

With the *subselection tool* for datasets, it is possible to perform analyses on a subset of data. The tool allows uploading of a selection of the available datasets for further analyses, the exclusion of certain sampling methodologies and definition of temporal and/or spatial boundaries. Rare taxa can be excluded from analyses using two possible cut-off criteria: (1) by setting the proportion of the samples in which the taxon has to be present or (2) by giving the minimum number of individuals that have to be present in a sample to force the species into the dataset. One can also extract information for a certain rank or taxon. Furthermore, the data matrix can be reduced to presence-absence data and/or to adult specimens only. Three different lumping

Table 1. Dataset identification number, dataset code, name, geographical and temporal range, number of sampled stations and distribution records and taxonomical coverage of each delivered dataset, arranged per type. *: incomplete time series on a yearly basis. –: only biometric data available. Meio: datasets dealing with meiofaunal information which is presented on a higher taxonomic level. Cope: datasets containing Harpacticoid copepod information on a detailed taxonomic level (e.g. family, genus, species level). Nema: datasets containing nematode information on a detailed taxonomic level (e.g. family, genus, species level).

IMIS ID	Code	dataset name	Geographical area	temporal range	stations sampled	distribution records	taxonomic coverage
Datasets derived from experimental studies (11)							
713	p1	Experimental effects of TBT on meiobenthic communities	ANE, British Isles, England	1993	3	1739	nema
712	pe	Nematodes from the Exe Estuary: microcosm experiments	ANE, British Isles, England	1992	1	792	nema
711	py	Nematodes from the Lynher Estuary: microcosm experiments	ANE, British Isles, England	1992	1	171	nema
702	ps	Nematodes of Solbergstrand, Norway (in presence and absence of *Brissopsis*)	Arctic, Norway	1995	1	319	nema
698	pr	Offshore nematodes from Rame and in microcosm experiment (exposure to metals)	ANE, British Isles, England	1993	1	1572	nema
1038	c10	Effects of physical disturbance on nematode communities in sand and mud	ANE, British Isles, England	1996	2	1196	nema
861	c6	Effects of various types of disturbances on nematode communities	ANE, British Isles, England	1995-1997	2	2946	nema
863	c7	Effects of simulated deposition of dredged material on the structure of nematode assemblages: the role of burial	ANE, British Isles, England	1998	1	1850	nema
864	c8	Effects of simulated deposition of dredged material on the structure of nematode assemblages: the role of contamination	ANE, British Isles, England	1999	1	1966	nema
865	c9	Effects of paint-derived TBT on the structure of estuarine nematode assemblages in experimental microcosms	ANE, British Isles, England	2001	1	1985	nema
706	py	Nematodes from the Lynher Estuary: microcosm experiments	ANE, British Isles, England	1992	1	171	nema
Deep-sea datasets (>200 m sampling depth) (16)							
883	ms	Meiofauna and nematodes from the Atacama slope and trench	South Pacific, Atacama	1997	4	425	meio +nema
759	Ha	Aegean Sea bathyal nematodes	MED, Aegean Sea	1997	8	1017	nema
982	da	ANDEEP-1: Antarctic deep-sea meiofauna	Antarctica	2002	16	1542	meio
841	sc	Length and width measurements of nematodes in the Ligurian Sea	MED, Ligurian Sea	1985	6	2290	nema
842	in	Length and width measurements of nematodes in the Indian Ocean	Indian Ocean	1992	4	493	nema
665	nd	Deep-sea meiobenthos	Global	1966-1991*	477	1583	nema
668	na	Size of Atlantic nematodes	ANE, Goban Spur	1993	18	1020	nema
1054	u12	Meiofauna from the Goban Spur 1993 – (OMEX)	ANE, Goban Spur	1993	7	1082	meio +nema
704	pk	Nematodes from Kongsfjord, Svalbard	Arctic, Kongsfjorden	1997	5	817	nema
758	us	Meiobenthos of the Darwin Mounds (Northeast Atlantic)	ANE, Darwin Mounds	2000	14	2858	meio +nema
827	ul	Meiobenthos and nematodes from the continental shelf of the Laptev Sea	Arctic, Laptev Sea	1993	5	448	meio +nema

IMIS ID	Code	dataset name	Geographical area	temporal range	stations sampled	distribution records	taxonomic coverage
Deep-sea datasets (>200 m sampling depth) (continued)							
1052	u11	Nematodes from the Goban Spur – 1994 (OMEX)	ANE, Goban Spur	1994	7	–	nema
1000	u9	Nematodes from the Weddell Sea	Antarctica, Weddell Sea	1989	17	960	nema
1002	u10	Nematodes from the South Sandwich Trench	Antarctica, South Sandwich Trench	2002	12	333	nema
866	u7	Nematodes at two abyssal sites in the Northeast Atlantic	ANE	1991-1993	2	318	nema
867	u8	Nematodes of the central Arctic Ocean	Arctic, Central Arctic	1991-1994	17	496	nema
Coastal and estuarine datasets (56)							
869	iz	Meiobenthos and nematodes from the sediment of *Zostera noltii* seagrass	ANE, Portugal, Mira estuary	1994-1995	1	1863	meio + nema
843	ug	Nematode fauna of the North Sea near the Westerschelde estuary	North Sea	1976	11	702	nema
1059	u13	Copepods from the Middelkerkebank (North Sea)	North Sea, Belgium	1997	7	248	cope
1061	u14	Bentho-pelagic coupling in the North Sea – Copepoda	North Sea, Belgium	1999	2	762	cope
683	mn	Data base Bougainville	Global	1979-2004	85	6659	nema
844	uz	Evaluation of the meiofauna and nematode community at a TiO_2 dumping site after recovery	North Sea, Southern Bight	1992	4	638	meio + nema
934	Id	Nematode data from the Gulf of Gdansk	Baltic, Gulf of Gdansk	2003-2004	15	2130	nema
886	nh	Nematodes from Humber estuary	ANE, British Isles, England	1995	5	535	nema
829	uo	Nematode length/width Trophos	North Sea, Belgium	2003	2	60	nema
675	ml	Meiofauna of the Ligurian Sea	MED, Ligurian Sea, Prelo Bay	1991-1992	1	447	meio + nema
676	ma	Meiofauna of the North Adriatic Sea	MED, Adriatic Sea	1996-1997	24	325	meio
694	ut	Nematode assemblages from a Belgian sandy beach	North Sea, Belgium	2000	1	641	nema
807	up	Nematodes from Italy and Poland	MED, Italy; Baltic, Poland	2000	4	612	nema
849	ub	Nematodes from the North Sea Benthos Survey	North Sea	1986	31	1057	nema
1120	u18	Copepods from the Southern Bight of the North Sea	North Sea, Southern Bight	1978-1984	19	993	cope
845	uc	The meiobenthos of the Southern Bight of the North Sea	North Sea, Southern Bight	1985-1986	6	1300	meio + nema + cope
1119	u17	Copepoda from the Dutch Continental Shelf, spring 1993	North Sea, Netherlands	1993	23	1522	cope
1121	u19	Copepods from a sublittoral sandy station in the North Sea	North Sea, Belgium	1983-1984	1	438	cope
846	ue	Nematode fauna from the bottom of the Southern North Sea	North Sea, Southern Bight	1973	2	853	nema
671	uj	Free-living nematodes in a brackish tidal flat of the Westerschelde	North Sea, Westerschelde	1982-1992	2	3049	nema
839	Im	Meiobenthic data Manuela	Baltic, Poland	1997-1998	4	742	meio

