Diversity and Copepods'composition off Moroccan Atlantic Coast (Northwest Africa): A Review

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Abstract

This overview sums up the results of main investigations and knowledge about zooplankton off Moroccan Atlantic coast. Copepods diversity, spatial distribution, seasonal variability and hydrology off Moroccan Atlantic coast are given. A compilation of taxonomic list of copepods' species found therein was established from published studies, they accounted for 210. Diversity and richness varied strongly between seasons, an onshore offshore gradient was observed as well. Species composition differed from northern to southern Moroccan Atlantic coast although most dominant species off Morocco's coasts were *Calanus helgolandicus, Paracalanus parvus, Acartia clausi* and *Corycaeus typicus*. In addition, the largest number of species was found in upwelling regions. A synthesis study was established in order to spatial distribution of copepods along Moroccan Atlantic coast. The Factorial Correspondence Analysis of copepod species characterizing the most important sectors has shown different patterns of copepods distribution across Moroccan Atlantic coast; three main areas were clearly segregated according to their taxonomic composition (Northern, Central and Southern Atlantic).

Keywords: Canary Current Large Marine Ecosystem, Copepods, Hydrology, NW Africa, Zooplankton

Introduction

Fishing industry is one of the pillars of Morocco's economy. Therefore, any factors involving this area will directly impact on this country's economy. That is why research in this field is crucial. Actually, rapid changes in the zooplankton dynamics may affect the biomass of many fish stocks (Harris, 1996). It is well-known that upwelling areas are considered as the most productive regions of the oceans (Longhurst et al., 1995, Jennings et al., 2001, Carr, 2002). Indeed, numerous studies, off Morocco and elsewhere, have shown strong relationship between upwelling activity and fish recruitment and distribution (e.g. Dickson et al., 1988, Belvèze & Erzini, 1983, Rodriguez et al., 1999, Berraho et al., 2012).

The first zooplankton investigations off the Moroccan Atlantic coast were done by Furnestin (1957). Later, several studies about zooplankton and especially copepod's distribution were conducted within the Moroccan coastal system (Furnestin, 1976, Belfequih, 1980, Chiahou, 1990, Chiahou & Ramdani, 1996, Chiahou, 1997, Chiahou et al., 1998, Somoue, 2004, Youssara et al., 2004, Somoue et al., 2005, Salah et al., 2012, Somoue et al., 2013, Zizah et al., 2012, Salah et al., 2013, El Arraj et al., 2015). All over the world zooplankton and copepod research has been increasing, however only a few studies (1 to 3/year) have been published about their distribution within the CCLME (Canary Current Large Marine Ecosystem) during the last two decades (Fig. 1).

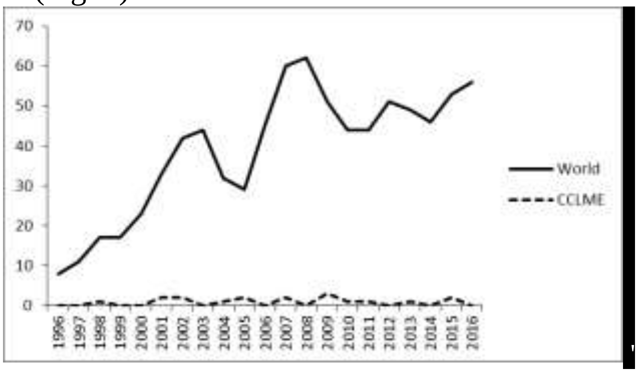

Fig. 1. Number of published papers on 'Science-direct' containing the words: zooplankton, copepod and Canary system in the title, abstract or keywords (from 1996 to 2016).

The Moroccan Atlantic coast is part of the Canary Current System (CCS) which extends between the Iberian Peninsula (43°N) and the south of Senegal (8°N), and dominates most hydrodynamic processes therein. Circulation along the Moroccan coast is determined by the Azores of the Saharan depression seasonal rhythm and ITCZ (Inter Tropical Convergence Zone) as well (Wooster et al., 1976, Parrish et al., 1983) (Fig. 2).

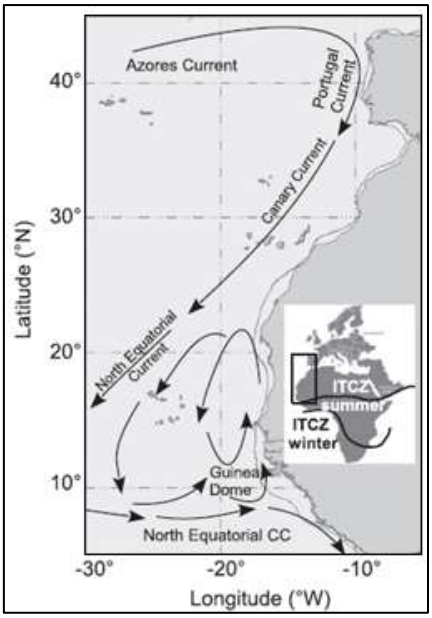

Fig. 2. Main surface currents: Azores, Portugal, Canary, North Equatorial current and North Equatorial counter-current. The 200 m isobath is superimposed (Benazzouz et al. 2014).

