Updating the zooplankton species list for the Belgian part of the North Sea

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ABSTRACT. Many marine species are threatened, and given the importance of biodiversity indices in the current European marine policy, taking stock of existing species and species diversity is crucial. Zooplankton form the basis of the pelagic food web, acting as staple food for fish larvae and adult pelagic fish, but are very susceptible to a changing climate. Inventorying zooplanktonic diversity is therefore important. Based on monthly sampling campaigns in 2009 and 2010, an update is provided on the zooplankton species list for the Belgian part of the North Sea. A total of 137 taxa are listed, some of which had rarely or never been observed in the area. This inventory revealed several species new to the Belgian marine species list: the calanoid copepod *Metridia lucens*, the cyclopoids *Oithona similis* and *Giardella callianassae*, the hydrozoans *Amphinema dinema* and *Eutima gracilis*, the mysid *Acanthomysis longicornis*, the polychaete worm *Tomopteris helgolandica*, the cladoceran *Penilia avirostris* and the monstrilloid copepod *Cymbasoma germanicum*. Additionally, we identified several males of *C. germanicum*, which have never been described before. Brief discussions are presented on spatial distribution and abundance of all taxa.

KEYWORDS. zooplankton, marine biodiversity, Belgian part of the North Sea, species list, faunal additions

INTRODUCTION

Biological diversity plays a crucial role in the way ecosystems function and in the many services they provide (VITOUSEK et al., 1997; LOREAU et al., 2001). Loss of marine biodiversity nationally, regionally and globally reduces the capacity of marine ecosystems to support the provision of goods and services, essential for human well-being (COCHRANE et al., 2010). Species lists are therefore indispensable fundamental tools to study species diversity and to calculate biodiversity indices in ecological studies.

The pelagic zone is the biggest habitat in the world, and also the biggest for Belgium (COSTELLO et al., 2010). Not only is it big, it is also ecologically very important, since the vast majority of fish species have a pelagic larval phase, including commercial fishes such as sole *Solea solea*, plaice *Pleuronectes platessa* and cod *Gadus morhua* (RUSSEL, 1976). These fish species must keep in step with their zooplanktonic food sources, for this is what their larvae eat. Furthermore, zooplanktonic organisms are very susceptible to a changing climate. The replacement of the cold water *Calanus finmarchicus* species assemblage in the North Sea by the warm water *C. helgolandicus*-dominated copepod assemblage with lower biomass and smaller species, is a textbook example of the severe consequences of a warming climate on marine ecosystems (RICHARDSON, 2008).

For the Belgian part of the North Sea (BPNS) very few historical lists of zooplankton species are available. The oldest known marine samples that contained zooplankton date from the early 20th century (Gilson collection, discussed in VAN LOEN & HOUZIAUX, 2002). However,

there was little to nothing published about the zooplanktonic species in these samples, as the main focus was on benthic organisms. VAN MEEL (1975) was the first to report zooplanktonic species lists from the Belgian part of the North Sea and adjacent waters.

More recent zooplanktonic research in Belgium has mainly focused on a limited number of species (e.g. VANDENDRIESSCHE et al., 2006; VAN HOEY, 2006), on diurnal zooplankton behavior (DARO, 1974) or on the interaction of calanoid copepods with the nuisance alga *Phaeocystis globosa* (SCHERFFEL, 1899) (e.g. GASPARINI et al., 2000; DARO et al., 2006; ROUSSEAU et al., 2006). In contrast, the zooplankton community structure and its dynamics in the Scheldt estuary have received considerably more attention (e.g. TACKX, 2002; MAES et al., 2002; APPELTANS et al., 2003; AZÉMAR et al., 2004; TACKX et al., 2005), but recent data on the marine part of the BPNS are extremely scarce. Considering climate change, the importance of biodiversity and the biogeographical changes in the distribution of planktonic species, an update of the zooplankton species list for the BPNS is certainly timely.

In 2010, the Flanders Marine Institute (VLIZ) compiled a species list for the Belgian marine waters (VANDEPITTE et al., 2010). For many zooplanktonic groups, the list is solely based on literature and therefore many species are geographically unverified. This study yields new and up-to-date information about the composition of zooplankton in the transitional region between the Atlantic Ocean and the North Sea and provides additional information for the Belgian Register of Marine Species (BeRMS) (VLIZ Belgian Marine Species consortium 2010).

MATERIALS AND METHODS

Sampling

Sampling was carried out monthly in 2009 and 2010 at ten monitoring stations in the BPNS positioned along a nearshore-midshore-offshore axis (Fig. 1). A WP2 net (200µm mesh size) fitted with flow meter (SMITH et al., 1968) was towed in an oblique haul from bottom to surface. Samples were fixed and preserved in a 4% formaldehyde solution.

Data are derived from a selection of 112 samples (53 nearshore, 30 midshore, 29 offshore), taken in salinity ranges from 29.9 – 35.0 PSU and temperature ranges from 2.0 – 20.9°C.

Species list

Using compound- and stereo-microscopes, taxa were identified to species level when possible, in order to attain the highest taxonomical resolution. The classification used is according to the World Register of Marine Species (WoRMS) (APPELTANS et al., 2011). Species that form an addition to the recently published Belgian Register of Marine Species (VANDEPITTE et al., 2010) are indicated with an asterisk (*) in Table 1. In addition, the different taxa have been subdivided according to their lifestyle; we distinguish between holoplanktonic (spend their entire life as plankton in the water column, *e.g.* calanoid copepods), meroplanktonic (spend a part of their life as plankters, e.g. decapod larvae) and tychoplanktonic taxa (are occasionally carried into the water column, e.g. species of Cumacea and Mysida).

RESULTS

Table 1 lists 137 taxa (101 identified to species level) found in the Belgian part of the North Sea in 2009 and 2010, of which 46 are considered holoplanktonic, 50 meroplanktonic and 41 tychoplanktonic. Four copepods, two hydrozoans, one mysid, one cladoceran and one polychaete have never been reported from the BPNS and are new for the Belgian Register of Marine Species. Additional information on densities and the spatial and temporal occurrence of these taxa in the BPNS is presented in Table 2 (appendix).