IMIS ID	Code	dataset name	Geographical area	temporal range	stations sampled	distribution records	taxonomic coverage
Coastal and estuarine datasets (continued)							
691	pc	Nematode data from the Firth of Clyde (Scotland)	ANE, British Isles, Scotland	1981	13	442	nema
884	Hm	Malia Nematodes	MED, Aegean Sea, Mali Bay	1992	11	488	nema
885	Hs	Nematodes from Crete sandy beaches	MED, Greece, Crete	1992	9	793	nema
672	Hc	Heraklion Harbour meiobenthos	MED, Greece, Crete	1993	17	1012	nema + cope
1039	Ht	Thermaikos Gulf: impact of trawling and resuspension of meiobenthos	MED, Aegean Sea, Greece	2001	6	292	meio
980	ds	Arctic meiofauna succession	Arctic	2003-2005	1	159	meio
1076	u16	Nematodes from the Porcupine Seabight	ANE, Porcupine Seabight	2000-2001	6	4780	nema
1064	u15	Nematodes from Kenya and Zanzibar	Indian Ocean, Kenya & Zanzibar	2002	12	7484	nema
859	dh	Major meiofauna taxa and Harpacticoida from Hooksiel	North Sea, Germany	2004	1	1266	meio + cope
658	c1	Structure of sublittoral nematode assemblages around the UK coast	ANE, British Isles, England	1997-1999	12	2222	nema + cope
659	c2	Structure of sublittoral nematode assemblages at four offshore stations around the UK	ANE, British Isles, England	1998-1999	4	1331	nema
661	c4	Impacts of chronic trawling disturbance on nematode communities	ANE, British Isles, England	2000-2001	9	3383	nema
660	c3	Impacts of experimental trawling disturbance on nematode communities	ANE, British Isles, England	1999-2000	4	3041	nema
662	c5	Structure of nematode communities in the south western North Sea	ANE, British Isles, England	2000-2001	19	2769	nema
848	uy	A study of the nematode fauna of three estuaries in the Netherlands	North Sea, Netherlands	1975-1980	5	957	nema
667	ne	European estuarine nematodes	ANE, West-European estuaries	1990-1992*	51	2667	meio + nema
707	nc	Meiofauna from the Firth of Clyde (Scotland)	ANE, British Isles, Scotland	1978	6	1299	nema
703	pl	Liverpool Bay meiofauna	ANE, British Isles, England	1991	7	2041	nema + cope
705	pa	Nematoda and Copepoda from the Fal estuary	ANE, British Isles, England	1991-1992	5	1617	nema + cope
699	pp	Nematodes of the Plymouth Sound	ANE, British Isles, England	1994	2	1433	nema
670	u3	Meiobenthos at the stations 115, 702, 790 on the Belgian Continental Shelf	North Sea, Belgium	1993-1994	3	4277	meio + nema
749	u2	Spatial heterogeneity of nematodes on an intertidal flat in the Westerschelde Estuary	North Sea, Westerschelde	1996	3	1540	nema
670	u1	Tidal migration of nematodes on an estuarine tidal flat	North Sea, Westerschelde	1997	1	1102	nema
54	u4	Meiobenthos at station 115bis – bentho-pelagic coupling	North Sea, Belgium	1999	1	4016	meio + nema
693	Ik	Meiofauna from Kongsfjord (Spitsbergen Arctic)	Arctic, Spitsbergen	2001	4	450	meio + nema
695	Ib	Meiofauna of the Southern Baltic	Baltic, Southern Baltic	2003-2004	1	447	meio + nema

IMIS ID	Code	dataset name	Geographical area	temporal range	stations sampled	distribution records	taxonomic coverage
Coastal and estuarine datasets (continued)							
830	u5	Length and width measurements of nematodes from coastal stations on the Belgian Continental Shelf	North Sea, Belgium	1993-1994	2	–	nema
832	u6	Length, width and biomass measurements of nematodes from sandbanks on the Belgian Continental Shelf	North Sea, Belgium	1997-1998	26	–	nema
209	un	Nematodes from station 330: structural and functional biodiversity on the Belgian Continental Shelf	North Sea, Belgium	1999	1	2848	nema
762	uk	Meiobenthos of subtidal sandbanks on the Belgian Continental Shelf	North Sea, Belgium	1997-2004	78	8845	meio + nema
847	ur	Study of the meiobenthos from a dumping site in the Southern Bight of the North Sea	North Sea, Southern Bight	1985	8	1495	meio + nema
664	ua	Free-living nematodes of the Voordelta	North Sea, Voordelta	1984-1985	20	2611	nema
663	um	Free-living marine nematodes from the Southern Bight of the North Sea	North Sea, Southern Bight	1971-1985	92	7521	nema
977	dw	Western Baltic Sea Copepods	Baltic, Western Baltic	2002	5	83	cope
744	mt	Meiofauna of the Gulf of Trieste (NIB-MBS database on meiofauna version 1.2)	MED, Adriatic, Gulf of Trieste	1978-2006	101	8094	meio + cope

strategies can be applied: lumping on species, genus or family level. Lumping on species level gives the highest taxonomic precision, but a lot of records are lost as taxa not identified to species level are omitted from the analysis. Lumping on genus or family level on the other hand, gives less taxonomic precision but the accuracy of the analysis is higher and more taxa can be included into the analysis, e.g. genera or family *indet*. Another built-in tool allows the user to pool information. Pooling is possible on the 'stage', 'slice' and 'replicate' levels, implying that respectively the developmental stage, the slicing of the cores and the replicate information is ignored in the analyses.

Once the desired data matrix has been composed, the density values for the 'nematodes', 'copepods' and 'rest' (i.e. all other meiofauna) can be calculated per slice, per replicate and per sample. Based on these values, a number of diversity indices frequently used in marine benthic ecology studies can be calculated: Shannon's diversity index (H', Shannon & Weaver 1949), Simpson's diversity index (D, Simpson 1949), Hill's numbers (N_1, N_2 and N_∞; Hill 1973) and Hurlbert's diversity index for 50 individuals (ES50, Hurlbert 1971).

Based on the taxonomic tree of ERMS, the MANUELA database allows for the calculation of indices describing taxonomic diversity and distinctness: Δ, Δ^*, Δ^+ and Λ^+ (Clarke & Warwick 1998, 1999, 2001).

Following selection and calculation, the data matrix can be exported to formats commonly used in multivariate statistical analysis software. Possible export formats are a condensed format (for import in e.g. TWINSPAN and CANOCO), an ASCI-II tab-delimited list (e.g. PCOrd) or table (e.g. Primer). The taxonomic hierarchy can also be exported and can then be used as an aggregation file in Primer.

Content of the database

All data in the integrated MANUELA database were collected between 1966 and 2006. Data collection took place across a wide variety of research projects and monitoring activities. For a comprehensive overview and a short description of each dataset, we refer to Appendix I. In total, data from 1283 unique stations on a global geographical scale was captured (figure 2). For

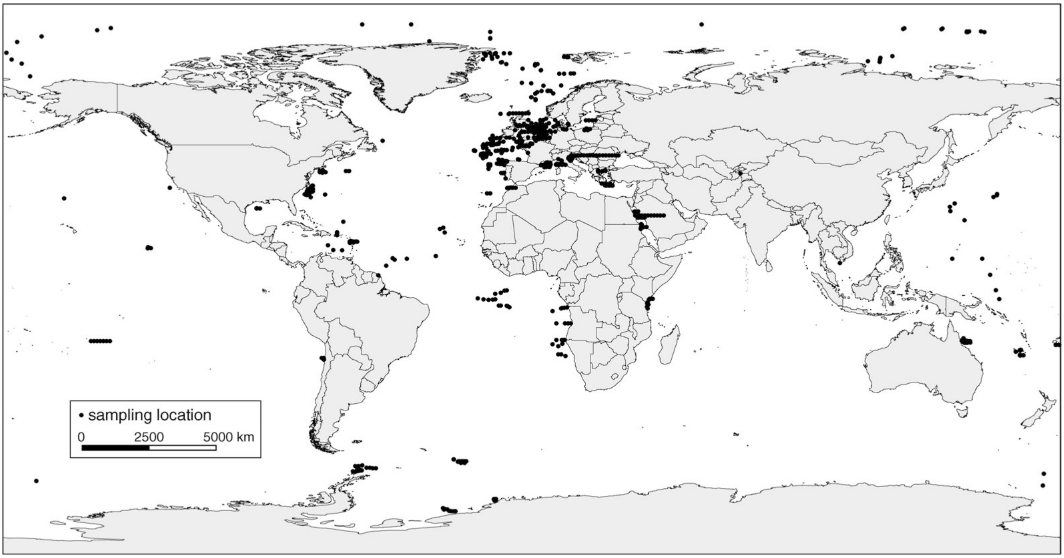

Fig. 2. Meiofauna sampling locations available in the MANUELA integrated database. Approximately 1300 stations and almost 140 000 distribution records were stored in the database on 27/03/2007.