Hydrology therein is mainly submitted to the action of upwelling phenomena (e.g. Barber & Smith, 1981, Mann & Lazier, 1991, Cushing, 1989, Barton, 1998, Arístegui, et al. 2009). Upwelling activity along this stream is not regular and often occurs in some regions of the coast according to their topography. These areas are often close to the capes (Binet, 1988, Mittelstaedet, 1991, Ould Dedah, 1995, Longhurst, 1998). Consequently, an enhancement of nutrients is induced which leads to a significant growth of phytoplankton (Fig. 3) and zooplankton (Pauly & Christensen, 1995). The highest densities of zooplankton are found during upwelling activity; especially near-shore (Bainbridge, 1972).

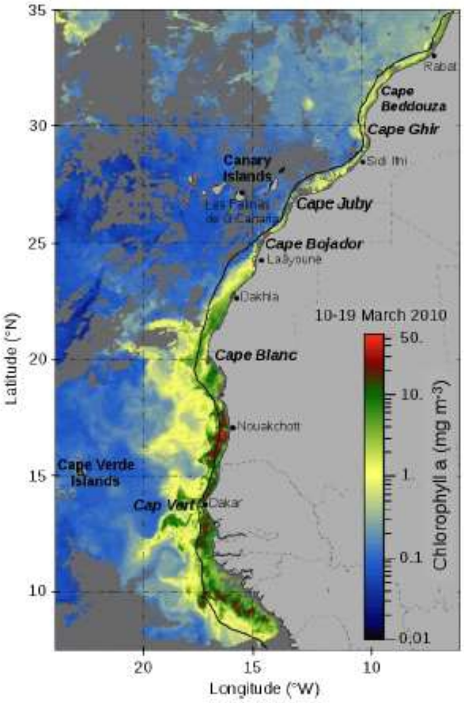

Fig. 3. Average chlorophyll-a computed from MODIS sensor data for the period 10-19 March 2010, The 200 m bathymetry contour (black line) is added (Demarcq & Somoue, 2015).

Since copepods are among the most numerous multicellular organisms in the Moroccan coastal system and they represent 80% of the total biomass of plankton in the oceans (Verity & Smetacek, 1996), special attention will be given to this group in this review. In this paper, we review the main information mentioned in the literature in order to state results about distribution and composition of mesozooplaknton; especially copepods; in Moroccan Atlantic coast. Our review provides an overview of the work conducted off the Moroccan Atlantic coast summarizing all the literature available and identifying gaps in our knowledge. This paper is not an exhaustive review of all mesozooplankton information, but we attempt to document the present state of our knowledge of this component in relation to spatial and temporal oceanographic patterns off Moroccan Atlantic coast. We particularly describe the main findings about copepods recorded until now within this area.

Study area: Hydrography and upwelling

Zooplankton abundances and community structure in coastal ecosystems are closely related to environmental changes in temperature, salinity, chlorophyll, nutrients, turbulence and particularly upwelling activity

(Harris et al., 2000, Calbet et al., 2001, Lawrence et al., 2004, Alcaraz et al., 2007, Glushko & Lidvanov, 2012). The pelagic resources off Atlantic Moroccan coast are mainly influenced by upwelling activity (Makaoui et al., 2005). Therefore, in order to establish distribution patterns of zooplankton in pelagic ecosystem, it is necessary to study and understand the circulation and distribution of water masses (Boltovskoy, 1999). Since the 70’s several studies have dealt with the Moroccan upwelling system of Atlantic coast where Latitudinal change from perennial to seasonal upwelling is observed (e.g. Hughes & Barton, 1974, Johnson et al., 1975, Mittelstaedt et al., 1975, Mittelstaedt & Hamann, 1981, Mittelstaedt, 1991, Hernández-Guerra & Nykjær, 1997, Makkaoui et al., 2005, Troupin, 2011, Makaoui et al., 2012, Laarisi et al., 2013, Benazouz et al., 2014). Makaoui et al. (2005) subdivided Moroccan Atlantic coast to four main sectors according to their upwelling activities: cape Ghir-cape Cantin (30°-33°N), cape Juby-cape Draa (28°-29°N) (characterized by an upwelling activity during summer), Dakhla-cape Bojador (24°-26°N), and cape Blanc-cape Barbas (21°-22°N) (upwelling activity throughout the year). Equally, Marcello et al. (2011) have identified two main upwelling areas: cape Juby-cape Ghir (28°-30°N) (seasonal upwelling) and cape Blanc-cape Bojador (21°-26°N) (perennial upwelling activity) which corroborate with previous studies (Mittelstaedt 1991, Hernández-Guerra & Nykjær 1997, Pelegri et al. 2005). In fact, the distribution of planktonic organisms is chiefly determined by currents and water masses (Chiahou 1997, Cheggour 1998, Hernández-León et al. 2002, Pelegri et al. 2005). Off cape Blanc (21°N), upwelling intensity shows an important variability on short scales (daily/weekly) (e.g. Mittelstaedt, 1991, Nykjær & Van Camp, 1994, Barton, 1998, Susek, 2005) and the productivity therein is highest in boreal winter (winter) and spring. Sea-surface temperatures (SST) are low ~ 18°C (Fig. 4) and yearly sea-surface salinity (36.2 psu) too (Indicating South Atlantic Central Water as the source of the upwelled water). As to sea-surface nitrate and phosphate concentrations, high values were recorded off this area; up to about 5 $\mu mol.L^{-1}$ and 0.4 $\mu mol.L^{-1}$ respectively (WOA, 2005).