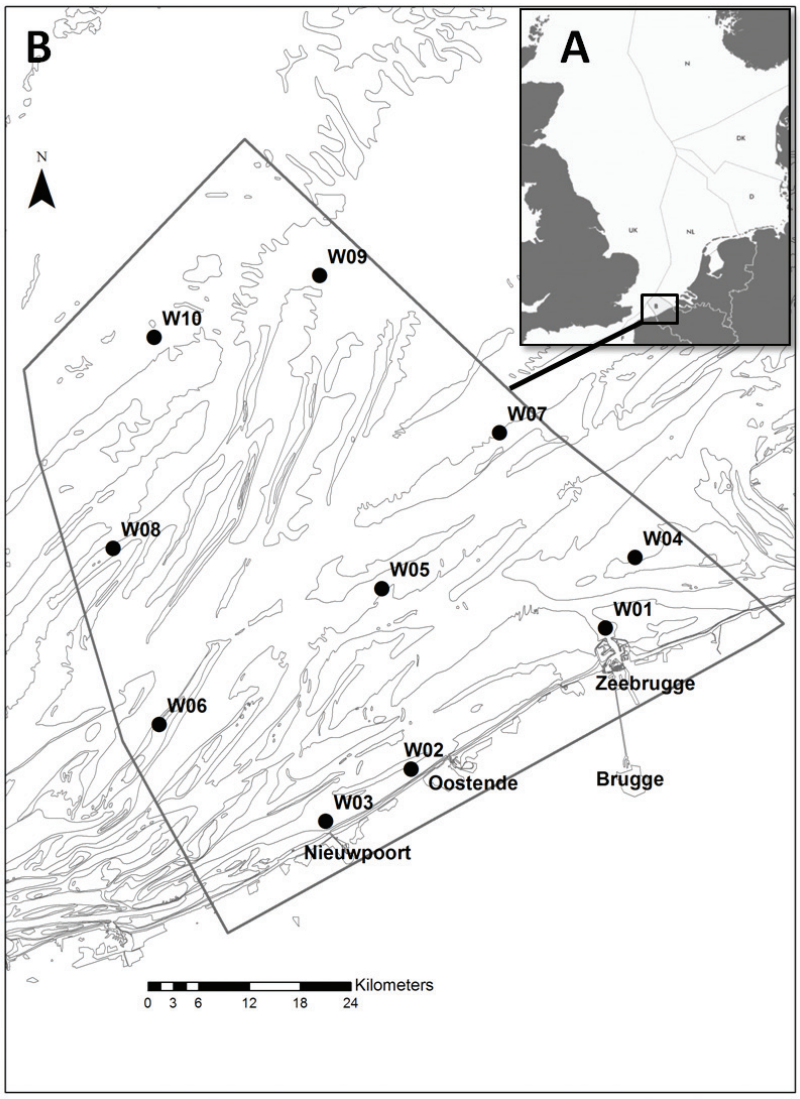


Fig. 1. – **A.** North Sea exclusive economic zones. **B.** Belgian part of the North Sea (BPNS) with ten stations (situated in nearshore W01-04-midshore W05-07-offshore areas W08-10) sampled monthly for zooplankton from January 2009 to December 2010.

DISCUSSION

This manuscript presents the first zooplanktonic inventory for the Belgian part of the North Sea in nearly forty years. Overall, 137 taxa were found in the net samples of which nine species (four copepods, two hydrozoans, one mysid, one cladoceran and one polychaete worm) were new to the Belgian Register of Marine Species (VANDEPITTE et al., 2010).

Species new for the BPNS

Cymbasoma germanicum is a rare monstrilloid species known only from a few female specimens collected at the Doggersbank, off Helgoland and Cuxhaven (RAZOULS et al., 2005-2011). We found 16 specimens, both males and females. The differences between *C. germanicum*, *C. rigidum* THOMPSON, 1888 and *C. zetlandicus* T. SCOTT, 1904 are subtle. A redescription of *C. germanicum*, including the description of the male, and comparison with its close relatives will be given elsewhere (FIERS & VAN GINDERDEUREN, in prep.).

Metridia lucens is a copepod most commonly found in the northern North Sea and northern

TABLE 1

List of holo-, mero- and tychoplanktonic taxa in the BPNS observed in the period 2009 - 2010. Species with asterisk (*) are new to the Belgian fauna (VANDEPITTE et al. 2010).

HOLOPLANKTON	
Protozoa **Dinoflagellata** **Order Noctilucales** Family Noctilucaceae *Noctiluca scintillans* (Macartney) KOFOID & SWEZY, 1921 **Cnidaria** **Scyphozoa** **Order Semaeostomeae** Family Cyaneidae *Cyanea lamarckii* PÉRON & LESUEUR, 1810 Family Pelagiidae *Chrysaora hysoscella* (LINNAEUS, 1767) Family Ulmaridae *Aurelia aurita* (LINNAEUS, 1758) **Order Rhizostomeae** Family Rhizostomatidae *Rhizostoma pulmo* (MACRI, 1778) **Cnidaria** **Hydrozoa** **Order Anthoathecata** Family Pandeidae *Amphinema dinema* (PÉRON & LESUEUR, 1810)* Family Bougainvilliidae *Nemopsis bachei* L. AGASSIZ, 1849 Family Margelopsidae *Margelopsis haeckeli* (HARTLAUB, 1897) Family Rathkeidae *Rathkea octopunctata* (M. SARS, 1835) Family Corynidae *Sarsia tubulosa* (M. SARS, 1835) **Order Leptothecata** Family Campanulariidae *Clytia hemisphaerica* (LINNAEUS, 1767) *Obelia* sp. Family Lovenellidae *Eucheilota maculata* HARTLAUB, 1894 Lovenellidae sp. Family Eirenidae *Eutima gracilis* (FORBES & GOODSIR, 1853)* *Eutonina indicans* (ROMANES, 1876)	**Ctenophora** **Order Beroida** Family Beroidae *Beroe gracilis* (KÜNNE, 1939) Family Bolinopsidae *Mnemiopsis leidyi* (A. AGASSIZ, 1865) Family Pleurobrachiidae *Pleurobrachia pileus* (O. F. MÜLLER, 1776) **Annelida** **Polychaeta** **Order Phyllodocida** Family Tomopteridae *Tomopteris (Johnstonella) helgolandica* (GREEFF, 1879)* **Arthropoda** **Crustacea** **Branchiopoda** **Order Diplostraca** Family Podonidae *Evadne nordmanni* LOVÉN, 1836 *Podon leuckartii* (G.O. SARS, 1862) Family Sididae *Penilia avirostris* DANA, 1849* **Arthropoda** **Crustacea** **Copepoda** **Order Calanoida** Family Acartiidae *Acartia* (*Acartiura*) *clausi* (GIESBRECHT, 1889) Family Calanidae *Calanus helgolandicus* (CLAUS, 1863) Family Candacidae *Candacia armata* (BOECK, 1872) Family Centropagidae *Centropages hamatus* (LILLJEBORG, 1853) *Centropages typicus* (KRØYER, 1849) *Isias clavipes* (BOECK, 1865) Family Pontellidae *Labidocera wollastoni* (LUBBOCK, 1857) Family Metridinae *Metridia lucens* (BOECK, 1865)*

Family Paracalanidae
Paracalanus parvus (Claus, 1863)
Family Clausocalanidae
Pseudocalanus elongatus (Boeck, 1865)
Family Temoridae
Temora longicornis (Müller O.F., 1785)

Order Cyclopoida
Family Corycaeidae
Corycaeus anglicus (Lubbock, 1857)
Family Cyclopinidae
Cyclopinoides littoralis (Brady, 1872)
Family Oithonidae
Oithona nana (Giesbrecht, 1893)
Oithona similis (Claus, 1866)*
Family Oncaeidae
Oncaea sp.