82 % of the stations the exact coordinates were known, for the remainder only information on the broader geographical area could be recovered. A total of 5638 samples were included in the database, representing 139 426 distribution records. Almost 20 % of the samples were collected with Reineck box corers, sub-sampled using small corers. Sampling by divers using a hand corer (12 % of the samples) was the second most important sampling technique. Other sampling devices were box corers, day grabs and Smith-McIntyre grabs. Information on sampling depth was available for 1222 stations, representing some 125 130 distribution records. Sampling depth varied between –0.8 metres (samples collected above the low water mark) and 8380 metres.

Table 2. Number of datasets, number of sampled stations and number of distribution records in relation to the larger defined geographical areas. * Global indicates that these datasets contain information on several regions and can thus not be classified in one of the other regions. ANE: North-East Atlantic; MED: Mediterranean Sea.

	datasets	stations sampled	distribution records
ANE	29	215	50 755
North Sea	26	343	47 731
MED	10	187	15 370
Arctic	6	33	2689
Baltic	4	25	3402
Antarctic	3	45	2835
Indian Ocean	2	16	7977
Global *	2	562	8242
South Pacific	1	4	425
Total	83	1430	139 426

The North-East Atlantic region, the North Sea and the Mediterranean were best represented, with respectively 50 755, 47 731 and 15 370 distribution records. Table 2 shows that there were large geographical differences in sampling effort between the explored regions, clearly expressed in the number of datasets compiled from each area.

A total of 1864 unique taxon names were made available in the integrated database, ranging from phylum to subspecies level. Only five of the collected datasets dealt exclusively with copepod information, whereas 51 only dealt with nematodes. Another five datasets only contained meiofaunal information on a higher taxonomic level and the remaining 21 contained mixed data (table 1). As this project primarily targeted nematodes and copepods, these taxa were strongly represented: 954 unique nematode and 269 unique copepod species names. For 29 % of the nematode species, the feeding type was defined in the database. The feeding type assigned to the nematode species was primarily based on the work by Wieser (Wieser

1953) but was fine-tuned where necessary, based on a wide variety of literature sources (pers. comm. Tom Moens).

12 of the 83 datasets also contained biometric information. A total of 38 361 length/width measurements and 12 214 biomass measurements of nematodes were included in the database.

Besides biological data, 44 datasets also contained abiotic information. In total, 21 325 abiotic readings were available from a wide variety of parameters from both the water column and the sediment. Most abiotic measurements were related to grain size analyses (6661), followed by nutrient analyses (2635). Surprisingly, only 202 temperature measurements were available.

Contributions to other initiatives

The MANUELA project has contributed significantly to two other international marine biodiversity initiatives. From the 954 nematode species names documented in the MANUELA database, 333 names were new to the European Register of Marine Species (ERMS). All names were added to the Register in August 2006, after their validity and correctness had been checked by a taxonomic expert. Additionally, the distribution information of meiofaunal taxa from 72 datasets was transferred to the European node of the Ocean Biogeographic Information System (EurOBIS) of the Census of Marine Life. (Eur)OBIS is a distributed system that allows simultaneous searching of multiple datasets for biogeographic information on marine organisms and this through an online, dynamic and global atlas (Grassle 2000; Costello et al. 2005). EurOBIS has been developed within the MarBEF network; the contribution of MANUELA represents some 100 000 distribution records to date.

Perspectives for future developments

Compiling an integrated database is a very useful, but time-consuming and difficult task. The exercise succeeds or fails according to the willingness of participating scientists to share data. Many scientists are still reluctant to share their data, but there are a number of possible ways to convince data custodians to contribute their data to integrated databases. The benefits of sharing data among scientists can be increased in several ways, for example by offering co-authorship to data providers when their data are used in publications resulting from an integrated analysis, and by explicitly citing the used datasets. The principles of data sharing and data use can be written down in a data policy document, which is at the basis of the trust relationship among scientists and data managers. This policy has to be approved by all participants. The MANUELA project has followed this strategy, thus making data sharing advantageous for every data contributor. An alternative to this approach could be to work with legal obligations, which are written down in contracts. This approach involves working with sponsors of scientific research, to make sure appropriate clauses are included in the contracts.

One cannot underestimate the importance of digitally recovering old, paper-based data. There is a common misconception that such an exercise might be too expensive an investment, but a cost comparison described by Zeller et al. (2005) has indicated that the price of recovering paper-based, archived data and creating electronic databases thereof is only 0.2 to 0.5 % of the original survey costs. Another important factor to consider is the uniqueness of the data. Even if a survey would be repeated today, it remains impossible to replicate the original conditions from e.g. 1970. This emphasizes the need for safeguarding historical data and underlines their importance for long-term studies.

Creating an integrated database such as the MANUELA database has offered a number of advantages. First of all, the available data were both quality controlled and standardised to European or international standards. Secondly, by clustering several datasets which vary over space and time, it became possible to compare between different periods, locations and/or habitats researchers can not sample themselves. Including or excluding certain datasets or sampling techniques gave the opportunity to create unique sub-datasets from the integrated database which directly meet the needs of the scientists to answer research questions or test hypotheses. Finally, the ready-made integrated database was easy to work with as all the work of integration and standardisation had already been done by data managers. Scientists thus did not have to expend any time on technicalities, but they could start analysing the data right away.

The MANUELA project is a clear-cut example of scientists realising the need to collaborate and exchange data to come to a more global vision – both in space and time – on a certain matter, in this case meiobenthology.

Recently, all the MANUELA collaborators have decided to begin a second phase of the project. This involves the continuation of capturing, standardising and integrating datasets. The MANUELA database is undoubtedly the largest integrated database on meiobenthos ever developed. It is hoped that this initiative will attract other scientists and data in the future.

At the time of finalising this manuscript (June 2008), two additional datasets representing 7024 distribution records have been submitted for processing and integration into the MANUELA database.

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Vanreusel, A. (1989). Ecologie van de vrijlevende mariene nematoden van de Voordelta (zuidelijke bocht van de Noordzee). PhD Thesis. Universiteit Gent: Gent, Belgium. 436 pp.
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Appendix I
Reference and short description of the delivered datasets

The citation of each dataset includes the dataset author(s), last year of sampling as the publication year, the institute responsible for the collection of the data and a link to the metadata description available in the metadata-database of MarBEF. Each dataset reference is also accompanied by a short description of the objective of the original data and the references of publications coming forth from this dataset. Datasets were divided according to the three major groups discussed in the article. Within each group, an alphabetical order was maintained.

Datasets dealing with laboratory experiments

Austen, M. & McEvoy, A. (1993). Experimental effects of TBT on meiobenthic communities. Plymouth Marine Laboratory (PML), UK.

http://www.marbef.org/modules.php?name=People&lvl=Das&dasid=713

This dataset arose from probably the first study on the effects of TBT on meiobenthic communities. Austen & McEvoy (1997a) have conducted microcosm experiments where meiobenthos was concentrated in TBT contaminated and uncontaminated sediments.

Austen, M. & McEvoy, A. (1993). Nematodes from the Exe estuary (UK): microcosm experiments. Plymouth Marine Laboratory (PML), UK.

http://www.marbef.org/modules.php?name=People&lvl=Das&dasid=712

Austen, M. & McEvoy, A. (1993). Nematodes from the Lynher estuary (UK): microcosm experiments. Plymouth Marine Laboratory (PML), UK.

http://www.marbef.org/modules.php?name=People&lvl=Das&dasid=711

Both datasets were the result of a laboratory experiment to determine the response of benthic nematode communities to different pollutants in various doses and in two sediment types. The Lynher estuary is characterised by muddy sediments, whereas the Exe estuary is sandy (Austen et al. 1994).

Austen, M. (1995). Nematodes of Solbergstrand, Norway (in presence and absence of *Brissopsis*). Plymouth Marine Laboratory (PML), UK.

http://www.marbef.org/modules.php?name=People&lvl=Das&dasid=702

Austen & Widdicombe (1998) conducted an enclosure experiment in a benthic mesocosm, where they aimed to determine the effects of the predatory and disturbance activities of the heart urchin on natural meiobenthic nematode communities.