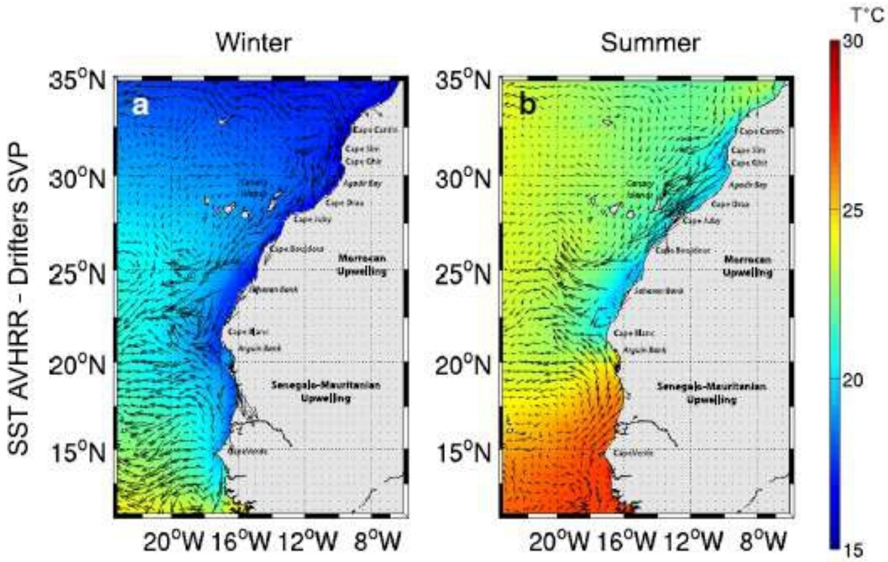

Fig. 4: Seasonal climatology of sea surface temperature (SST in background) and near-surface currents (vectors) from AVHRR satellite data (1985–2009) and the Global Drifter Program (1979–present, Lumpkin and Johnson, 2013) in winter and summer (Auger et al. 2015).

Thus, the southern area, between Cap Blanc (21°N) and cape Bojador (26°N) is considered as the most productive, thanks to its intense and permanent upwelling activity (Fig. 5) (Minas et al., 1982, Binet, 1991, Makaoui et al., 2005, Benazouz et al., 2014, Cropper et al., 2014).

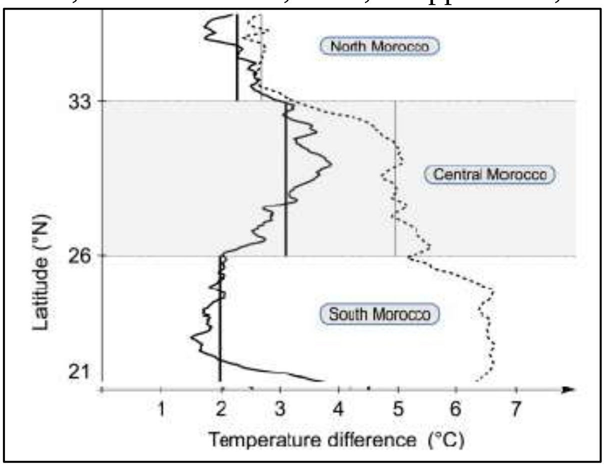

Fig. 5. Latitudinal classification of the upwelling activity off Morocco based on the average value of thermal zonal difference (discontinuous line) and its seasonal amplitude (continuous line). The vertical bars help to visualize the average values of the parameters (Modified from Benazzouz et al. 2014).

Off these two capes, intensity of upwelling is apparently increasing with global warming (Hughes & Barton, 1974). In the region of cape Ghir

(30°N), Salah et al (2012) have used the neritic species *A. clausi* to follow the flow of the upwelling filament from inshore to offshore. In the same study, chlorophyll-*a* seemed to be the major factor affecting mesozooplankton's biomass. Periods characterized by low temperature were the richest. The same results were found between cape Blanc (21°N) and cape Bojador (26°N) since a strong relationship was set between copepod abundance and diversity and low temperature and chl-*a* (Somoue et al., 2005).

Copepods: Specific composition and seasonal variability

Several authors have observed dominance of copepods among zooplankton groups within the Moroccan Atlantic coast (e.g. Furnestin, 1957, Thiriot, 1978, Belfequih, 1980, Chiahou & Ramdani, 1997, Chiahou et al., 1998, Somoue et al., 2005, Youssara et al., 2004, Salah et al., 2012, Zizah et al., 2012, Zaafa et al., 2012, Salah et al., 2013, Zaafa et al., 2014). Recently, their relative abundances were calculated across CCLME system; they are about 60-95% of total zooplankton abundance (Berraho et al., 2015). Main copepods studies conducted off Moroccan Atlantic system are described in table 1. Although the checklist of copepods' species is from different expeditions with different sampling methods, all of them were focusing on mesozooplankton (>160 – 200 µm).