Order Harpacticoida
Family Euterpinidae
Euterpina acutifrons (Dana, 1847)

Order Monstrilloida
Family Monstrillidae
Cymbasoma germanicum (Timm, 1893)*

Arthropoda
Crustacea
Eucarida
Order Euphausiacea
Family Euphausiidae
Nyctiphanes couchii (Bell, 1853)

Arthropoda
Crustacea
Peracarida
Order Amphipoda
Family Hyperiidae
Hyperia galba (Montagu, 1815)

Chordata
Tunicata
Order Copelata
Family Oikopleuridae
Oikopleura (Vexillaria) dioica Fol, 1872

Chaetognatha
Order Aphragmophora
Family Sagittidae
Parasagitta elegans (Verrill, 1873)
Parasagitta setosa (Müller, 1847)

MEROPLANKTON

Mollusca
Bivalvia sp.
Gastropoda sp.
Order Pectinoida
Family Pectinidae
Pectinidae sp.
Order Euheterodonta
Family Pharidae
Ensis sp.
Order Myopsida
Family Loliginidae
Loligo sp.

Arthropoda
Crustacea
Copepoda
Family Clausidiidae
Giardella callianassae Canu, 1888*

Cirripedia
Cirripedia sp.

Order Decapoda
Anomura sp.
Brachyura sp.
Caridea sp.
Decapoda sp.
Family Callianassidae
Callianassa sp.
Family Crangonidae
Crangon crangon (Linnaeus, 1758)
Family Porcellanidae
Pisidia longicornis (Linnaeus, 1767)

Order Isopoda
Isopoda sp.

Order Tanaidacea
Family Tanaidae
Tanais dulongii (Audouin, 1826)

Cephalochordata
Order Amphioxiformes
Family Branchiostomidae
Branchiostoma lanceolatum (Pallas, 1774)

Echinodermata
Order Camarodonta
Family Parechinidae
Psammechinus miliaris (P.L.S. MÜLLER, 1771)

Order Forcipulatida
Family Asteriidae
Asterias rubens LINNAEUS, 1758

Order Ophiurida
Family Ophiotrichidae
Ophiothrix fragilis (ABILDGAARD, in O.F. MÜLLER, 1789)
Family Ophiuridae
Ophiura sp.

Order Spatangoida
Family Loveniidae
Echinocardium sp.
Bryozoa
Bryozoa sp.

Phoronida
Phoronida sp.

Chordata
Pisces
Pisces sp.
Order Perciformes
Family Ammodytidae
Ammodytidae sp.
Ammodytes marinus RAITT, 1934
Ammodytes tobianus LINNAEUS, 1758
Hyperoplus lanceolatus (LE SAUVAGE, 1824)
Family Callionymidae
Callionymus sp.
Family Trachinidae
Echiichthys vipera (CUVIER, 1829)
Trachinus draco (LINNAEUS, 1758)
Family Gobiidae
Gobiidae sp.
Pomatoschistus sp.
Family Carangidae
Trachurus trachurus (Linnaeus, 1758)

Order Pleuronectiformes
Family Bothidae
Arnoglossus laterna (WALBAUM, 1792)
Family Soleidae
Buglossidium luteum (RISSO, 1810)
Solea solea (LINNAEUS, 1758)
Family Pleuronectidae
Limanda limanda (LINNAEUS, 1758)
Pleuronectes platessa LINNAEUS, 1758

Order Clupeiformes
Family Clupeidae
Clupeidae sp.
Clupea harengus LINNAEUS, 1758
Sardina pilchardus (WALBAUM, 1792)
Sprattus sprattus (LINNAEUS, 1758)
Family Engraulidae
Engraulis encrasicolus (LINNAEUS, 1758)

Order Gadiformes
Family Gadidae
Merlangius merlangus (LINNAEUS, 1758)

Order Osmeriformes
Family Osmeridae
Osmerus eperlanus (LINNAEUS, 1758)

Order Syngnathiformes
Family Syngnathidae
Syngnathus rostellatus NILSSON, 1855

Order Scorpaeniformes
Family Triglidae
Triglidae sp.

TYCHOPLANKTON

Platyhelminthes
Platyhelminthes sp.

Nemertea
Nemertea sp.

Annelida
Oligochaeta sp.

Arthropoda
Arachnida
Acarina sp.

Arthropoda
Crustacea
Eucarida
Order Decapoda

Family Processidae
Processa modica WILLIAMSON, 1979

Peracarida
Order Amphipoda
Family Amphilochidae
Amphilochus neapolitanus DELLA VALLE, 1893
Family Calliopiidae
Apherusa bispinosa (BATE, 1857)
Apherusa ovalipes NORMAN & SCOTT, 1906
Family Atylidae
Atylus falcatus (METZGER, 1871)
Atylus swammerdami (MILNE-EDWARDS, 1830)
Family Pontopereiidae
Bathyporeia sp.
Family Corophiidae
Corophium sp.
Family Gammaridae
Gammarus crinicornis (STOCK, 1966)
Gammarus salinus (SPOONER, 1947)
Family Caprellidae
Caprella linearis (LINNAEUS, 1767)
Pariambus typicus (KRØYER, 1884)
Family Ischyroceridae
Jassa herdmani (WALKER, 1893)
Family Leucothoidae
Leucothoe incisa (ROBERTSON, 1892)
Family Megaluropidae
Megaluropus agilis (HOECK, 1889)
Family Microprotopidae
Microprotopus maculatus (NORMAN, 1867)
Family Microprotopidae
Orchomenella nana (KROYER, 1846)
Family Oedicerotidae
Pontocrates altamarinus (BATE & WESTWOOD, 1862)
Pontocrates arenarius (BATE, 1858)

