



Plankton net mesh size influences the resultant diversity and abundance estimates of copepods in tropical oligotrophic ecosystems

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ABSTRACT

Quantitative assessment of planktonic organisms is a key issue in understanding biodiversity, biomass, and carbon fluxes in marine ecosystems during the ongoing Anthropocene. However, the implications of the choice of plankton sampling equipment in tropical marine ecosystems have not been fully addressed. The goal of this study was to investigate the abundance and diversity of copepods derived from two different mesh sizes, 120 and 300 μm , to determine differences that may change our perception of the actual role of the key planktonic organisms in tropical marine ecosystems, due to the fact that missing information may be a real problem in trophic estimations (e.g. benthic-pelagic coupling processes in coastal areas). Samples were collected along 650 km of coastline in the Equatorial Atlantic. The average abundance of copepods calculated using the 120 μm net was five times higher than that of the 300 μm net. However, species richness was higher when using the 300 μm net compared to that of the 120 μm . Using the 300 μm net, the number of exclusive taxa (not found in the 120 μm mesh sampling) was higher. The Venn diagram showed that 10% of the copepod taxa were recorded exclusively in 120 μm net, whereas only 30% occurred in the 300 μm net. To improve our understanding of the structure and functioning of tropical marine ecosystems, plankton nets with smaller mesh openings should always be used to estimate abundance because of the dominance of small organisms in the nutrient-poor food webs, giving a new perspective on the available energy in water column and benthic processes of suspension feeding organisms. The absence of these smaller nets will produce an inaccurate picture of the plankton communities and their contributions to other trophic levels, including the blue carbon budget estimates worldwide.

1. Introduction

Small planktonic marine copepods (<1 mm in length) are undoubtedly the most abundant marine animals on Earth (Turner, 2004) and can be assessed in terms of biodiversity and abundance (Hopcroft et al., 1998). These copepods play a key role in the trophic webs and the biological pump (Guidetti et al., 2016) because they feed on autotrophic and heterotrophic protists (Calbet, 2008), the marine snow (Kiorboe, 2001), bacteria (Roff et al., 1995), and are the main source of food for many pelagic organisms (Turner, 2004). Moreover, they also transfer carbon to the seafloor that may be captured by suspension feeders on the benthic-pelagic coupling (Coma et al., 2001; Rossi et al., 2019) or sequestered and buried in the coastal and ocean sediments (Macreadie et al., 2019). Copepod abundance is thus one of

the keys to estimating the blue carbon budget (Guidetti et al., 2016).

Zooplankton can be an important contributor to particulate organic carbon exportation through the production of sinking fecal pellets, eggs, mucous feeding webs, molts, and carcasses (Steinberg and Landry, 2017). Planktonic Copepoda (already exhibiting small sizes in confined and mesotrophic-eutrophic areas) (Belmonte and Cavallo, 1997; Uye, 1994) are expected to shift their dominance towards smaller individuals in response to climate change (Daufresne et al., 2009; Smetacek and Cloern, 2008). This ongoing process during the Anthropocene will affect carbon capture by planktonic organisms, their exportation to the ocean floor, possibly weakening benthic-pelagic coupling processes (Rossi et al., 2019).

In the present-day warm and oligotrophic waters, such as tropical ones, the phytoplankton community is dominated by very small cells

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(<2 μm), unable to be directly consumed by mesozooplankton because of the morphological limitation of their food system (Calbet and Landry, 1999; Hansen et al., 1994). Thus, nauplii and copepodites (juvenile forms), which feed on particles smaller than those used by large copepods, transfer the energy from the microbial loop to the metazoan food webs (Azam et al., 1983; Hopcroft et al., 2001). Despite their importance in sustaining biological pumps and the underpinning function in tropical marine ecosystems (Ibarbalz et al., 2019), the abundance and composition of copepods are not satisfactorily characterized and compared because of the use of inappropriate mesh nets in the sampling regime (Tseng et al., 2011).