In our study, 210 species of copepods were recorded off the Moroccan Atlantic coast according to data collected from literature (see table 2). Recently, copepods composition has been reviewed within the same study area (cape Spartel 36°N-cape Blanc 21°N) by Berraho et al. (2015) who reported 104 species; 103 of these species found among species listed on table 2 except the species *Clausocalanus parapergens.*

Within the Moroccan continental shelf, several authors have recorded higher diversity offshore than inshore stations (e.g. Grall et al., 1974, Belfequih, 1980, Boucher, 1987, Somoue, 2004, Salah et al., 2012, El Arraj et al., 2015) which is probably due to the extension of the filaments generated from Canary Current which are born near the capes of African coast since they are a result of the interaction of the current with the coastal cape morphology (Hagen et al., 1996, Hernández-Guerra & Nykjær, 1997, Barton et al., 1998, Stevens & Johnson, 2003). They could extend for hundreds of kilometers offshore at pronounced capes like cape Ghir (30°N), cape Juby (28°N) and cape Blanc (21°N) (Van Camp et al., 1991, Nykjær & Van Camp, 1994, Hernández-Guerra & Nykjær, 1997, Hagen, 2001).

Somoue (2004) has noted greater richness within the southern region of Dakhla (24°N) than in the northern area (26°-24°N).

Earlier, Furnestin (1957) has found important abundances during autumn along Moroccan Atlantic shore. According to Somoue (2004), in winter, higher copepods densities (3-183 ind. m^{-3}) were observed within latitudes 21°N, 22°30N, 23°30N, 25°N and 26°N. During summer, their densities were relatively low (2-83 ind. m^{-3}) except in cape Blanc (21°N) and cape Barbas (22°N) whereas in the northern part of Morocco, high abundances were recorded within inshore stations, particularly during warm seasons (spring and summer) compared to autumn (Zaafa et al., 2012, 2014).

Generally, copepods are more abundant during hot seasons within several studied areas along Moroccan Atlantic coast (Belfequif, 1980, Chiahou & Ramdani, 1996, Zizah et al., 2012, Salah et al., 2013, Somoue et al., 2013). Actually, their seasonal variability is closely related to hydrological characteristics and phytoplankton dynamic while inter-annual variability is apparently related to atmospheric circulation (Valdés & Moral, 1998). By contrast, diversity and richness were higher during cold seasons coinciding with upwelling activities (e.g. Chiahou & Ramdani, 1997, Somoue et al., 2005, Zaafa et al., 2010, Salah et al., 2013, Somoue et al., 2013).

Synthesis study

In order to illustrate geographical distribution of copepod species, we have selected upwelling areas of which data are available [(cape Spartel (36°N), cape Ghir (30°N), cape Juby (28°N), cape Bojador (26°N), cape Barbas (22°N) and cape Blanc (21°N)]. A Factorial Correspondence Analysis (FCA) was established between total species recorded within the six areas based on binary matrix (presence-absence) to visualize preferential geographic distribution of the species recorded within these areas. Although the campaigns were carried out during different seasons and conducted using different methods, this analysis had a descriptive objective ignoring sampling conditions (Fig. 6).