McEvoy, A. & Austen, M. (1996). Offshore nematodes from Rame (UK) and in microcosm experiment (exposure to metals). Plymouth Marine Laboratory (PML), UK.

http://www.marbef.org/modules.php?name=People&lvl=Das&dasid=698

A microcosm experiment was carried out to determine the effect of four heavy metals on offshore meiobenthic nematode communities (Austen & McEvoy 1997b). Both field and experimental data were available.

Schratzberger, M. (1996). Effects of physical disturbance on nematode communities in sand and mud. Centre for Environment, Fisheries and Aquaculture Science (CEFAS), UK.

http://www.marbef.org/modules.php?name=People&lvl=Das&dasid=1038

Prior to 1996, no microcosm experiments had been undertaken to examine the effects of different frequencies of physical disturbances on meiofaunal communities. This dataset was the first of its kind, making use of simplified ecosystem models or so-called microcosms (Schratzberger & Warwick 1998a).

Schratzberger, M. (1997). Effects of various types of disturbances on nematode communities. Centre for Environment, Fisheries and Aquaculture Science (CEFAS), UK.

http://www.marbef.org/modules.php?name=People&lvl=Das&dasid=861

Data resulted from a series of microcosm experiments designed to examine the differential response of estuarine nematode assemblages from sand and mud habitats to different types of perturbation, including physical disturbance, organic enrichment and bioturbation by *Carcinus maenas* (Schratzberger & Warwick 1998a, b; Schratzberger & Warwick 1999a,b).

Schratzberger, M. (1998). Effects of simulated deposition of dredged material on the structure of nematode assemblages: the role of burial. Centre for Environment, Fisheries and Aquaculture Science (CEFAS), UK.

http://www.marbef.org/modules.php?name=People&lvl=Das&dasid=863

The main objective of this microcosm experiment was to assess the ability of nematodes to vertically migrate into native muddy and non-native sandy sediment deposited in different amounts and frequencies (Schratzberger et al. 2000a).

Schratzberger, M. (1999). Effects of simulated deposition of dredged material on the structure of nematode assemblages: the role of contamination. Centre for Environment, Fisheries and Aquaculture Science (CEFAS), UK.

http://www.marbef.org/modules.php?name=People&lvl=Das&dasid=864

Data were the result of a laboratory experiment, designed to investigate the effects of the degree of contamination and the role of burial associated with the deposition of dredged material on meiobenthic nematodes (Schratzberger et al. 2000b).

Schratzberger, M. (2001). Effects of paint-derived tributyltin (TBT) on the structure of estuarine nematode assemblages in experimental microcosms. Centre for Environment, Fisheries and Aquaculture Science (CEFAS), UK.

http://www.marbef.org/modules.php?name=People&lvl=Das&dasid=865

This experimental laboratory study assessed the effects of different levels of paint-derived TBT, and different modes of exposure, on estuarine nematodes. Fauna was exposed to two types of treatments (mixture and deposit), containing uncontaminated sediment and sediment spiked with paint-derived TBT (Schratzberger et al. 2002a).

Somerfield, P.J. & Austen, M. (1993). Meiofauna from Lynher estuary in microcosms with contaminated sediment from the Fal estuary. Plymouth Marine Laboratory (PML), UK.

http://www.marbef.org/modules.php?name=People&lvl=Das&dasid=706

A laboratory microcosm experiment was conducted to study the relationship between the nematode community structure and contaminated field sediments (Austen & Somerfield 1997).

Deep-sea datasets
(containing samples taken below 200 meters depth)

Danovaro, R. (1997). Meiofauna and nematodes from the Atacama slope and trench. Polytechnic University of Marche; Faculty of Sciences; Department of Marine Sciences, Italy.

http://www.marbef.org/modules.php?name=People&lvl=Das&dasid=883

The meiofaunal abundance, biomass, community structure and nematode diversity were investigated in relation to the spatial distribution of the potential food sources in the Atacama trench and open slope (South Pacific Ocean) (Danovaro et al. 2002; Gambi et al. 2003).

Lampadariou, N. (1998). Aegean Sea bathyal nematodes. Hellenic Centre for Marine Research (HCMR), Greece.

http://www.marbef.org/modules.php?name=People&lvl=Das&dasid=759

Data were collected within the Mass Transfer and Ecosystem Response (MTP-II-MATER) project, as part of an extensive study of the benthic communities in the Aegean Sea. These data were used to evaluate meiofauna parameters and link them to processes taking place in the water column and the water/sediment interface (Lampadariou & Tselepides 2006).

Martínez Arbizu, P. & Veit-Köhler, G. (2002). ANDEEP-1: Antarctic deep-sea meiofauna. Forschungsinstitut Senckenberg; Deutsches Zentrum fur Marine Biodiversitätsforschung (DZMB), Germany.

http://www.marbef.org/modules.php?name=People&lvl=Das&dasid=982

These data gave – for the first time – an overview of the meiofauna that inhabits the slope and the abyssal plains in Antarctic waters to a depth of 5200 m (Gutzmann et al. 2004).

Soetaert, K. (1985). Length and width measurements of nematodes in the Ligurian Sea. Netherlands Institute of Ecology, Centre for Estuarine and Marine Ecology (NIOO-CEME), the Netherlands.

http://www.marbef.org/modules.php?name=People&lvl=Das&dasid=841

The size distribution of nematodes was investigated for samples collected from six stations along a transect in the Mediterranean Sea (Corsica) (Soetaert & Heip 1989).

Soetaert, K. (1992). Length and width measurements of nematodes in the Indian Ocean. Netherlands Institute of Ecology, Centre for Estuarine and Marine Ecology (NIOO-CEME), the Netherlands.

http://www.marbef.org/modules.php?name=People&lvl=Das&dasid=842

These data were collected in order to investigate the effect of oxygen, granulometry and food availability on the nematode density and community structure along four parallel bathymetric transects off the Kenyan coast (Muthumbi et al. 2004).

Soetaert, K. (1993). Deep-sea meiobenthos. Netherlands Institute of Ecology, Centre for Estuarine and Marine Ecology (NIOO-CEME), the Netherlands.

http://www.marbef.org/modules.php?name=People&lvl=Das&dasid=665

This dataset is a collection of several sampling campaigns examining meiobenthos at different locations and times. All data were gathered between 1966 and 1993, in depths ranging between 30 and 8 380 meters. Meiobenthic information is available for the Arctic, the Atlantic, the Pacific, the Mediterranean and the Red Sea (e.g. Tietjen 1971, Dinet & Vivier 1979, Thiel 1979, Pfannkuche 1985, Sibuet et al. 1989, Jensen et al. 1992, Vanreusel et al. 1992).

Soetaert, K. (1993). Size of Atlantic nematodes. Netherlands Institute of Ecology; Centre for Estuarine and Marine Ecology (NIOO-CEME), the Netherlands.

http://www.marbef.org/modules.php?name=People&lvl=Das&dasid=668

Vanaverbeke, J. (1993). Meiofauna from the Goban Spur (OMEX) – 1993. Ghent University, Department of Biology, Marine Biology Section (MARBIOL), Belgium.

http://www.marbef.org/modules.php?name=People&lvl=Das&dasid=1054

As part of the OMEX-programme (Ocean Margin Exchange, CEC-MAST II), data were collected on the metazoan meiobenthos along the continental slope of the Goban Spur. These data filled the gap in knowledge about the meiobenthic communities along the continental slope systems in the Northeast Atlantic (Vanaverbeke et al. 1997a).

Somerfield, P. J (1997). Nematodes from Kongsfjord, Svalbard. Plymouth Marine Laboratory (PML), UK.

http://www.marbef.org/modules.php?name=People&lvl=Das&dasid=704

These data were compiled in order to investigate the spatial patterns in nematode communities collected with box-corers and van Veen grabs at five different locations in a high-latitude glacial fjord (Somerfield et al. 2006).