Although tropical and subtropical waters cover 42% of the coastal regions worldwide (Longhurst and Pauly, 1987), little is known about comparing the efficiency of plankton mesh net size and its potential implications on marine food web energy fluxes (Tseng et al., 2007, 2011) at the global scale. The quantitative assessment of tropical plankton is a key issue to characterizing the biological pump and carbon exportation fluxes to the seafloor and benthic suspension feeders (Guidi et al., 2016; Makabe et al., 2012), but the choice of the sampler is not simple (Bernardi, 1984). In fact, it is an axiom in plankton research wherein no sampler or combination of samplers can provide a true abundance estimative for all planktonic components of the water column at any time (Owens et al., 2013).

The efficiency of the collecting instrument is usually related to the composition, structure, and abundance of the population to be sampled and the characteristics of the marine environment (Riccardi, 2010). When a plankton net-type sampler is used, it is necessary to choose an option with a net mesh size of suitable dimensions to avoid incorrect estimative of the zooplankton (Belmonte et al., 2013). These errors have serious implications for understanding the role of plankton in blue carbon quantification (Macreadie et al., 2019) and the carbon immobilization through benthic-pelagic coupling processes (Coppari et al., 2019) in marine animal forests (Rossi et al., 2019), or in seed banks in bottom sediments (Belmonte and Rubino, 2019). Moreover, they will produce biases in the scenarios of climate change impacts and energy fluxes on tropical marine ecosystems (Rossi et al., 2019), such as shallow-water coral reefs (<30 m depth) and mesophotic coral ecosystems (~30–150 m depth) (Soares et al., 2016, 2020) that are important biodiversity hotspots globally.

In the present study, we tested the hypothesis that the 120 μm mesh nets collect a higher abundance and diversity of copepods than the 300 μm mesh nets in a warm, nutrient-poor region. The final target was to investigate the copepod assemblages captured with the 120 and 300 μm mesh nets, analyze the derived calculations for the abundance, diversity, and frequency of occurrence in an extensive oligotrophic Equatorial area to better understand how much energy may be transferred in pelagic or benthic processes. Smaller nets will potentially provide a more

methodological approach to measuring plankton communities and their contributions to benthic-pelagic coupling in tropical marine ecosystems (e.g., coral reefs), as well as blue carbon budget estimates worldwide.

2. Methodology

2.1. Study area

The study area is located in the Equatorial Southwestern Atlantic (Fig. 1), on a 650 km coastline with a continental shelf width of 35–90 km. In this area, there is an influence of the warm and fast-flowing North Brazil Current. The pelagic ecosystem has warm continental waters with higher (>26 $^{\circ}\text{C}$), stable sea temperatures and is considered a nutrient-poor (oligotrophic) zone (Teixeira and Machado, 2013). This zone is immersed in the continuous subequatorial atmospheric circulation of the trade winds, which are persistent and intense throughout the year (Ferreira and Mello, 2005). The climate is dry (semiarid), and the coastal estuaries are shallow, with overall low river flow (Schettini et al., 2017).

Tropical estuaries influencing this area include the Parnaíba River Delta, which is the largest deltaic formation in the Americas (Guimaraes-Costa et al., 2019), and the Jaguaribe River estuary, which has the largest hydrographic basin in the Brazilian semiarid coast (Dias et al., 2013) (Fig. 1). Historical data of river runoff show a reduction in riverine contributions to the continental shelf waters because of the construction of multiple dams along the hydrographic basin (Schettini et al., 2017). These probably decrease the exportation of organic matter from the estuaries to the inner continental shelf. This tropical coast shelters extensive marginal coral reefs in shallow and mesophotic depths (Soares et al., 2016, 2020), rhodolith and seagrass beds (Costa et al., 2020), as well as mangrove forests (Ferreira and Lacerda, 2016). In general, during dry season, there is no difference of salinity, dissolved oxygen (mg/L), temperature ($^{\circ}\text{C}$), conductivity or pH among continental shelf regions (Campos et al., 2017).

2.2. Plankton sampling

Sampling was conducted on two occasions (July and October) during the dry season of 2010. A coastal profile line was drawn parallel to the coast and had 18 sampling stations along 650 km at the inner continental shelf (Fig. 1). Zooplankton samples were collected via 5 min superficial horizontal hauls using two conical plankton nets (mouth opening: 50 cm, mesh size: 120 and 300 μm) equipped with a flowmeter. Two samples were collected per station site, one with 120 μm mesh net and other with 300 μm mesh net, totaling 36 samples. After collection, the samples were immediately fixed with 4% formalin buffered with 4 g/L sodium tetraborate.