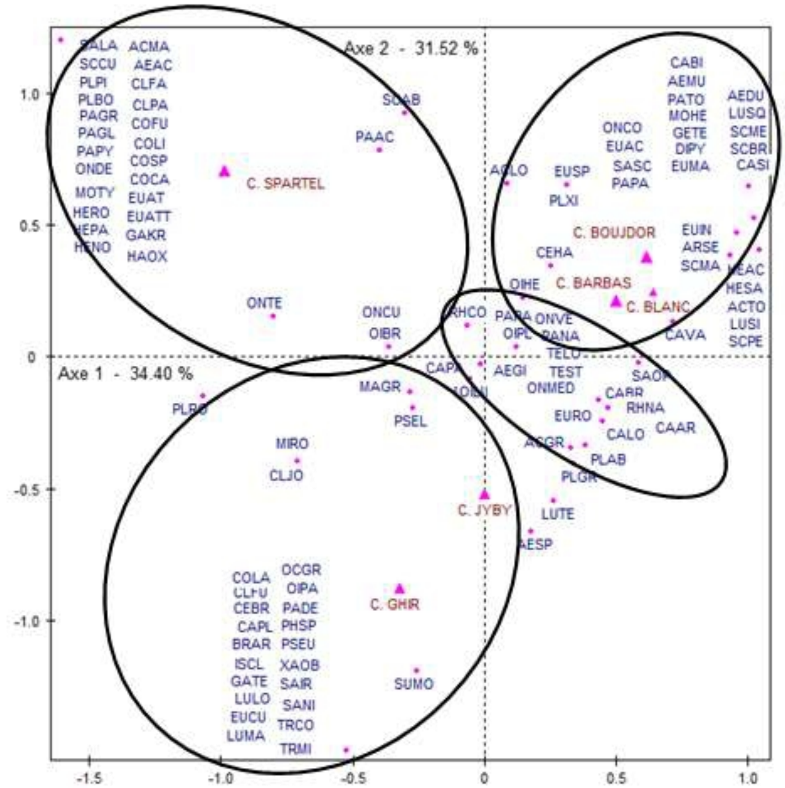

Fig. 6. FCA (Factorial Correspondence Analysis) of total species reported within Cape Spartel (36°N), Cape Ghir (30°N), Cape Juby (28°N), Cape Bojador (26°N), Cape Barbas (22°N) and Cape Blanc (21°N) using the software ADE4 (Descriptive Analysis Ecological: methods Exploratory and Euclidean in Environmental Sciences). "Four capital letters indicate species name of dominant species at each region (cf. Table 2)".

As a result, the factorial plan F1XF2 presented 65.92% of total inertia at the rate of 34.40% for F1 axis and 31.52% for F2 axis. Therefore, the projection of species on the factorial plane reveals a segregation of 4 distinguished groups of species. The first assemblage that includes only the three capes of the southern area: cape Bojador (26°N), cape Barbas (22°N) and cape Blanc (21°N). These three regions have in common a number of species which are for the most of them tropical to sub-tropical origin as *L. squillimana*, *A. tonsa* (Owre & Foyo, 1967). In addition, this group harbors the highest number of species. The second group included species of both capes of the central studied area (cape Ghir 30°N and cape Juby 28°N). Most of the species recorded therein have been qualified as predominant within the canary current system as *C. pavo, S. opalina, L. tenuicauda* (Lozano Sedovilla et al., 1988, Chiahou & Ramdani, 1998) whereas the region of cape Spartel (36°N) was individualized harboring Mediterranean, Lusitanian and boreal species as *A. margalefi, P. borealis, P. gracilis, M. typical, G.*

kruppi and *C. limbatus* (Mazza, 1967, Coen & Mazzocchi, 1985, Chiahou & Ramdani, 1998). According to Chiahou & Ramdani (1998), the faunistical exchange between the Mediterranean Sea and Atlantic Ocean is apparently easier than the exchange between the Moroccan Atlantic region and the Ibero-French area. Deep currents, bringing Mediterranean waters to Atlantic Ocean seems to have its maximum flow during summer and autumn (Furnestin, 1957). The fourth group contained species commonly recorded within at least 4 capes. Most of these species are cosmopolitan as cited bellow like *O. venusta, T. longicornis, T. stylifera, P. nanus, P. parvus* and *O. nana* (Belfquih, 1980, Nishida, 1985, Razouls, 1995, Razouls, 1996).

Conclusion and perspectives

Our results suggest that species mainly dominant within the study area are *C. helgolandicus, P. parvus, A. clausi* and *C. typicus*; they constitute the most abundant species of coastal zooplankton communities (e.g. Seguin, 1966, Belfquih, 1980, Boucher, 1982, Vieira et al., 2003). We conclude that three distinct regions were clearly individualized by their own composition and hydrological particularities: Northern, Central and Southern area. Although Moroccan Atlantic coast is one the most productive zones in the world, the southern part (from cape Bojador 26°N to cape Blanc 21°N) remains the richest owing to the heterogeneity of factors affecting this region; particularly to permanent upwelling activity therein. Many species considered as indicators of upwelling activity were recorded within this area like *C. helgolandicus* and *C. carinatus* (Bainbridge et al., 1960, De Decker, 1964, Seguin, 1966, Smith, 2000). Moreover, *C. helgolandicus* is a species widely distributed and closely related to the Canary Current System (Flenminger & Hulseman, 1973). The central zone harbors a large number of species as well, since it is submitted to a seasonal intense upwelling activity; most of them are Atlanto-Mediterranean species; while in the northern part, this activity is weaker and harbors species brought by the intrusion of Mediterranean waters.

More comprehensive studies need to be carried out researching the regular diurnal vertical flux monitoring of copepods, the consequences of the oxygen minimum zone (OMZ) on their distribution patterns, the trophic relations and information on size spectra which should enrich and improve our knowledge of biological resources. Sampling in the huge Moroccan Atlantic coast needs to be done more regularly in order to further understand the apparent self-regulatory micro- and mesozooplankton response to environmental conditions. Performing a large scale study is necessary for a better understanding of mesozooplankton communities' evolution and distribution across this area and their response to climate change.

Acknowlegments

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Tables

Table 1. Overview of the selected publications related to copepods in marine waters off Moroccan Atlantic coast.