Order Cumacea
Family Bodotriidae
Bodotria arenosa (GOODSIR, 1843)
Bodotria scorpioides (MONTAGU, 1804)
Family Diastylidae
Diastylis rathkei (KRØYER, 1841)
Family Pseudocumatidae
Pseudocuma sp.
Monopseudocuma gilsoni (GILSON, 1906)
Pseudocuma (Pseudocuma) longicorne (BATE, 1858)
Pseudocuma (Pseudocuma) simile G.O. SARS, 1900

Order Isopoda
Family Cirolanidae
Eurydice spinigera HANSEN, 1890

Order Mysida
Family Mysidae
Acanthomysis longicornis (MILNE-Edwards, 1837)*
Anchialina agilis (G.O. SARS, 1877)
Gastrosaccus sp.
Gastrosaccus sanctus (VAN BENEDEN, 1861)
Gastrosaccus spinifer (GOËS, 1864)
Mesopodopsis slabberi (VAN BENEDEN, 1861)
Schistomysis kervillei (G.O. SARS, 1885)
Schistomysis ornata (G.O. SARS, 1864)
Schistomysis spiritus (NORMAN, 1860)
Siriella armata (MILNE-EDWARDS, 1837)

Atlantic (FRASER, 1965; BARNARD et al., 2004). Its occurrence in the southern part of the North Sea appears to be rare: VAN MEEL (1975) detected the species in 1902-1910 samples. BRYLINSKI (2009) reported the find of a single male specimen in the Strait of Dover over a period of 30 years and FRANSZ (2000) emphasized the low abundance of the copepod among the zooplankton in the Dutch Part of the North Sea.

VAN MEEL (1975) considered *Oithona similis* as a species typical for the central part of the North Sea. In the southern part *O. similis* was reported near Gravelines (ANTAJAN, 2008) and in the Solent, English Channel (MUXAGATA & WILLIAMS, 2004). VAN MEEL (1975) however reported this species from a transect between Blankenberge (Belgium) and Orfordness (England), indicating that *O. similis* was found in the BPNS region.

Saphirella (SCOTT, 1894) morphs are now considered as the first copepodite stages (C1) of certain Clausiididae (BRYLINKSI, 2009). The adults of these pelagic larvae are parasitic species of Cyclopoida (RAZOULS et al., 2005-2011). BRYLINSKI (2009) identified *Saphirella* specimens in the French Channel corresponding to C1 of *Giardella callianassae*, a species never

reported from Belgian waters (VANDEPITTE et al., 2010). These copepodites of *Giardella* were also found in high numbers in our samples (Table 2).

The hydrozoan *Amphinema dinema* was collected by Gilson near Calais in 1905 (mentioned by VAN MEEL 1975). FRASER (1965) found *A. dinema* in the English Channel. Its presence off the Belgian coast was reported previously (LELOUP, 1952) but the species was omitted in the Belgian Register of Marine Species. The present study confirms its presence in the BPNS.

Eutima gracilis is a hydrozoan not mentioned from the North Sea or the English Channel by FRASER (1965) and VAN MEEL (1975), but it has been observed in English waters by others (RUSSEL, 1953; MEDIN, 2011). It appears to be restricted to European waters.

The mysid *Acanthomysis longicornis* has been observed in the vicinity of the BPNS. MEES et al. (1993) found it in the Westerschelde estuary close to the Belgian border, MÜLLER (2004) found it at Wimereux and ZIMMER (1933) as well reported *A. longicornis* from the southern North Sea.

Penilia avirostris is an abundant and widely distributed cladoceran in neritic tropical and subtropical waters, which has expanded north to temperate latitudes in the 20th century (ATIENZA et al., 2008). JOHNS et al. (2005) described how *P. avirostris* has increased in the North Sea since 1999, most probably due to warmer sea surface temperatures. The egg-carrying female found in this study proves that this species occurs and reproduces in the Belgian part of the North sea. *Evadne nordmanni* is a cladoceran not mentioned in the BeRMS (VANDEPITTE et al., 2010) and as such could be regarded as new for Belgian waters. However, VAN MEEL (1975) reports it present in high numbers in the BPNS in the early 20th century, indicating that this species has been found in the past.

Tomopteris (*Johnstonella*) *helgolandica* is the only holoplanktonic polychaete in the southern North Sea. It is known from Dutch waters, although rare (FRANSZ, 2000), and in the French Channel near Wimereux (DAUVIN et al., 2003).

Additional observations

The most abundant copepods (Table 2) were the calanoids *Acartia clausi*, *Temora longicornis*, *Paracalanus parvus*, *Centropages hamatus*, *Pseudocalanus elongatus* and the harpacticoid copepod *Euterpina acutifrons*. This corresponds with the observations by VAN MEEL (1975), DARO et al. (2006) and BRYLINSKI (2009).

In the North Sea, *Calanus finmarchicus* has shifted progressively northwards, while *C. helgolandicus* became more abundant and widely distributed in the 1980s (REID et al., 2003). In 2009-2010 only *C. helgolandicus* and not *C. finmarchicus* occurred in the samples taken in the BPNS, corresponding with the results of BRYLINSKI (2009) finding only the former species of *Calanus*. VAN MEEL (1975) on the other hand, mentions the calanoid *C. finmarchicus* attaining high densities in the southern North Sea in the '70s, while in the 19th century CANU (1892) reported only *C. finmarchicus* from the Boulonnais. SARS (1903) reported "*C. helgolandicus* has been recorded from the western coast of France by Dr. Canu", suggesting he did not agree with Canu's identification. This indicates that confusions exist in older literature between the two species *C. helgolandicus* and *C. finmarchicus*.

We investigated *Calanus* specimens from VAN MEEL (1975), sampled in the region of the BPNS in the early 20th century (stored in the RBINS collections in Brussels). They were *C. finmarchicus*, in contrast to the *C. helgolandicus* in our 2009 and 2010 samples.

In the present study, *C. helgolandicus* typically occurred around/on the offshore stations and was only occasionally caught nearshore. This copepod is known to reach high densities in the English Channel (BARNARD et al., 2004), and

TABLE 2

Average density (#m^{-3}), maximum density (#m^{-3}), and seasonal and spatial occurrence (near-mid-offshore) of all 137 taxa found in this study from January 2009 to December 2010. Spatial regimes (near-mid-offshore) with highest density are bold.