In the laboratory, each sample was fractionated with a Motoda-type

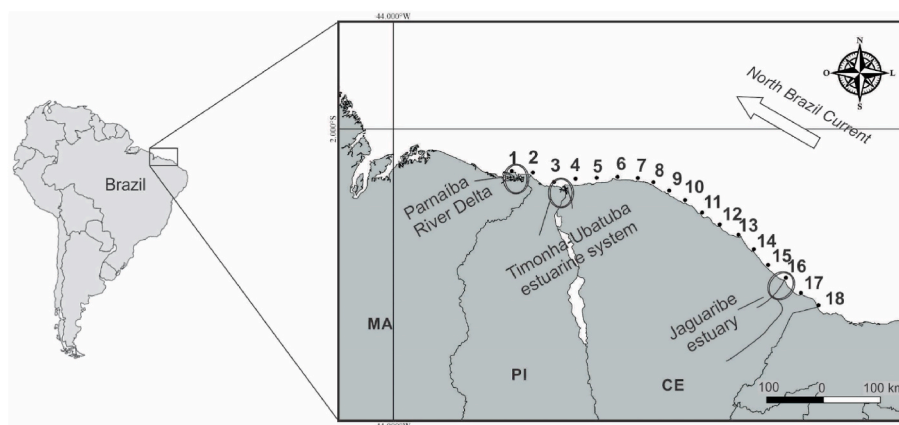


Fig. 1. Sampling stations (1–18) in the Equatorial Southwestern Atlantic (oligotrophic waters) through the coast of the Brazilian states of Ceará (CE), Piauí (PI), and Maranhão (MA) (Northeastern Brazil).

subsampler. Once the samples were split into suitable fractions, varying from 1/32 to 1/4096, all copepods present in the subsamples were counted under a stereo microscope (Omori and Ikeda, 1984). The species were identified based on the main literature (Bjönberg, 1981; Bradford-Grieve et al., 1999; Tregouboff and Rose, 1957).

2.3. Data analysis

The differences between the 120 and 300 µm mesh net were analyzed in terms of abundance, diversity, and frequency of occurrence. The Mann-Whitney non-parametric test was used to compare the abundances collected using the two mesh nets. A Venn diagram was drawn to show the number of copepod species exclusive of each net and those that were collected by both nets. To describe the structure of copepod assemblages, Margalef's richness index (d), Pielou's evenness index (J), and the Shannon-Weaver diversity index (H', loge) were used. All the indexes were log (x + 1) transformed. Moreover, the Mann-Whitney tests were used to analyze differences in Margalef richness, Shannon-Wiener Diversity Index (H') and Pielou's evenness index between the 120 µm and 300 µm plankton nets.

3. Results

There was a significant difference between the abundance of copepods collected with the 120 and 300 µm mesh nets (Mann-Whitney U Test; p < 0.050) (Fig. 2).

The Venn diagram showed that the number of copepod species (18) was higher in the 300 µm mesh plankton net (Fig. 3). Two species were captured only in the 120 µm mesh net, and six species were exclusive to the 300 µm mesh net. Twelve species were common to both plankton nets (Fig. 3).

The values of richness index (d) were higher in the 300 µm net (Mann-Whitney U Test; p < 0.050) (Fig. 4A). Regarding diversity and equitability, there was no significant difference (Mann-Whitney U Test; p > 0.050) between mesh nets (Fig. 4B and C).

Considering the frequency of occurrence (Table 1), the copepodites of Paracalanidae, Oithona spp., and Euterpina acutifrons were present in all 18 samples collected with the 120 µm net. In 300 µm net, 100% of occurrence consisted of Temora stylifera, Corycaeus (Ditrichocorycaeus) amazonicus, and Corycaeus (Onychocorycaeus) giesbrechti.