Study Sites	Period of cruises	Nb. of Sp.	Dominant species	References
Cape Spartel (35°N)- Oued Draa (28°30’N)	February, May, August and November 1950.	100	*A. clausi, C. typicus, C. chierchiae, C. arcuicornis, C. helgolandicus*	Furnestin & Belfquih 1976.
		103	*A. clausi, C. chierchiae, C. typicus, C. arcuicornis, C. furcatus, E. acutifrons, O. nana, O. similis* and *P. parvus.*	Belfquih 1980.
Cape Blanc (21°N)- Cape Ghir (31°N)	February, May, August and November 1950.	87	*A. clausi, O. curta, O. nana, P. parvus. C. jobei, T. stylifera* and *T. longicornis.*	Boucher et al. 1982.
Region of El Jadida (33°30’N)	From December 1994 to December 1995 (2-3 sampling/month).	90	*A. discaudata, A. grani* and *Eucalanus crassus.*	Chiahou & Ramdani 1996.
Region of Agadir (31°N)	From May 1999 to December 2000 (1 sampling/15 days).	36	*A. clausi* and *P. parvus.*	Youssara et al. 2004.
Cape Bojador (26°N)- Cape Blanc (21°N)	March and July 1998.	79	*C. helgolandicus, P. parvus, A. clausi* and *C. typicus.*	Somoue et al. 2005.
Cape Ghir (31°N)	December 2008, February, April, June and October 2009.	86	*O. similis, O. nana, O. venusta, A. clausi, P. parvus, E. acutifrons O. plumifera, C. helgolandicus* and *C. arcuicornis.*	Salah et al. 2012.
Cape Bojador (26°N)- Cape Blanc	June and November 2007. June, November and July 2008.	85	*C. helgolandicus, P. parvus, A. clausi* and *C. typicus.*	Zizah et al. 2012.

(21°N)				
Cape Juby (28°N)	February, April, June and October 2009.	56	*A. clausi, E. acutifrons, O. similis, O. venusta* and *P. parvus.*	Salah et al. 2013.
Cape Spartel (35°N)	March, May and December 2006. May, July and November 2007.	85	*P. parvus* and *O. venusta..*	Zaafa et al. 2014.
Cape Bojador (26°N)- Cape Blanc (21°N)	November 2011 and July 2012.	76	*O. venusta, C. arcuicornus* and *A. clause..*	El Arraj et al. 2015.

Table 2. Taxonomic checklist of copepod species recorded off Moroccan Atlantic coast according to studies listed above "table 1" with their respective codes (only species mentioned in "Figs. 9 and 10" are coded).

Species	Code	Species	Code
Acartia (Acartiura) clausi Giesbrecht, 1889	ACCL	*Mecynocera clausi* Thompson I.C., 1888	
Acartia (Acartia) danae Giesbrecht, 1889	ACDA	*Megacalanus princeps* Wolfenden, 1904	
Acartia (*Acartiura) discaudata* (Giesbrecht, 1881)		*Mesocalanus tenuicornis* Dana, 1849	
Acartia (Acartiura) longiremis (Lilljeborg, 1853)	ACLO	*Metacalanus inaequicornis* (Sars G.O., 1903)	
Acartia (Acartiura) margalefi Alcaraz, 1976	ACMA	*Metridia brevicauda* Giesbrecht, 1889	
Acartia (Acartia) negligens Dana, 1849		*Metridia lucens* Boeck, 1865	
Acartia (Acanthacartia) tonsa Dana, 1849	ACTO	*Metridia macrura* Sars G.O., 1905	MEMA
Aegisthus aculeatus Giesbrecht, 1891	AEAC	*Metridia princeps* Giesbrecht, 1889	
Aegisthus mucronatus Giesbrecht, 1891	AEMU	*Metridia venusta* Giesbrecht, 1889	
Aegisthus spinulosus Farran, 1905		*Microcalanus pusillus* Sars G.O., 1903	
Aetideus armatus (Boeck, 1872)	AESP	*Microsetella norvegica* (Boeck, 1865)	MINO
Aetideus giesbrechti Cleve, 1904	AEGI	*Microsetella rosea* (Dana, 1847)	MIRO
Aetideopsis armatus (Boeck, 1872)		*Miracia efferata* Dana, 1849	
Aetideopsis carinata Bradford, 1969		*Monacilla typica* Sars G.O., 1905	MOTY
Aetideopsis multiserrata (Wolfenden, 1904)		*Monstrilla grandis* Giesbrecht, 1891	
Agetus limbatus (Brady, 1883)	AGLI	*Monstrilla helgolandica* Claus, 1863	MOHE
Agetus flaccus (Giesbrecht, 1891)		*Monstrillopsis dubia* Scott T., 1904	
Agetus typicus Krøyer, 1849	AGTY	*Nannocalanus minor* (Claus, 1863)	NAMI
Anomalocera patersoni Templeton, 1837		*Neocalanus gracilis* (Dana, 1852)	NEGR
Arietellus setosus Giesbrecht, 1893	ARSE	*Neocalanus robustior* (Giesbrecht ,1888)	
Augaptilus longicaudatus (Claus, 1863)		*Nullosetigera bidentata* (Brady, 1883)	
Augaptilus megalurus Giesbrecht, 1889		*Oculosetella gracilis* (Dana, 1849)	OCGR
Augaptilus spinifrons Sars G.O., 1907		*Oithona brevicornis* Giesbrecht, 1891	OIBR
Bradyidius armatus (Vanhöffen, 1897)	BRAR	*Oithona linearis* Giesbrecht, 1891	OILI
Calanoides carinatus (Krøyer, 1849)	CACA	*Oithona nana* Giesbrecht, 1893	OINA
Calocalanus finmarchicus (Gunnerus, 1770)	CAFI	*Oithona parvula* (Farran, 1908)	OIPA
Calanus hyperboreus Krøyer, 1838		*Oithona plumifera* Baird, 1843	OIPL
Calocalanus contractus Farran, 1926	CACO	*Oithona setigera* (Dana, 1849)	
Calocalanus pavo (Dana, 1852)	CAPA	*Oithona similis* Claus, 1866	OISI
Calocalanus plumulosus (Claus, 1863)	CAPL	*Oncaea curta* Sars G.O., 1916	ONCU
Calocalanus styliremis Giesbrecht, 1888		*Oncaea media* Giesbrecht, 1891	ONME