Taxon/Species	Average density	Maximum density	Seasonal occurrence	Spatial occurrence	Remarks
HOLOPLANKTON					
Dinoflagellata					
Noctiluca scintillans	1294,4	39806,3	Jul-Aug	off < near < **mid**	Summer species, but also very low densities found until October
Scyphozoa					
Aurelia aurita	< 0,1	< 0,1	Apr-Jul	off < mid < **near**	
Chrysaora hysoscella	< 0,1	< 0,1	Jun-Nov	off < mid < **near**	
Cyanea lamarckii	< 0,1	0,4	Mar-Jul	near < mid < **off**	
Rhizostoma pulmo	< 0,1	< 0,1	Sep-Nov	off < mid < **near**	
Hydrozoa					
*Amphinema dinema**	< 0,1	< 0,1			Six specimens found at W09: on 19/8/2009, 5/10/2009 and 11/8/2010
Clytia hemisphaerica	18,9	204,6	May-Dec	off < near < **mid**	
Eucheilota maculata	< 0,1	< 0,1			Two specimens found at W07 on 11/8/2010 and 6/9/2010
*Eutima gracilis**	< 0,1	0,84	Aug-Sept	near < **off**	Seventeen specimens found, almost all of them offshore
Eutonina indicans	< 0,1	< 0,1			Seen just once at station W02 on 7/4/2009
Lovenellidae sp.	< 0,1	0,5	Jul-Oct	mid < **off**	Twelve specimens found at W06, W08, W09 and W10
Margelopsis haeckeli	12,5	268,4	Apr-Oct	off < mid < **near**	
Nemopsis bachei	1,0	23,6	May-Sep	mid < **near**	Mainly found at station W01
Obelia sp.	2,2	104,4	Mar-Oct	off < mid < **near**	
Rathkea octopunctata	59,7	1402,2	Mar-Jun	**near**	Only found at station W01 and W02
Sarsia tubulosa	< 0,1	< 0,1	Mar-Oct		Five specimens found at stations W02, W07 and W09
Ctenophora					Peak in June,
Beroe gracilis	6,9	139,4	Apr-Dec	off < mid < **near**	Peak in October
Mnemiopsis leidyi	< 0,1	0,8	Sep-Dec	off < mid < **near**	Peak in spring (March-May)
Pleurobrachia pileus	1,6	79,3	All year	off < mid < **near**	
Polychaeta					
*Tomopteris helgolandica**	< 0,1	< 0,1			Two specimens at W09 (11/8/2010 and 6/9/2010) and W10 (6/7/2009)

Taxon/Species	Average density	Maximum density	Seasonal occurrence	Spatial occurrence	Remarks
Branchiopoda					
Evadne nordmanni	39,6	1085,2	Feb-Jul	off < mid < **near**	
*Penilia avirostris**	< 0,1	< 0,1			One specimen (female carrying eggs) found at W07 on 5/10/2009
Podon leuckartii	26,6	800,1	May-Oct	near < mid < **off**	
Copepoda					
Acartia clausi	753,6	3735,4	All year	near < mid < **off**	Highest densities in autumn and offshore
Calanus helgolandicus	5,0	96,7	All year	near < mid < **off**	Much lower densities in winter
Candacia armata	< 0,1	< 0,1			One adult individual was caught on 6/12/2010 at station W09
Centropages hamatus	265,3	4500,2	All year	off < near < **mid**	Highest densities in spring and summer
Centropages typicus	9,9	116,9	All year	off < near < **mid**	
Corycaeus anglicus	9,8	108,3	Aug-Feb	near < mid < **off**	
Cyclopinoides littoralis	11,9	118,1	All year	near < mid < **off**	
*Cymbasoma germanicum**	< 0,1	1,5	Jul-Sep	near < **mid**	16 specimens found (8 ♀, 1 copepodite and 7 ♂) at W01-05-06-07
Euterpina acutifrons	348,8	4250,0	Jul-Dec	off < mid < **near**	Very low numbers seen in Jan, Feb and May
Isias clavipes	4,4	46,7	Jun-Oct	off < near < **mid**	higher abundance at Westcoast (w03,w06) than at Eastcoast
Labidocera wollastoni	2,2	18,4	Aug-Sept	off < mid < **near**	
*Metridia lucens**	< 0,01	15,6			Only found at W02: 6 individuals on 18/10/2010 and 1 on 8/11/2010
Oithona nana	4,9	40,4	Jul-Oct	off < mid < **near**	
*Oithona similis**	20,6	283,0	Jul-Dec	off < mid < **near**	Much higher numbers at the coastal stations
Oncaea sp.	< 0,1	85,1			Only seen on 9/12/2009 at station W09
Paracalanus parvus	241,1	1663,0	All year	near < mid < **off**	Highest densities in summer and autumn
Pseudocalanus elongatus	17,1	540,5	All year	near < mid < **off**	Highest densities in spring and summer
Temora longicornis	713,6	7616,9	All year	off < near < **mid**	
Euphausiacea					
Nyctiphanes couchii	< 0,1	0,2	Jan-Feb	mid < **off**	In total 6 specimens were found
Amphipoda					
Hyperia galba	< 0,1	< 0,1			One specimen found at W01 on 11/6/2009 and 1 at W09 on 11/6/2010
Tunicata					
Oikopleura dioica	445,1	4153,8	All year	off < near < **mid**	Peak in spring (May-June)
Chaetognatha					
Parasagitta elegans	< 0,1	< 0,1			Only 1 specimen was found, on 11/6/2010 at station W02,
Parasagitta setosa	40,6	492,0	All year	near < mid < **off**	Densities much higher in summer than in other seasons