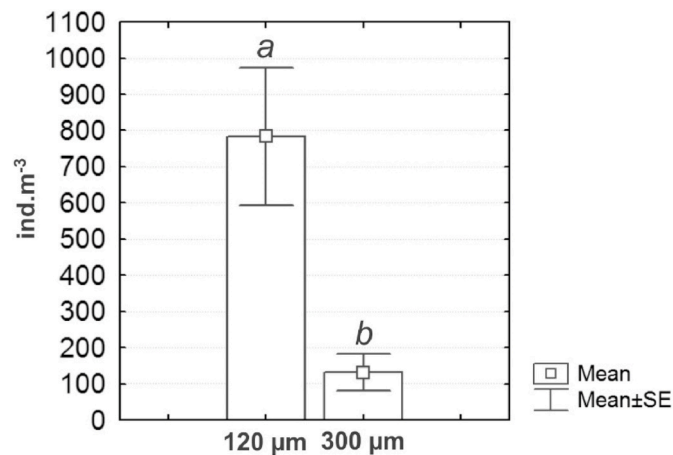


Fig. 2. Abundance (ind m⁻³) of copepods for the 120 and 300 µm plankton nets in oligotrophic waters in the Equatorial Southwestern Atlantic (Brazil). Different letters indicate significant differences in abundance between mesh sizes (Mann-Whitney U Test; p < 0.050).

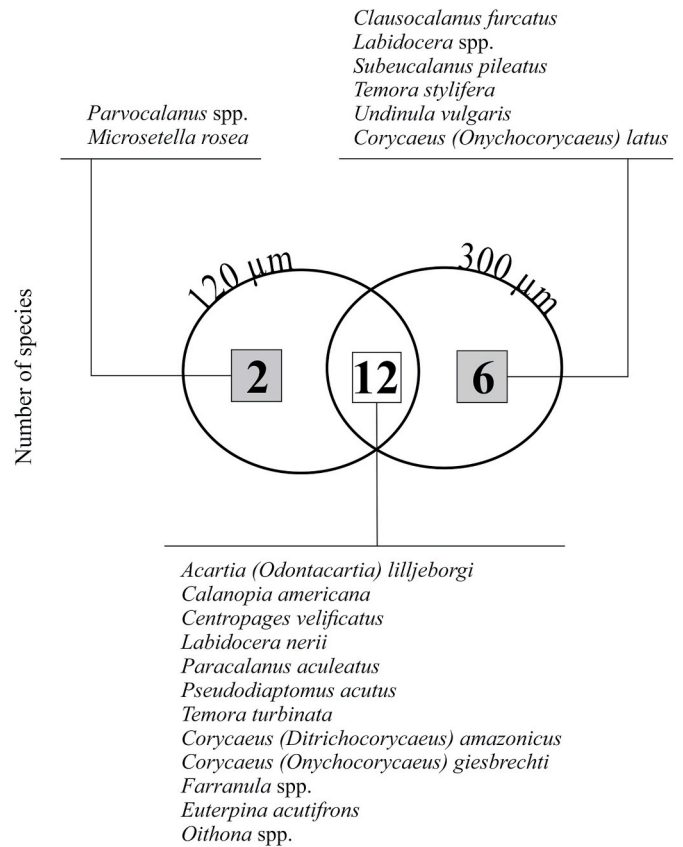


Fig. 3. Venn diagram based on the number of species in the 120 and 300 µm plankton nets in oligotrophic waters in the Equatorial Southwestern Atlantic (Brazil).