Candacia armata Boeck, 1872	CAAR	*Oncaea mediterranea* (Claus, 1863)	
Candacia bipinnata (Giesbrecht, 1889)	CABI	*Oncaea notopus* Giesbrecht, 1891	
Candacia elongata (Boeck, 1872)		*Oncaea tenella* Sars G.O., 1916	ONTE
Candacia ethiopica (Dana, 1849)		*Oncaea venusta* Philippi, 1843	ONVE
Candacia longimana (Claus, 1863)	CALO	*Onchocorycaeus latus* (Dana, 1849)	ONLA
Candacia simplex (Giesbrecht, 1889)	CASI	*Onchocorycaeus ovalis* (Claus, 1863)	
Candacia tenuimana (Giesbrecht, 1889)		*Paracalanus aculeatus* Giesbrecht, 1888	PAAC
Candacia varicans (Giesbrecht, 1893)	CAVA	*Paracalanus denudatus* Sewell, 1929	PADE
Centropages bradyi Wheeler, 1900	CEBR	*Paracalanus nanus* Sars G.O., 1925	PANA
Centropages chierchiae Giesbrecht, 1889	CECH	*Paracalanus parvus* (Claus, 1863)	PAPA
Centropages hamatus (Lilljeborg, 1853)	CEHA	*Paracalanus pygmaeus* (Claus, 1863)	PAPY
Centropages Krøyeri Giesbrecht, 1893		*Paracartia grani* Sars G.O., 1904	PAGR
Centropages typicus Krøyer, 1849	CETY	*Paraeuchaeta barbata* (Brady, 1883)	
Centropages violaceus (Claus, 1863)		*Paraeuchaeta bisinuata* (Sars G.O., 1907)	
Chirundina streetsii Giesbrecht, 1895		*Paraeuchaeta glacialis* (Hansen, 1887)	PAGL
Clausocalanus arcuicornis (Dana, 1849)		*Paraeuchaeta gracilis* (Sars G.O., 1905)	PAGR
Clausocalanus farrani Sewell, 1929	CLFA	*Paraeuchaeta hebes* (Giesbrecht, 1888)	
Clausocalanus furcatus (Brady, 1883)	CLFU	*Paraeuchaeta norvegica* (Boeck, 1872)	
Clausocalanus jobei Frost & Fleminger, 1968	CLJO	*Paraeuchaeta sarsi* (Farran, 1908)	
Clausocalanus mastigophorus (Claus, 1863)		*Paraeuchaeta tonsa* (Giesbrecht, 1895)	PATO
Clausocalanus paululus Farran, 1926	CLPA	*Paraeuchaeta sp.*	
Clausocalanus pergens Farran, 1926	CLPE	*Paraheterorhabdus robustus* (Farran, 1908)	PARO
Clytemnestra gracilis (Claus, 1891)		*Pareucalanus attenuatus* (Dana, 1849)	PAAT
Clytemnestra scutellata Dana, 1847		*Phaenna spinifera* Claus, 1863	PHSP
Copilia mediterranea (Claus, 1863)		*Pleuromamma abdominalis* (Lubbock, 1856)	PLAB
Copilia quadrata Dana, 1849		*Pleuromamma borealis* Dahl F., 1893	PLBO
Corycaeus clausi Dahl F., 1894	COCL	*Pleuromamma gracilis* Claus, 1863	PLGR
Corycaeus crassiusculus Dana, 1849		*Pleuromamma piseki* Farran, 1929	PLPI
Corycaeus obtusus Dana, 1849		*Pleuromamma robusta* (Dahl F., 1893)	PLRO
Corycaeus speciosus Dana, 1849	COSP	*Pleuromamma xiphias* (Giesbrecht, 1889)	PLXI
Corycaeus sp.		*Pontella atlantica* (Milne Edwards, 1840)	
Ctenocalanus vanus Giesbrecht, 1888		*Pontella lobiancoi* (Canu, 1888)	
Cymbasoma thompsonii (Giesbrecht, 1893)		*Pontella sp.*	
Diaixis pygmaea (Scott T., 1894)	DIPY	*Pontellina plumata* (Dana, 1849)	
Ditrichocorycaeus anglicus (Lubbock, 1857)		*Pontellopsis regalis* (Dana, 1849)	
Eucalanus elongatus Dana, 1848	EUEL	*Pontellopsis villosa* Brady, 1883	
Euchaeta acuta Giesbrecht, 1893		*Pseudoamallothrix ovata* (Farran, 1905)	
Euchaeta marina Prestandrea, 1833	EUMA	*Pseudocalanus elongatus* (Boeck, 1865)	PSEL
Euchaeta pubera Sars G.O., 1907		*Pseudocalanus minutus* (Krøyer, 1845)	
Euchaeta spinosa Giesbrecht, 1893	EUSP	*Pseudhaloptilus eurygnathus* (Sars G.O., 1920)	PSEU
Euchirella curticauda Giesbrecht, 1888	EUCU	*Rhincalanus cornutus* (Dana, 1849)	RHCO
Euchirella messinensis (Claus, 1863)		*Rhincalanus nasutus* Giesbrecht, 1888	RHNA
Euchirella rostrata (Claus, 1866)	EURO	*Sapphirina gemma* Dana, 1852	
Euchirella truncata Esterly, 1911	EUTR	*Sapphirina intestinata* Giesbrecht, 1891	
Euchirella sp.		*Sapphirina iris* Dana, 1849	SAIR
Euterpina acutifrons (Dana, 1847)	EUAC	*Sapphirina lactens* Giesbrecht, 1893	SALA
Farranula carinata Giesbrecht, 1891	FACA	*Sapphirina nigromaculata* Claus, 1863	SANI
Farranula rostrata (Claus, 1863)		*Sapphirina opalina* Dana, 1849	SAOP
Gaetanus kruppii Giesbrecht, 1903	GAKR	*Sapphirina scarlata* Giesbrecht, 1891	SASC
Gaetanus tenuispinus (Sars G.O., 1900)	GATE		