Taxon/Species	Average density	Maximum density	Seasonal occurrence	Spatial occurrence	Remarks
MEROPLANKTON					
Mollusca					
Bivalvia sp.	102,9	1753,2	Feb-Dec	off < mid < **near**	Veliger larvae and juvenile bivalvia
Pectinidae sp.	< 0,1	0,2			Found at 3 sites: W07 (8/9/2009), W09 (19/8/2009) and W10 (7/9/2009)
Ensis sp.	19,6	363,6	Mar-Oct	off < mid < **near**	*Ensis* spat, densities much higher nearshore (peak observed at W04).
Loligo sp.	< 0,1	< 0,1			One juvenile (1cm) found at W06 on 9/9/2009
Gastropoda sp.	5,1	65,0	May-Dec	near < off < **mid**	Juveniles, not identifiable
Copepoda					
Giardella callianassae *	104,2	1198,0	Jul-Dec	off < near < **mid**	Autumn species, peaking in October and November
Cirripedia					
Cirripedia sp.	115,4	987,6	All year	off < near < **mid**	Nauplius larvae and cyprid larvae
Decapoda					
Anomura sp.	< 0,1	0,4	Jul-Oct	near < mid < **off**	Zoea larvae, present in low densities
Brachyura sp.	6,1	73,2	All year	off < near < **mid**	Zoea larvae
Caridea sp.	6,4	45,2	All year	mid < near < **off**	Zoea larvae
Callianassa sp.	< 0,1	< 0,1			Three juvenile specimens caught on 11/8/2010 (W09) and 6/9/2010
Crangon crangon	0,3	3,1	May-Nov	off < mid < **near**	(W07), Zoea larvae, only counted when clearly identifiable, if not
Decapoda sp.	1,2	25,5	All year	near < off < **mid**	then record added to Caridea sp.
Pisidia longicornis	11,6	221,1	May-Oct	near < mid < **off**	Megalopa larvae, peak in numbers from Jul-Sep
					Zoea larvae, also 1 individual at W09 on 9/12/2009
Isopoda					
Isopoda sp.	1,8	21,6		near < off < **mid**	Microniscus larvae, found in Jan, Aug, Sep and Dec.
Tanaidacea					
Tanais dulongii	< 0,1	< 0,1			One specimen found on 15/7/2010 at W02
Cephalochordata					
Branchiostoma lanceolatum	1,1	11,3	Jul-Sep	mid < **off**	
Echinodermata					
Asterias rubens	30,5	592,5	Mar-Sep	off < mid < **near**	Bipinnaria and brachiolaria larvae
Echinocardium sp.	411,5	2881,5	May-Jul	off < near < **mid**	Echinopluteus larvae

Taxon/Species	Average density	Maximum density	Seasonal occurrence	Spatial occurrence	Remarks
Ophiothrix fragilis	263,3	10861,3	May-Dec	near < mid < **off**	Ophiopluteus larvae
Ophiura sp.	62,1	1593,9	All year	off < mid < **near**	Ophiopluteus larvae
Psammechinus miliaris	4,6	58,5	May-Jul	off < near < **mid**	Echinopluteus larvae
Bryozoa					
Bryozoa sp.	18,2	230,9	All year	off < near < **mid**	Cyphonauta larvae of Bryozoa
Phoronida					
Phoronida sp.	< 0,1	< 0,1			Actinotrocha larvae, 3 at W02 (14/05/09) and 1 at W07 (10/6/2010)
Pisces					
Ammodytidae sp.	2,2	31,5	Jan-Jul	near < mid < **off**	Larvae, found at W09 on 11/3/2009 and 10/3/2010
Ammodytes marinus	< 0,1	7,2			Larvae, found at W03 on 17/2/2009 and at W08 on 26/1/2009
Ammodytes tobianus	< 0,1	< 0,1	Jan-Jul	near < mid < **off**	Larvae, no larvae were recorded in nearshore samples
Arnoglossus laterna	< 0,1	0,8	Jun-Aug	mid < **off**	Larvae, 1 individual found at W05 on 8/7/2009
Buglossidium luteum	< 0,1	< 0,1			Larvae
Callionymus sp.	0,2	1,6	May-Aug	mid < **off**	Larvae, too small to be identifiable to species level
Clupeidae sp.	0,3	2,9	Mar-Jul	near < off < **mid**	Larvae
Clupea harengus	1,1	16,8	Jan-May	near < mid < **off**	Larvae, 1 specimen at W09 on 19/8/2009
Echiichthys vipera	< 0,1	< 0,1			Larvae, only seen at station W01 and W02. Five specimens found
Engraulis encrasicolus	< 0,1	0,9	Jul-Aug	**near**	Larvae
Gobiidae sp.	0,4	13,1	Jun-Oct	off < mid < **near**	Larvae, 8 specimens could be identified with certainty
Hyperoplus lanceolatus	< 0,1	0,6			Larvae, not found in nearshore and midshore samples
Limanda limanda	< 0,1	0,87	Feb-May	**off**	Larvae, scarce
Merlangius merlangus	< 0,1	0,9	Apr-May	mid < **off**	Larvae, 1 specimen found at station W01 on 15/7/2010
Osmerus eperlanus	< 0,1	< 0,1			Larvae, too small to be identifiable to order/family level
Pisces sp.	11,7	221,1	All year	near < off < **mid**	Larvae, positively identified once on 17/2/2009 at station W06
Pleuronectes platessa	< 0,1	< 0,1			Larvae, too small to be identifiable to family level
Pleuronectiformes sp.	< 0,1	0,5	Jan-Sep	near < mid < **off**	Larvae, only counted when clearly identifiable, if not then added to
Pomatoschistus sp.	< 0,1	0,6	July-Dec	off < mid < **near**	Gobiidae
Sardina pilchardus	0,5	4,7	Jun-Jul	mid < **off**	Larvae, not recorded nearshore
Solea solea	< 0,1	0,6	May-Jul	mid < **off**	Larvae, found in low numbers, not found in nearshore samples
Sprattus sprattus	0,9	26,1	Apr-Jul	near < mid < **off**	Larvae
Syngnathus rostellatus	< 0,1	< 0,1			Larvae, 1 specimen found at station W01 on 10/8/2010
Trachinus draco	< 0,1	< 0,1			Larvae, 1 specimen at W09 on 14/7/2010
Trachurus trachurus	0,2	1,9	Jun-Sep	mid < **off**	Larvae, no larvae were recorded in nearshore samples
Triglidae sp.	< 0,1	< 0,1			Larvae, 4 specimens found at W05, W07 and W09 in July 2009