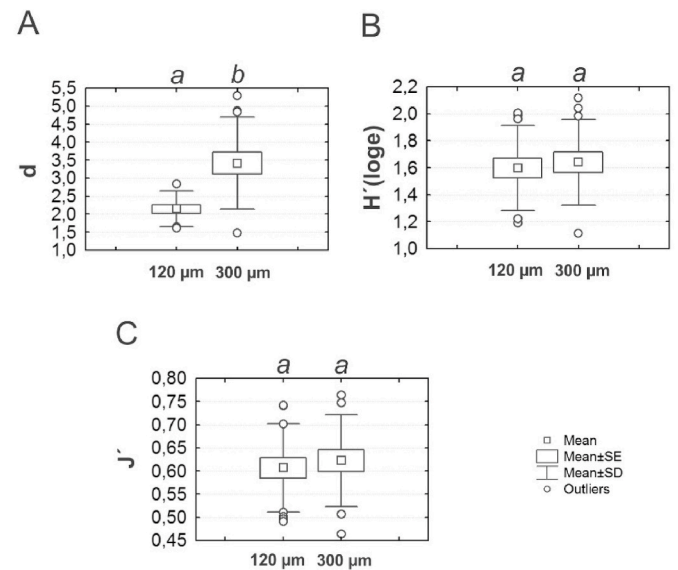


Fig. 4. (A) Margalef richness (d), (B) Shannon-Wiener Diversity Index (H' loge) and (C) Pielou's evenness index (J') for the 120 and 300 µm plankton nets in oligotrophic waters in the Equatorial Southwestern Atlantic (Brazil). Different letters above box plots indicate significant differences in richness between mesh nets (Mann-Whitney U Test; p < 0.050).

Table 1

The number of samples, identified taxa, mean abundance (ind.m-3 ± Standard Deviation), and frequency of occurrence (FO) of the taxa captured with the 120 and 300 µm mesh nets in oligotrophic waters in the Tropical Southwestern Atlantic (Brazil). Very frequent (****), Frequent (***), Uncommon (**), Sporadic (*), and without occurrence (–) according to Campos et al. (2017).

		Mesh size of nets			
		120 µm		300 µm	
Number of samples		18		18	
Abundance (Mean ± Standard deviation)		54.71 ± 150.38		9.67 ± 41.21	
		ind m ⁻³	FO	ind m ⁻³	FO
Calanoida					
	Calanoida (copepodites)	5.31 ± 8.86	***	0.02 ± 0.06	**
Acartiidae	<i>Acartia</i> (<i>Odontacartia</i>) <i>lilljeborgi</i>	1.40 ± 2.95	**	0.85 ± 1.26	***
	<i>Acartia</i> (<i>Odontacartia</i>) <i>lilljeborgi</i> (copepodites)	3.61 ± 11.85	**	0 ± 0	–
Calanidae	<i>Undinula vulgaris</i>	0 ± 0	–	0.003 ± 0.01	*
	<i>Undinula vulgaris</i> (copepodites)	0 ± 0	–	0.03 ± 0.09	**
Centropagidae	<i>Centropages velificatus</i>	1.24 ± 2.08	***	1.01 ± 1.17	****
	<i>Centropages velificatus</i> (copepodites)	2.82 ± 7.37	**	0.56 ± 0.70	****
Clausocalanidae	<i>Clausocalanus furcatus</i>	0 ± 0	–	0.05 ± 0.22	**
Eucalanidae	<i>Subeucalanus pileatus</i>	0 ± 0	–	0.05 ± 0.11	**
	<i>Subeucalanus pileatus</i> (copepodites)	0 ± 0	–	0.02 ± 0.1	*
Paracalanidae	<i>Parvocalanus</i> spp.	42.38 ± 63.27	****	0 ± 0	–
	<i>Paracalanus aculeatus</i>	65.12 ± 167.61	****	1.43 ± 1.96	****
	Paracalanidae (copepodites)	20.20 ± 28.64	****	31.12 ± 66.25	****
Pontellidae	<i>Calanopia americana</i>	5.28 ± 8.62	***	1.15 ± 3.17	****
	<i>Calanopia americana</i> (copepodites)	3.42 ± 8.94	**	0.85 ± 1.33	****
	<i>Labidocera nerii</i>	0.06 ± 0.26	*	0.05 ± 0.07	**
	<i>Labidocera</i> spp. (copepodites)	0 ± 0	–	0.25 ± 0.46	***
Pseudodiaptomidae	<i>Pseudodiaptomus acutus</i>	0.31 ± 1.31	*	0.08 ± 0.27	**
	<i>Pseudodiaptomus acutus</i> (copepodites)	0 ± 0	–	0.01 ± 0.06	*
Temoridae	<i>Temora stylifera</i>	0 ± 0	–	0.01 ± 0.02	*
	<i>Temora turbinata</i>	30.43 ± 49.49	****	55.52 ± 123.57	****
	Temoridae (copepodites)	4.06 ± 60.74	****	9.42 ± 29.09	****
Cyclopoida					
Corycaeidae	<i>Corycaeus</i> (<i>Ditrichocorycaeus</i>) <i>amazonicus</i>	14.85 ± 22.85	****	9.03 ± 10.30	****
	<i>Corycaeus</i> (<i>Onychocorycaeus</i>) <i>giesbrechti</i>	18.67 ± 23.70	****	17.91 ± 23.66	****
	<i>Corycaeus</i> (<i>Onychocorycaeus</i>) <i>latus</i>	0 ± 0	–	0.003 ± 0.01	*
			**	0 ± 0	–