Goniopsyllus rostratus Brady, 1883		*Sapphirina sp.*	SAAB
Haloptilus longicornis (Claus, 1863)		*Sarsarietellus abyssalis* (Sars G.O., 1905)	SCBR
Haloptilus oxycephalus (Giesbrecht, 1889)	HAOX	*Scaphocalanus brevicornis* (Sars G.O., 1900)	SCCU
Heterocope saliens (Lilljeborg, 1863)	HESA	*Scaphocalanus curtus* (Farran, 1926)	
Heteroptilus acutilobus (Sars G.O., 1905)	HEAC	*Scaphocalanus echinatus* (Farran, 1905)	SCMA
Heterorhabdus abyssalis (Giesbrecht, 1889)		*Scaphocalanus magnus* (Scott T., 1894)	SCME
Heterorhabdus norvegicus (Boeck, 1872)	HENO	*Scaphocalanus medius* (Sars G.O., 1907)	
Heterorhabdus papilliger (Claus, 1863)	HEPA	*Scolecithricella dentata* (Giesbrecht, 1893)	
Heterorhabdus spinifrons (Claus, 1863)		*Scolecithricella minor* (Brady, 1883)	
Isias clavipes Boeck, 1865	ISCL	*Scolecithrix bradyi* Giesbrecht, 1888	
Labidocera brunescens (Czerniavsky, 1868)		*Scolecithrix danae* (Lubbock, 1856)	
Labidocera pavo Giesbrecht, 1889		*Scottocalanus helenae* (Lubbock, 1856)	SCPE
Labidocera wollastoni (Lubbock, 1857)		*Scottocalanus persecans* (Giesbrecht 1895)	
Labidocera sp.		*Subeucalanus crassus* (Giesbrecht, 1888)	
Lubbockia squillimana Claus, 1863	LUSQ	*Subeucalanus monachus* (Giesbrecht, 1888)	TELO
Lucicutia clausi (Giesbrecht, 1889)		*Temora longicornis* Müller O.F., 1785	TEST
Lucicutia magna Wolfenden, 1903		*Temora stylifera* (Dana, 1849)	TRCO
Lucicutia flavicornis (Claus, 1863)	LUFL	*Triconia conifera* (Giesbrecht, 1891)	TRDE
Lucicutia gemina Farran, 1926		*Triconia dentipes* (Giesbrecht, 1891)	TRMI
Lucicutia longicornis (Giesbrecht, 1889)	LULO	*Triconia minuta* (Giesbrecht, 1893 ["1892"])	
Lucicutia longiserrata (Giesbrecht, 1889)		*Undeuchaeta plumosa* (Lubbock, 1856)	
Lucicutia maxima Steuer, 1904	LUMA	*Undinula vulgaris* (Dana, 1849)	URFU
Lucicutia tenuicauda Sars G.O., 1907	LUTE	*Urocorycaeus furcifer* (Claus, 1863)	
Macrosetella gracilis (Dana, 1847)	MAGR	*Valdiviella insignis* Farran, 1908	XAOB
		Xanthocalanus obtusus Farran, 1904	

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