Van Gaever, S. (2000). Meiobenthos of the Darwin mounds (North-East Atlantic). Ghent University, Department of Biology, Marine Biology Section (MARBIOL), Belgium.

http://www.marbef.org/modules.php?name=People&lvl=Das&dasid=758

The Darwin mounds area was sampled to investigate the importance of local-scale topographic features and small-scale biogenic structures in influencing the density and diversity of the associated meiobenthic communities and nematodes in particular (Van Gaever et al. 2004).

Vanaverbeke, J. (1993). Meiobenthos and nematodes from the continental shelf of the Laptev Sea. Ghent University, Department of Biology, Marine Biology Section (MARBIOL), Belgium.

http://www.marbef.org/modules.php?name=People&lvl=Das&dasid=827

Meiobenthic communities along a depth gradient in the Laptev Sea were sampled in order to identify densities and community compositions. Special attention was paid to the present nematode communities (Vanaverbeke et al. 1997b).

Vanaverbeke, J. (1994). Nematodes from the Goban Spur (OMEX) - 1994. Ghent University, Department of Biology, Marine Biology Section (MARBIOL), Belgium.

http://www.marbef.org/modules.php?name=People&lvl=Das&dasid=1052

Data were collected as part of the Ocean Margin Exchange (OMEX) project of the EU. The general aim was to compare the densities, biomass and mean individual weight from meiofauna and macrofauna along the continental slope of the Goban Spur (Flach et al. 1999). Only nematode information was retained for the MANUELA database.

Vanhove, S. (1989). Nematodes from the Weddell Sea. Ghent University, Department of Biology, Marine Biology Section (MARBIOL), Belgium.

http://www.marbef.org/modules.php?name=People&lvl=Das&dasid=1000

Focussing on nematode genera, this study provided geographically extensive nematode information from one of the largest shelf areas around the Antarctic continent (Vanhove et al. 1999).

Vanhove, S. (2002). Nematodes from the South Sandwich Trench. Ghent University, Department of Biology, Marine Biology Section (MARBIOL), Belgium.

http://www.marbef.org/modules.php?name=People&lvl=Das&dasid=1002

Data were collected to investigate if the nematode fauna varied with bathymetry and if nematodes from the South Sandwich Trench differed from other trenches and from other deep-water areas elsewhere in Antarctica (Vanhove et al. 2004).

Vanreusel, A. (1993). Nematodes at two abyssal sites in the Northeast Atlantic. Ghent University, Department of Biology, Marine Biology Section (MARBIOL), Belgium.

http://www.marbef.org/modules.php?name=People&lvl=Das&dasid=866

Data were collected as part of the international project "Community structure and processes in the deep-sea benthos" (EU MAST II). Meiobenthic sampling was carried out on the Porcupine abyssal Plain and the Cape Verde Abyssal Plain, with the focus on nematodes. (unpublished data; description of the metadata: Vanreusel et al. 1995).

Vanreusel, A. (1994). Nematodes of the central Arctic Ocean. Ghent University, Department of Biology, Marine Biology Section (MARBIOL), Belgium.

http://www.marbef.org/modules.php?name=People&lvl=Das&dasid=867

The abundance, biomass and community structure of nematodes along two transpolar transects in the central Artic Ocean was documented (Vanreusel et al. 2000).

Coastal and estuarine datasets

Adão, H. (1995). Meiobenthos and nematodes from the sediment of *Zostera noltii* seagrass. University of Coimbra, Institute of Marine Research (IMAR), Portugal.

http://www.marbef.org/modules.php?name=People&lvl=Das&dasid=869

This study investigated the seasonal changes of meiofauna taxa and free-living marine nematode communities (densities, genus composition, trophic groups, and population structure) associated with sediments of *Zostera noltii* seagrass beds in the Mira estuary (Southwest Coast of Portugal) based on high temporal resolution (biweekly samples during fourteen months) (Adão 2004).

Bisschop, G. & Vincx, M. (1976). Nematode fauna of the North Sea near the Westerschelde Estuary. Ghent University, Department of Biology, Marine Biology Section (MARBIOL), Belgium.

http://www.marbef.org/modules.php?name=People&lvl=Das&dasid=843

Data were collected as part of a thesis study. The general aim was to give a detailed inventory of the nematode communities present in the Westerschelde area, based on biomass, diversity and physico-chemical characteristics of the sediment (Bisschop 1977).

Bonne, W. (1997). Copepods from the Middelkerkebank (North Sea). Ghent University, Department of Biology, Marine Biology Section (MARBIOL), Belgium.

http://www.marbef.org/modules.php?name=People&lvl=Das&dasid=1059

Bonne, W. (1999). Bentho-pelagic coupling in the North Sea – Copepoda. Ghent University, Department of Biology, Marine Biology Section (MARBIOL), Belgium.

http://www.marbef.org/modules.php?name=People&lvl=Das&dasid=1061

Both datasets were compiled in the course of a PhD programme. The first study focused on the copepod density, diversity and community structure in relation to sediment characteristics and depth for one sandbank, whereas the second study concentrated on the temporal fluctuations in the vertical distribution of harpacticoid copepods in the sediment and if this response was different for epi- and endobenthic interstitial copepod species (Bonne 2003).

Boucher, G. & Rzeznik-Orignac, J. (2003). Data base Bougainville. Muséum national d'Histoire Naturelle Paris (MNHN), France.

http://www.marbef.org/modules.php?name=People&lvl=Das&dasid=683

This dataset is a compilation of free-living nematode inventories in both intertidal and sublittoral sediments of temperate and tropical ecosystems (Boucher 1980a,b, Boucher 1981, Boucher 1983, Boucher 1985, Boucher 1990, Boucher & Clavier 1990, Boucher & Gourbault 1990, Boucher & Lambshead 1995, Boucher & Kotta 1996, Boucher 1997, Kotta & Boucher 2001, Lambshead & Boucher 2003, Rzeznik-Orignac et al. 2003, Rzeznik-Orignac et al. 2004, Guo et al. submitted).

Derong, Z. & Smol, N. (1992). Evaluation of the meiofauna and nematode community at a TiO_2 dumping site after recovery. Ghent University, Department of Biology, Marine Biology Section (MARBIOL), Belgium.

http://www.marbef.org/modules.php?name=People&lvl=Das&dasid=844

Until 1992, no research had been done on the evaluation of the meiofaunal community of the TiO_2-dumping site off the Dutch coast after recovery. These data were collected to investigate a possible recovery of the meiofauna in general and nematodes in particular in this restricted area (Derong 1995).

Drgas, A. (2004). Nematode data from the Gulf of Gdansk. Sea Fisheries Institute, Department of Fisheries Oceanography and Marine Ecology, Poland.

http://www.marbef.org/modules.php?name=People&lvl=Das&dasid=934

The data were collected as part of the EU project "Costing the impact of demersal fishing on marine ecosystem processes and biodiversity (COST-IMPACT)". The main aim of this study was to asses how demersal fishing impacted the biodiversity of marine benthos (Drgas, unpublished).

Ferrero, T. (1995). Nematodes from Humber estuary. Natural History Museum, Department of Zoology (NHM), UK.

http://www.marbef.org/modules.php?name=People&lvl=Das&dasid=886

Data originated from the LISP-UK (Littoral Investigation of Sediment Properties) study, which was part of the Land Ocean Interaction Study (LOIS) Community Research Programme and aimed primarily at studying sediment transport on mudflats within the Humber estuary. Meiofauna samples were taken on the extreme spring and neap tides and aimed to relate assemblage structure to short term changes in sediment parameters associated with the differences in tidal regime (unpublished).

Franco, M. (2003). Nematode length/width Trophos. Ghent University, Department of Biology, Marine Biology Section (MARBIOL), Belgium.

http://www.marbef.org/modules.php?name=People&lvl=Das&dasid=829

These data were part of a PhD programme, but were in fact originally collected in the course of the Belgian SPSD II – project (Second scientific support plan for a sustainable development policy) "TROPHOS – Higher trophic levels in the Southern North Sea". The lengths and widths were measured for a maximum of 120 nematodes per sample. All samples were collected at two stations on the Belgian Continental Shelf (Franco 2003).