Table 1 (continued)

		Mesh size of nets		
		120 µm		300 µm
	Corycaeidae (copepodites)	1.55 ± 3.55		
	<i>Farranula</i> spp.	10.95 ± 13.37	****	0.25 ± 0.33
Oithonidae	<i>Oithona</i> spp.	387.86 ± 391.00	****	0.66 ± 1.28
	Oithonidae (copepodites)	12.50 ± 16.67	****	0 ± 0
Harpacticoida				
Ectinosomatidae	<i>Microsetella rosea</i>	0.19 ± 0.82	*	0 ± 0
Euterpinidae	<i>Euterpina acutifrons</i>	53.47 ± 93.89	****	1.24 ± 2.09
	<i>Euterpina acutifrons</i> (copepodites)	27.07 ± 71.26	***	0 ± 0
Miraciidae	<i>Macrosetella gracilis</i>	0 ± 0	–	0.13 ± 0.29
Copepoda unidentified nauplius		35.42 ± 67.73	****	0 ± 0

4. Discussion

4.1. The methodological approach

This work shows that the mesh size of nets is a determinant for the diversity and abundance data collection of copepods in a tropical nutrient-poor region. The results clearly show that narrower net mesh sizes collected a higher abundance of copepods (mainly juveniles and larvae). However, species richness and exclusive taxa were higher for the nets with the 300 µm mesh size. The results also highlighted that the 120 µm mesh size more efficiently captured not only juveniles and nauplii but also adults of small species, completely missed by the nets with the 300 µm mesh size. This information may have important repercussions for methodological aspects that support future research mainly when the importance of zooplankton on the underspin of the functioning of the oligotrophic marine environment is considered, especially in tropical regions, such as coral reefs (Santos et al., 2019) and seagrass and rhodolith beds (Costa et al., 2020). Owing to the fact that zooplankton are one of the most common sources of organic matter (Geraldini et al., 2019), knowledge regarding how this component is essential to make energy flux approaches.

Researches comparing copepod assemblages using variations of plankton mesh size nets in a tropical marine environment are scarce (Neumann-Leitão et al., 2019). Reducing the mesh size may increase the retention of small organisms, but will also reduce the filtration efficiency and cause large organisms avoiding the net because they have greater ability to feel the vibrations in the water column of the oncoming net and escape (Skjoldale et al., 2013). Some taxa were underestimated when only one of the net mesh sizes was considered. The 120 µm mesh net showed greater efficiency in collecting smaller organisms (0.3–1.1 mm) (Neumann-Leitão et al., 2019), including small planktonic cnidarians (Tosetto et al., 2019). In terms of abundance, these included copepods of the genus *Oithona* spp., *Farranula* spp., and *Euterpina acutifrons*, in addition to the nauplii that were effectively collected by the smallest mesh net. 300 µm mesh net demonstrated selectivity for larger organisms (1.7–3.25 mm), such as *Subeucalanus pileatus* and *Undinula vulgaris*, and a greater number of exclusive taxa.

In tropical and subtropical oligotrophic waters, microzooplankton are the main grazers of phytoplankton, consuming an average of 75% of primary production and approximately half of the phytoplankton biomass per day (Calbet, 2008). Most of the taxa present in the tropical plankton fell into the category of small marine copepods, and all the early stages (nauplii) could be considered part of the microzooplankton

(Turner, 2004).