Taxon/Species	Average density	Maximum density	Seasonal occurrence	Spatial occurrence	Remarks
TYCHOPLANKTON					
Platyhelminthes					
Platyhelminthes sp.	3,3	63,8	Jun-Oct	near < **off**	
Nemertea					
Nemertea sp.	< 0,1	< 0,1			Found twice on 14/5/2009, at station W08 and W10
Annelida					
Oligochaeta sp.	< 0,1	0,9			Four specimens found at W01 on 26/1/2009
Arachnida					
Acarina sp.	< 0,1	< 0,1			Two specimens found, at station W02 (14/5/2009) and W07 (8/7/2009)
Decapoda					
Processa modica	< 0,1	< 0,1			Only 1 specimen found at station W09 on 14/7/2010
Amphipoda					
Amphilochus neapolitanus	< 0,1	< 0,1			Found once at station W06 (9/9/2009) and once at W07 (6/9/2010)
Apherusa bispinosa	< 0,1	< 0,1			Found once at station W05 on 26/1/2009
Apherusa ovalipes	0,2	4,6	All year	near < mid < **off**	
Atylus falcatus	< 0,1	< 0,1			Strikingly, only found once, at W01 (6/10/2009)
Atylus swammerdami	4,2	122,0	All year	near < off < **mid**	Very common in pelagic samples, caught at each station each month
Bathyporeia sp.	< 0,1	0,6	Jan-Sep	mid < off < **near**	Only juveniles were caught in pelagic samples
Corophium sp.	0,1	3,2	Jan-Jun	near < off < **mid**	
Gammarus crinicornis	< 0,1	< 0,1			Found once at W01 on 11/6/2009
Gammarus salinus	< 0,1	< 0,1			Two specimens found: 1 at W01 (11/6/2009) and 1 at W02 (9/3/2010)
Caprella linearis	< 0,1	< 0,1			Found once at W09 on 6/7/2009
Pariambus typicus	0,9	21,6	Aug-Sep	mid < **near**	
Jassa herdmani	< 0,1	< 0,1			Found once at W01 on 15/7/2010
Leucothoe incisa	< 0,1	< 0,1			Found once at W06 on 10/7/2009
Megaluropus agilis	0,9	31,6	All year	near < off < **mid**	
Microprotopus maculatus	0,1	6,1	Aug-Mar	off < mid < **near**	
Orchomenella nana	< 0,1	< 0,1			One found at W02 (6/10/2009), W03 (9/9/2009) and W06 (17/2/2009)
Pontocrates altamarinus	< 0,1	0,5	Feb-Dec	near < off < **mid**	
Pontocrates arenarius	< 0,1	0,2			Found once at W01 (7/12/2010) and once at W09 (9/11/2010)

Taxon/Species	Average density	Maximum density	Seasonal occurrence	Spatial occurrence	Remarks
Cumacea					
Bodotria arenosa	< 0,1	0,3			Five specimens found at W03, W06, W07 and W09
Bodotria scorpioides	< 0,1	< 0,1			One specimen found at W09 on 6/12/2010
Diastylis rathkei	< 0,1	0,6			Three found at W01 (8/9/2010) and W02 (12/5/2010 and 8/11/2010)
Monopseudocuma gilsoni	0,3	6,6			11 found at stations W02, W07 and W09 from February until March
Pseudocuma sp.	9,8	169,3			Juvenile *Pseudocuma* sp. Were sometimes found in very high densities
Pseudocuma longicorne	< 0,1	< 0,1			One specimen found at W09 on 13/05/2009
Pseudocuma simile	< 0,1	6,2			Seen at W07 (8/4/2009 and 11/8/2010) and W09 (11/3/2009)
Isopoda					
Eurydice spinigera	< 0,1	< 0,1			Only 1 specimen found at station W10 on 21/1/2009
Mysida					
*Acanthomysis longicornis**	< 0,1	0,5	Feb-Dec	**off**	10 specimens found in Feb, Sep and Dec, at stations W08, W09 and W10
Anchialina agilis	< 0,1	< 0,1			Found once at W09 on 16/2/2009
Gastrosaccus sp.	1,4	174,7	All year	mid < off < **near**	Many juvenile *Gastrosaccus* were observed
Gastrosaccus sanctus	0,2	2,4	Jan-Sep	near < **off**	
Gastrosaccus spinifer	0,2	14,4	All year	mid < near < **off**	
Mesopodopsis slabberi	1,3	43,3	All year	off < mid < **near**	
Schistomysis kervillei	0,8	32,8	All year	off < mid < **near**	
Schistomysis ornata	< 0,1	< 0,1			Found once at W03 on 14/5/2009
Schistomysis spiritus	0,8	69,0	All year	mid < **near**	Almost all specimens were caught nearshore
Siriella armata	< 0,1	0,6			Three specimens found at W07 (8/9/2009) and 1 at W09 (21/1/2009)

is often transported to the BPNS by prevailing marine currents conveying Atlantic water through the Channel towards the southern North Sea (HOWARTH, 2001).

Parasagitta elegans is a chaetognath from the Atlantic Ocean and the more boreal parts of the North Sea (FRASER, 1965). VAN MEEL (1975) described how the species sometimes occurred in the Channel when conveyed in Atlantic currents reaching the North Sea. The fact that we caught only one individual of *P. elegans* but many thousands of *P. setosa* suggests that it is (or has become) a very rare species. Although species discrimination in chaetognaths is difficult, the present study confirms the presence of *P. elegans* in the BPNS.

Nyctiphanes couchii is the only euphausid recorded in the present study. It occurs in high densities in the central and northern North Sea, straying into the BPNS, especially during the colder winter months (RUSSEL, 1935; VAN MEEL, 1975). It has previously been reported from Belgian waters by CATTRIJSSE & VINCX (2001) and LOCK et al. (2011).

The invasive ctenophore *Mnemiopsis leidyi* was first reported from the North Sea in Dutch coastal waters in August 2006 (HOLSTEIJN, 2002). Reports of autumn blooms of lobate ctenophores off the Dutch coast prior to the first *M. leidyi* sightings were previously attributed to *Bolinopsis infundibulum* (O.F. MÜLLER, 1779) (FAASSE & BAYHA, 2006). Whether *M. leidyi* was present along the Dutch coast before 2006 remains to be settled as the two ctenophores can easily be confused. *Bolinopsis infundibulum* is a cold-water species and considered rare along the Dutch coasts. It was only in August 2007 that *M. leidyi* was first seen in the BPNS, in the port of Zeebrugge (DUMOULIN, 2007). Because of its presence within the port, its introduction into Belgian waters is most probably related to ballast water transport in cargo ships, as was indicated for *M. leidyi* in the Black and Caspian Seas and in the Dutch part of the North Sea (VINOGRADOV et al., 1989; IVANOV et al., 2000; FAASSE & BAYHA, 2006). Today, only four years after the first sighting/observation in 2007, *M. leidyi* occurs all along the Belgian coastline, up to 27 km offshore at the Thornton wind park as well as in all ports. Sightings of adult individuals in the coldest winter months imply that the species can survive Belgian winters. The spatial and temporal distribution along the Belgian coastal zone of *M. leidyi* is separately described in VAN GINDERDEUREN et al. (subm.).