Gambi, C. & Danovaro, R. (1992). Meiofauna of the Ligurian Sea. Polytechnic University of Marche; Faculty of Sciences, Department of Marine Sciences, Italy.

http://www.marbef.org/modules.php?name=People&lvl=Das&dasid=675

The hypothesis that, temporal variation in nematode abundance, community composition and trophic structure is coupled with changes in the quantity and quality of their potential food sources was tested. Different variables were investigated over an annual cycle in a *Posidonia oceanica* seagrass bed (NW Mediterranean Sea) (Danovaro & Gambi 2002).

Gambi, C. & Danovaro, R. (1997). Meiofauna of the North Adriatic Sea. Polytechnic University of Marche, Faculty of Sciences, Department of Marine Sciences, Italy.

http://www.marbef.org/modules.php?name=People&lvl=Das&dasid=676

The direct or indirect influence of a river plume on meiofaunal abundance and community composition was investigated in the North Adriatic Sea (NW Mediterranean Sea). The meiofaunal response to the river plume was investigated in the coastal zone, beneath the river front and in open-sea sediments in summer and winter (Danovaro et al. 2000).

Gheskiere, T. (2000). Nematode assemblages from a Belgian sandy beach. Ghent University, Department of Biology, Marine Biology Section (MARBIOL), Belgium.

http://www.marbef.org/modules.php?name=People&lvl=Das&dasid=694

Data were collected as part of a PhD programme. Gheskiere (2005) aimed – amongst others – at contributing to the rare studies on nematofaunal zonation patterns by collecting samples on a Belgian macrotidal, ultra-dissipative sandy beach.

Gheskiere, T. (2000). Nematodes from Italy and Poland. Ghent University, Department of Biology, Marine Biology Section (MARBIOL), Belgium.

http://www.marbef.org/modules.php?name=People&lvl=Das&dasid=807

The general aim of the study was to describe and investigate the biodiversity and zonation patterns of nematodes in relation to several abiotic factors. This was done for two undisturbed wave-dominated beaches. Secondly, the existence of community convergence was examined between these two beaches (Gheskiere et al. 2005).

Heip, C. (1986). Nematodes from the North Sea Benthos Survey. Netherlands Institute of Ecology, Centre for Estuarine and Marine Ecology (NIOO-CEME), The Netherlands.

http://www.marbef.org/modules.php?name=People&lvl=Das&dasid=849

All nematode data from the North Sea Benthos Survey (NSBS) were compiled in a smaller dataset. The NSBS was carried out in 1986 as an activity of the Benthos Ecology Working Group of ICES. Benthic samples were taken in a standardised way, on a regular grid covering the whole of the North Sea, and analysed by scientists from 10 laboratories. Extensive work was done to standardise taxonomy and identifications across the different laboratories. A total of just over 1000 species were reported from 235 stations. Most research however was focused on macrobenthos, while only limited research was done for meiobenthos (Huys 1991, Craeymeersch et al. 1997).

Herman, R. (1984). Copepods from the Southern Bight of the North Sea. Ghent University, Department of Biology, Marine Biology Section (MARBIOL), Belgium.

http://www.marbef.org/modules.php?name=People&lvl=Das&dasid=1120

Data were collected as part of a PhD programme. The main aim was to describe the meiobenthos communities and their relationship with environmental parameters in the Southern Bight of the North Sea, with an emphasis on copepods (Herman 1989).

Huotong, C. & Vincx, M. (1986). The meiobenthos of the Southern Bight of the North Sea. Ghent University, Department of Biology, Marine Biology Section (MARBIOL), Belgium.

http://www.marbef.org/modules.php?name=People&lvl=Das&dasid=845

This data, collected as part of an MSc thesis, contained information on the meiobenthic communities at six different stations in the Southern Bight of the North Sea, together with information on a number of environmental parameters (Huotong 1987).

Huys, R. & De Smet, G. (1993). Copepoda from the Dutch Continental Shelf, spring 1993. Ghent University, Department of Biology, Marine Biology Section (MARBIOL), Belgium.

http://www.marbef.org/modules.php?name=People&lvl=Das&dasid=1119

Data represented the third springtime sampling campaign of meiofauna on the Dutch Continental Shelf, with special attention for the copepod communities. These data were collected in the course of the Dutch Biological Monitoring Programme (Huys & De Smet 1991).

Huys, R. (1984). Copepods from a sublittoral sandy station in the North Sea. Ghent University, Department of Biology, Marine Biology Section (MARBIOL), Belgium.

http://www.marbef.org/modules.php?name=People&lvl=Das&dasid=1121

During one year, samples were collected from a sublittoral sandy station to investigate the present meiofauna and in particular the copepods. The goal was to study the vertical distribution of the meiofauna in space and time. Meiobenthic communities were analysed both in a qualitative and quantitative manner (Huys 1984). Only the copepod data have been made available to MANUELA.

Jensen, P. & Vincx, M. (1973). Nematode fauna from the bottom of the Southern North Sea. Ghent University, Department of Biology, Marine Biology Section (MARBIOL), Belgium.

http://www.marbef.org/modules.php?name=People&lvl=Das&dasid=846

These data were collected as part of a PhD programme. The main aim of this study was to get a better insight in the nematode fauna living in the Southern North Sea, with an emphasis on morphological, systematic and ecological aspects (Jensen 1974).

Jian, L. (1992). Free-living nematodes in a brackish tidal flat of the Westerschelde. Ghent University, Department of Biology, Marine Biology Section (MARBIOL), Belgium.

http://www.marbef.org/modules.php?name=People&lvl=Das&dasid=671

Data were collected as part of an MSc thesis. The objective was to compare the horizontal distribution of meiofaunal parameters among several scales, by using statistical methods (Jian 1989, Jian & Vincx 1993, Jian et al. 1997).

Kotwicki, L. (1998). Meiobenthic data Manuela. Polish Academy of Sciences, Institute of Oceanology (IOPAS), Poland.

http://www.marbef.org/modules.php?name=People&lvl=Das&dasid=839

The main purpose of this study was to formulate an answer on the following questions: (1) what are the differences between meiofauna assemblages from beaches and the sublittoral zone; (2) is a sandy beach an independently functioning ecosystem and (3) what is the role of meiofauna in an energy flow through a beach ecosystem (Kotwicki 2004). These data were also delivered to a larger study, where the density and diversity of meiofauna along a large latitudinal gradient was compared (Kotwicki et al. 2005).

Lambshead, J. (1978). Nematode data from the Firth of Clyde (Scotland). Natural History Museum (NHM), UK.

http://www.marbef.org/modules.php?name=People&lvl=Das&dasid=691

The general aim of this study was to investigate aspects of the practical potential of nematodes as pollution monitoring organisms. To this end, six stations with different scales of contamination were sampled for nematodes and compared (Lambshead 1986).

Lampadariou, N. (1992). Malia nematodes. Hellenic Centre for Marine Research (HCMR), Greece.

http://www.marbef.org/modules.php?name=People&lvl=Das&dasid=884

The nematode community structure from Malia Bay (north Crete, Aegean Sea) was investigated in order to provide a baseline for the benthic environment prior to the initiation of a domestic sewage outfall into the Bay (Buchholz & Lampadariou 2002).

Lampadariou, N. (1992). Nematodes from Crete sandy beaches. Hellenic Centre for Marine Research (HCMR), Greece.

http://www.marbef.org/modules.php?name=People&lvl=Das&dasid=885

Samples were collected in order to study the nematode communities from the eulittoral zone of a sandy beach on Crete (Greece, eastern Mediterranean) in relation to the physical parameters of the sediment and the degree of exposure to wave action (Lampadariou 1993).

Lampadariou, N. (1993). Heraklion harbour meiobenthos. Hellenic Centre for Marine Research (HCMR), Greece.

http://www.marbef.org/modules.php?name=People&lvl=Das&dasid=672

Samples were collected in Heraklion Harbour to investigate the relationship between the meiofaunal community structure and the anthropogenic disturbance. The data also contributed to the knowledge of nematode and copepod components of the meiobenthic communities in the Eastern Mediterranean Sea (Lampadariou et al. 1997).