Another invasive coelenterate recorded in this study is the hydrozoan *Nemopsis bachei*. This species was caught along the entire coastline, most abundantly around the port of Zeebrugge, where it was discovered in 1996 (DUMOULIN, 1997).

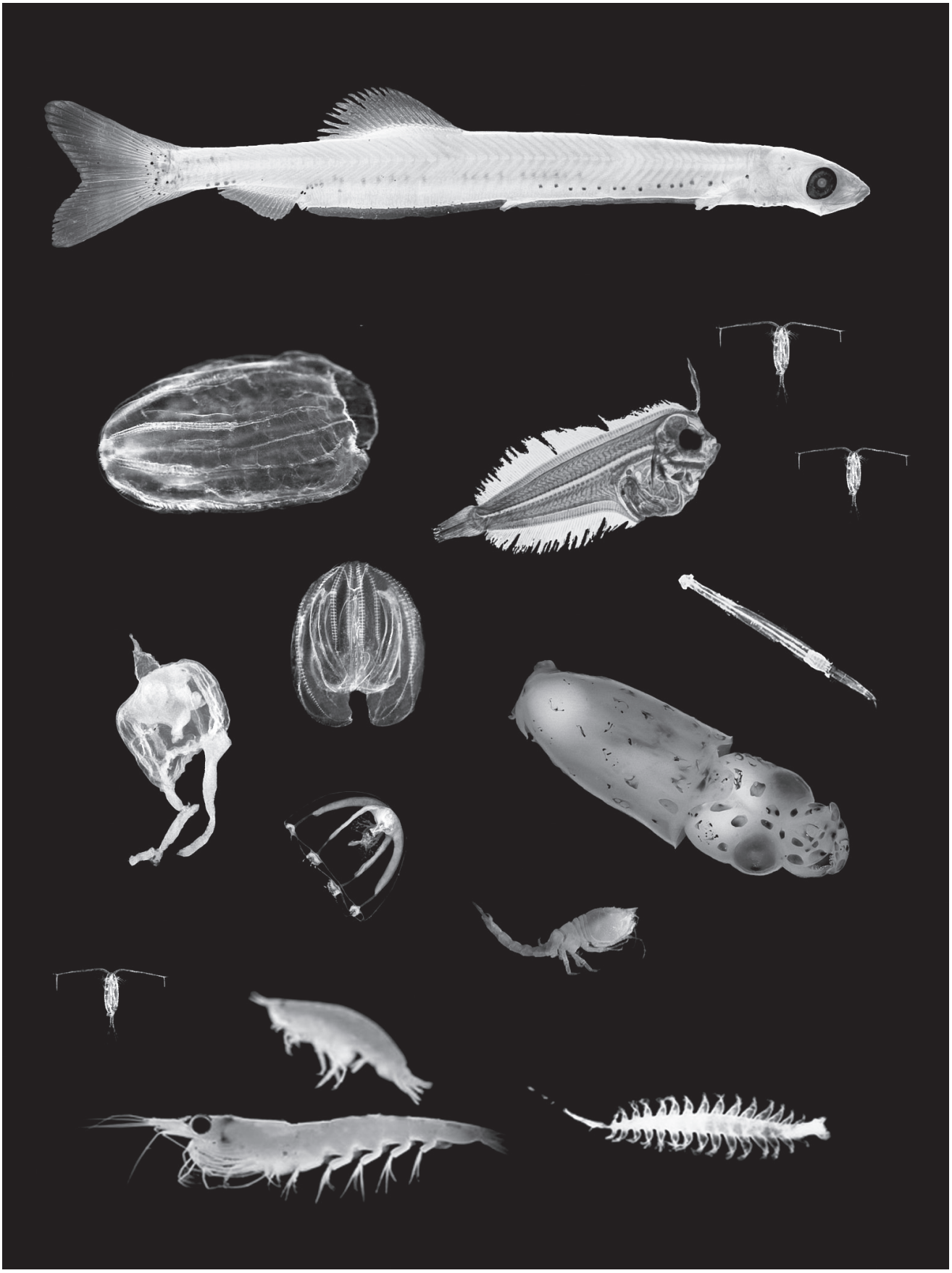
Cyanea lamarckii is the most frequently observed scyphozoan in this study. Its occurrence is in accordance with other jellyfish studies in the southern North Sea (BARZ & HIRCHE, 2007). In contrast to other species of Scyphozoa encountered, this jellyfish reached its highest densities offshore rather than nearshore (Table 2).

CONCLUSIONS

This study presents the first zooplanktonic inventory for the Belgian part of the North Sea in nearly 40 years. Among the 137 taxa encountered, nine are additions to the Belgian Register of Marine Species (BeRMS). We found 16 specimens of the very rare monstrilloid *Cymbasoma germanicum*, including several male specimens, which have not previously been described.

The calanoid copepod *Calanus finmarchicus* appears to have completely disappeared from the scene. The sole member of this genus in the collected samples is *C. helgolandicus*.

The distribution of the invasive coelenterates *Nemopsis bachei* and *Mnemiopsis leidyi* appears to have considerably expanded since their introduction in 1996 and 2007 respectively, as



they now occur along the entire Belgian coastline in well established populations.

This list contributes to the present-day knowledge of the total species richness in the southern North Sea and as such forms a valuable basis for ecological surveys.

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Fig. 2. – The pelagic is the biggest habitat in Belgium, in fact on a broader scale it is the biggest habitat in the world. Not only is it big, it is also very important. Almost all fish species - including all commercial fish we want on our plate such as sole *Solea solea*, place *Pleuronectes platessa* and cod *Gadus morhua* - have a pelagic larval phase. These fish species must keep in step with their planktonic food sources, for this is what their larvae eat. Therefore we must consider this as a possible "planktonic bottleneck". Combine this with the fact that the zooplankton is very susceptible to a changing climate (some species are moving north by 40km/y), due to shifts in sea water temperature, oceanic inflow and phytoplankton production and it becomes easy to understand why in many countries lots of minds are bent towards zooplanktonic research.
I hope that this illustration draws attention to the great zooplanktonic biodiversity in the Belgian part of the North Sea, portrayed in this manuscript.
From top to bottom and left to right: *Clupea harengus* larva; *Cymbasoma germanicum* female and male, *Arnoglossus laterna* larva, two *Calanus helgolandicus*, *Mnemiopsis leidyi*, *Sagitta setosa*, *Amphinema dinema*, *Nemopsis bachei*, *Loligo* sp. juvenile, *Diastylis rathkei*, *Aurelia aurita*, *Nyctiphanes couchii*, *Tomopteris helgolandica*.

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