Lampadariou, N. (2001). Thermaikos Gulf: impact of trawling and resuspension on meiobenthos. Hellenic Centre for Marine Research (HCMR), Greece.

http://www.marbef.org/modules.php?name=People&lvl=Das&dasid=1039

Data gathering was supported through the INTERPOL project (Impact of Natural and Trawling Events on Resuspension, Dispersion and Fate of Pollutants). The study aimed at describing the meiofauna before and after trawling events from real fishing grounds in the Greek coastal waters (Lampadariou et al. 2005).

Raes, M. (2001). Nematoda from the Porcupine Seabight. Ghent University, Department of Biology, Marine Biology Section (MARBIOL), Belgium.

http://www.marbef.org/modules.php?name=People&lvl=Das&dasid=1076

A first overview of the nematode communities inhabiting cold-water coral degradation zones was presented through these data. The main focus within this research was on the influence of habitat type on the nematode community structure (Raes & Vanreusel 2006).

Raes, M. (2004). Nematoda from Kenya and Zanzibar. Ghent University, Department of Biology, Marine Biology Section (MARBIOL), Belgium.

http://www.marbef.org/modules.php?name=People&lvl=Das&dasid=1064

Coral degradation zones (CDZ) in Kenya and Zanzibar were sampled in order to contribute to the knowledge of the nematode assemblages in these areas of the Indian Ocean. Raes et al. (2007) wanted to investigate – amongst others – if these CDZs harboured a typical nematode community (on genus level).

Rose, A. (2004). Major meiofauna taxa and Harpacticoida species from Hooksiel. Forschungsinstitut Senckenberg; Deutsches Zentrum fur Marine Biodiversitätsforschung (DZMB), Germany.

http://www.marbef.org/modules.php?name=People&lvl=Das&dasid=859

Rose & Seifried (2006) conducted a quantitative small-scale snap-shot investigation on an intertidal sandflat in Jade Bay (North Sea). The goal was to screen most of the Harpacticoida species present in the investigated domain and to assess some aspects of the spatial scale dependence of the harpacticoid diversity.

Schratzberger, M. (1998). Structure of sublittoral meiofauna assemblages around the UK coast. Centre for Environment, Fisheries and Aquaculture Science (CEFAS), UK.

http://www.marbef.org/modules.php?name=People&lvl=Das&dasid=658

Meiobenthos was sampled and environmental variables were measured at a number of stations around the UK coast to improve the understanding of how species assemblages respond to both anthropogenic impacts and natural environmental factors (Schratzberger et al. 2000).

Schratzberger, M. (1999). Structure of sublittoral nematode assemblages at four offshore stations around the UK. Centre for Environment, Fisheries and Aquaculture Science (CEFAS), UK.

http://www.marbef.org/modules.php?name=People&lvl=Das&dasid=659

This dataset represents a subset of data collected from offshore locations around England and Wales under the auspices of the National Marine Monitoring Programme (NMMP). This subset comprises nematode data and a number of environmental variables for four stations (Schratzberger et al. 2004).

Schratzberger, M. (2000). Impacts of chronic trawling disturbance on nematode communities. Centre for Environment, Fisheries and Aquaculture Science (CEFAS), UK.

http://www.marbef.org/modules.php?name=People&lvl=Das&dasid=661

An impact study was conducted on fishing grounds in the Silver Pit (central North Sea). The aim of the data collection was to assess the response of meiofaunal nematode communities to chronic trawling disturbance (Schratzberger & Jennings 2002).

Schratzberger, M. (2000). Impacts of experimental trawling disturbance on nematode communities. Centre for Environment, Fisheries and Aquaculture Science (CEFAS), UK.

http://www.marbef.org/modules.php?name=People&lvl=Das&dasid=660

A BACI experimental approach was used to investigate the short-term effects of beam trawling on the diversity, biomass and community structure of meiofauna on real fishing grounds in the Southern North Sea. Meiofauna species counts from two locations sampled once before and twice post-trawling were analysed (Schratzberger et al. 2002b).

Schratzberger, M. (2000). Structure of nematode communities in the south western North Sea. Centre for Environment, Fisheries and Aquaculture Science (CEFAS), UK.

http://www.marbef.org/modules.php?name=People&lvl=Das&dasid=662

This study aimed at providing information on the species composition and abundance of North Sea meiobenthic nematode assemblages in relation to a suite of environmental variables, biogeographical factors and potential anthropogenic impacts that determine the distribution of community types. Since nematodes had not yet been studied in detail in this region, the data provided novel insights into the relationship between nematode patterns and those of other faunal group in the study area (Schratzberger et al. 2006).

Sharma, J. Vincx, M. (1980). A study of the nematode fauna of three estuaries in the Netherlands. Ghent University, Department of Biology, Marine Biology Section (MARBIOL), Belgium.

http://www.marbef.org/modules.php?name=People&lvl=Das&dasid=848

Free-living nematode fauna of lake Grevelingen, the Eastern and Western Scheldt was examined over a period of one year as part of a PhD programme. Relationships between environmental factors and the structure of the nematode communities were analysed, together with the vertical distribution of nematodes in the sediment (Sharma 1985).

Soetaert, K. (1992). European estuarine nematodes. Netherlands Institute of Ecology, Centre for Estuarine and Marine Ecology (NIOO-CEME), the Netherlands.

http://www.marbef.org/modules.php?name=People&lvl=Das&dasid=667

Data were collected in the course of the Joint European

Estuaries Programme (MAST CEC project, JEEP92) of the EEC, which aimed at understanding major biological processes in the European tidal estuaries. A baseline study was carried out on the meiobenthos of five European estuaries, with a focus on the nematode species composition (Soetaert et al. 1994, Soetaert et al. 1995).

Somerfield, P.J. (1981). Meiofauna from the Firth of Clyde (Scotland). Plymouth Marine Laboratory (PML), UK.

http://www.marbef.org/modules.php?name=People&lvl=Das&dasid=707

The meiofauna of the Firth of Clyde was sampled to examine changes in community structure along a classical gradient of organic enrichment and to compare the responses of the different meiofaunal groups. Additionally, the data were used to investigate the response patterns as revealed by various community measurements (e.g. abundance and diversity) (Moore & Somerfield 1997).

Somerfield, P.J. (1991). Liverpool Bay Nematoda and Copepoda (UK). Plymouth Marine Laboratory (PML), UK.

http://www.marbef.org/modules.php?name=People&lvl=Das&dasid=703

Data were collected to look for changes in meiofauna community structures through a disposal site, to assess the utility of meiofauna samples collected by taking subsamples from grab samples compared to samples collected with a Craib corer and finally to relate the observed changes to the measured environmental variables (Somerfield & Clarke 1995, Somerfield et al. 1995).

Somerfield, P.J. (1992). Nematoda and Copepoda from the Fal estuary (UK). Plymouth Marine Laboratory (PML), UK.

http://www.marbef.org/modules.php?name=People&lvl=Das&dasid=705

The Fal estuary system presented an ideal site for a natural experiment on the effects of long-term contamination by heavy metals on the meiofaunal communities of an intertidal mudflat, and the short-term effects of a spill of minewaters (Somerfield et al. 1994a,b, Somerfield & Clarke 1995).

Somerfield, P.J. (1994). Nematodes of the Plymouth Sound. Plymouth Marine Laboratory (PML), UK.

http://www.marbef.org/modules.php?name=People&lvl=Das&dasid=699

Nematodes were collected using four different collection methods at two sites with contrasting sediment types. The aim was to assess differences between samplers by looking at the variation in nematode community structure (Somerfield & Clarke 1997).

Steyaert, M. (1994). Meiobenthos at the stations 115, 702, 790 on the Belgian Continental Shelf. Ghent University, Department of Biology, Marine Biology Section (MARBIOL), Belgium.

http://www.marbef.org/modules.php?name=People&lvl=Das&dasid=749

Nematode communities were sampled at three localities along the Belgian coast. The main aim was to describe vertical distribution patterns and species diversity and relate this to both particular natural environmental parameters and anthropogenic influences (Steyaert et al. 1999).

Steyaert, M. (1996). Spatial heterogeneity of nematodes on an intertidal flat in the Westerschelde Estuary. Ghent University, Department of Biology, Marine Biology Section (MARBIOL), Belgium.

http://www.marbef.org/modules.php?name=People&lvl=Das&dasid=669

Steyaert et al. (2003) investigated the spatial heterogeneity of the nematode associations on a small intertidal estuarine flat. Data were specifically used to test the extent to which macroscale variability was more important than microscale variability.

Steyaert, M. (1997). Tidal migration of nematodes on an estuarine tidal flat. Ghent University, Department of Biology, Marine Biology Section (MARBIOL), Belgium.

http://www.marbef.org/modules.php?name=People&lvl=Das&dasid=670

Data were collected in the course of the multidisciplinary project ECOFLAT, which aimed to study the ecometabolism of the Molenplaat (SW Netherlands). Here, the tidal migration of nematodes was investigated both on species and community level, and Steyaert et al. (2001) also tested whether the community level approach masks species specific patterns.

Steyaert, M. (1999). Meiobenthos at station 115bis – bentho-pelagic coupling. Ghent University, Department of Biology, Marine Biology Section (MARBIOL), Belgium.

http://www.marbef.org/modules.php?name=People&lvl=Das&dasid=54

This study was carried out as part of a PhD programme, where the abundance, community composition and species diversity of the nematode community at a station on the Belgian Continental Shelf was documented on a monthly basis (Steyaert 2003).

Urban-Malinga, B. (2001). Meiofauna from Kongsfjorden (Spitbergen, Arctic). Polish Academy of Sciences, Institute of Oceanology (IOPAS), Poland.

http://www.marbef.org/modules.php?name=People&lvl=Das&dasid=693

This study aimed to describe the intertidal meiobenthic community of Kongsfjorden and to better understand the relationship between the horizontal and vertical distribution of meiofauna with a special focus on nematodes and environmental features in the fjord (Urban-Malinga et al. 2005).

Urban-Malinga, B. (2004). Meiofauna of the Southern Baltic. Polish Academy of Sciences, Institute of Oceanology (IOPAS), Poland.

http://www.marbef.org/modules.php?name=People&lvl=Das&dasid=695

These data were collected as part of a large study, aiming to compare the structure of the nematode communities at two comparable sublittoral sites, located in the Southern Baltic and the south-eastern part of the North Sea. The goal was to increase the understanding of the controlling factors in abundance, diversity and spatial distribution patterns (Urban-Malinga et al. 2006).

Vanaverbeke, J. & Steyaert, M. (1994). Length and width measurements of nematodes from coastal stations on the Belgian Continental Shelf. Ghent University, Department of Biology, Marine Biology Section (MARBIOL), Belgium.

http://www.marbef.org/modules.php?name=People&lvl=Das&dasid=830

Vanaverbeke, J. (1998). Length, width and biomass measurements of nematodes from sandbanks on the Belgian Continental Shelf. Ghent University, Department of Biology, Marine Biology Section (MARBIOL), Belgium.

http://www.marbef.org/modules.php?name=People&lvl=Das&dasid=832

The principal aim of these studies was twofold. Firstly, Vanaverbeke et al. (2003) wanted to analyse the response of nematode biomass spectra (NBS) to three distinct stressors upon the sediment habitat and secondly, they analysed the NBS in different ways to be able to discuss the advantages and disadvantages of the various methods. The second set of data was collected in the course of the PODO-I project: "Structural and functional biodiversity of North Sea ecosystems: species and their habitats as indicators for a sustainable development of the Belgian Continental Shelf".

Vanaverbeke, J. (1999). Nematodes from station 330: structural and functional biodiversity on the Belgian Continental Shelf. Ghent University, Department of Biology, Marine Biology Section (MARBIOL), Belgium.

http://www.marbef.org/modules.php?name=People&lvl=Das&dasid=209

The principle aim of this research was to investigate the morphometry of nematode communities as triggered by a phytoplankton spring bloom deposition in a well oxygenated North Sea sampling station. Length and width measurements were available together with densities (Vanaverbeke et al. 2003; Vanaverbeke et al. 2004a,b).

Vanaverbeke, J., Deprez, T. & Vincx, M. (2006). Meiobenthos of subtidal sandbanks on the Belgian Continental Shelf. Ghent University, Department of Biology, Marine Biology Section (MARBIOL), Belgium.

http://www.marbef.org/modules.php?name=People&lvl=Das&dasid=762

This study collected meiobenthic data from several subtidal sandbanks on the Belgian Continental Shelf during several sampling campaigns from 1978 until 2004. Taxon densities, nematode species densities and nematode biomass information per station were linked with the available sedimentological variables (Vincx 1990, Vincx et al. 1990, Vanaverbeke et al. 2000, Vanaverbeke et al. 2002, Vanaverbeke et al. 2003).

Vandenberghe, R. & Coomans, A. (1985). Study of the meiobenthos from a dumping site in the Southern Bight of the North Sea. Ghent University, Department of Biology, Marine Biology Section (MARBIOL), Belgium.

http://www.marbef.org/modules.php?name=People&lvl=Das&dasid=847

The meiobenthos of a dumping site in the Southern Bight of the North Sea was examined as part of a PhD programme. Next to the faunistic research, Vandenberghe (1987) also examined the link between certain abiotic parameters and the characteristics of the present nematode communities.

Vanreusel, A. (1985). Free-living nematodes of the Voordelta. Ghent University, Department of Biology, Marine Biology Section (MARBIOL), Belgium.

http://www.marbef.org/modules.php?name=People&lvl=Das&dasid=664

Data collected during this PhD programme were employed to inventory the nematode communities found in the Voordelta and evaluating their stability over time (Vanreusel 1989). They also contributed to a more global research project, aiming to evaluate the effect of the Delta works on the Dutch Delta ecosystem.

Veit-Köhler, G., Seifried, S. & Laudien, J. (2005). Arctic meiofauna succession. Forschungsinstitut Senckenberg; Deutsches Zentrum fur Marine Biodiversitätsforschung (DZMB), Germany.

http://www.marbef.org/modules.php?name=People&lvl=Das&dasid=980

This experimental research in glacial Kongsfjorden (Spitzbergen) investigated the long term colonisation capacities of Arctic soft bottom meiofauna (Veit-Köhler et al. submitted).

Vincx, M. (1984). Free-living marine nematodes from the Southern Bight of the North Sea. Ghent University, Department of Biology, Marine Biology Section (MARBIOL), Belgium.

http://www.marbef.org/modules.php?name=People&lvl=Das&dasid=663

As part of a PhD programme, data were collected on the nematode community of the Southern Bight of the North Sea. Vincx (1987) focused on both ecological and taxonomical matters.

Volkers, C. & George, K-H. (2002). Western Baltic Sea copepods. Forschungsinstitut Senckenberg; Deutsches Zentrum fur Marine Biodiversitätsforschung (DZMB), Germany.

http://www.marbef.org/modules.php?name=People&lvl=Das&dasid=977

The main question in this research was how Harpacticoid copepod communities differ in species composition and diversity on a north to south gradient in the Western Baltic area and what factors might explain these differences (Volkers, unpublished data).

Vriser, B. & Grego, M. (2005). Meiofauna of the Gulf of Trieste (NIB-MBS database on meiofauna version 1.2). National Institute of Biology, Marine Biological Station Piran (MBS), Slovenia.

http://www.marbef.org/modules.php?name=People&lvl=Das&dasid=744

Copepod and meiobenthic species information has been gathered from 1978 till 2004. The data were also part of different research projects, all carried out in the Slovenian part of the Gulf of Trieste (North Adriatic Sea) (e.g. Vriser 1996a,b, Vriser 1998, Vriser & Vukovic 1999, Vriser 2000a,b, Vriser 2001).

MEIOFAUNA MARINA

Biodiversity, morphology and ecology of small benthic organisms

INSTRUCTIONS TO CONTRIBUTORS

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Examples of reference style:

Pesch, G. G., C. Müller & C. E. Pesch (1988). Chromosomes of the marine worm *Nephtys incisa* (Annelida: Polychaeta). Ophelia 28: 157-167.

Fish, A. B. & C. D. Cook (1992). Mussels and other edible Bivalves. Roe Publ., New York.

Smith, X. Y. (1993). Hydroid development. In: Development of Marine Invertebrates, vol. 2, Jones, M. N. (ed.), pp. 123-199. Doe Press, New York.

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