Copepodites (juveniles), such as those of *Acartia* (*Odontacartia*) *lilljeborgi*, *Euterpina acutifrons*, Corycaeidae, and Oithonidae, were frequent in the whole studied area and had a remarkably high average abundance. Similar results were documented by Neumann-Leitão et al. (2019), in which young forms were part of the microzooplankton fraction. Copepod nauplii occurred only in the 120 µm net, but also at a high abundance. The high abundance of the early developmental stages captured by the 120 µm net, suggests that it is not appropriate to perform a collection with the 300 µm net if the objective is to measure the total contribution of copepod species to the plankton biomass and energy transfer, because juvenile and nauplii are strongly underestimated in collections with the larger mesh nets.

Another important neglected aspect is concerned with the role of copepods and their eggs play as carbon exportation sources to other trophic components and to the sea bottom. The calanoid copepods highlighted in our study emit eggs freely in the marine waters (Bunker and Hirst, 2004). Each female produces between 5 and 100 per day, for 30–40 days thereafter, throughout its entire existence as an adult (Brugnano et al., 2014; Holste and Peck, 2006; Kosobokova et al., 2006). This also is an overlooked component of blue carbon, which is conspicuous and unexplored. Thus, the large copepods make a greater number of eggs per day, continuously, and more than do the small copepods (Kiorboe and Sabatini, 1995). However, the small copepods renew the generations more quickly (Turner, 2004) and are over six times more abundant according to our results. Finally, the greater emission of copepods eggs to the sea bottom needs to be evaluated using both mesh size nets and also needs to be included in the blue carbon budget estimates.

The take home message of our results is that an integration of collection devices (more than one mesh size, in the present case) is becoming unavoidable (Belmonte et al., 2013; Rubino et al., 2009) in studies on marine zooplankton. Additionally, the presence of an abundant component of small-sized specimens (and species) also suggests a reduction of the time interval between successive collections.

4.2. Importance of the microzooplankton abundance: the example of benthic-pelagic coupling in marginal coral reefs

Following the previous discussion we now understand that despite the widespread use overseas of plankton nets with greater mesh sizes, the information generated both regarding abundance and spatial and temporal distribution is doubtful (Tseng et al., 2011) or incomplete, especially if it does not consider the smaller size fractions, which include the juvenile stages and smaller copepods (Calbet et al., 2001). The smaller fraction is probably the most abundant and diverse in these tropical oligotrophic ecosystems (Fernandez-Alamo and Farber-Lorda, 2006). The importance of the small copepods has been recorded in different marine ecosystems (Anjusha et al., 2018; Calbet, 2008; Fonda Umani et al., 2005; Satapoomin et al., 2004; Zervoudaki et al., 2007). However, studies regarding the capture of different size fractions of zooplankton have been concentrated primarily in temperate regions of Europe, such as the North Sea (Nichols and Thompson, 1991), the Mediterranean Sea (Belmonte et al., 2013; Calbet et al., 2001), in North America (Chick et al., 2010; Ohman and Smith, 1995), in South America, near Patagonia (Antaclí et al., 2010), and in the polar region of Antarctica (Makabe et al., 2012).

In shallow coastal areas, with high water column mixing, there is no difference between the pelagic and benthic plankton (Calbet et al., 2001). This means that the copepods present in a pelagic sampling are likely the same we find in the near-bottom benthic layers, in which a rich seston is retained in the three-dimensional alive structures (Rossi and Gili, 2009), such as coral reef ecosystems (Santos et al., 2019). In the study area, the marginal tropical reefs are especially abundant in shallow-water (Soares et al., 2016), and also reach mesophotic zones (~30–150 m depth) in some cases (Soares et al., 2020). These marginal

coral reefs have a moderate to a high presence of benthic suspension feeders, such as mixotrophic corals, ascidians, bryozoans, gorgonians, and sponges (Soares et al., 2016). Benthic suspension-feeding organisms vary their seston preferences, depending on morphology and trophic strategies (Coma et al., 2001), ranging from bacteria to microzooplankton. Copepods and other crustaceans may be an important part of their energy budget - more than 50% in some cases (Ribes et al., 1999; Rossi et al., 2004), and it has been suggested that even in mixotrophic species, the importance of the plankton capture rates is not negligible (Rossi et al., 2020).

Tropical waters are very important, as is highlighted in our results, with the presence of small copepods (Schmoker et al., 2016) and the number of potential prey that is not considered for the benthic suspension feeders - *sensu* in Rossi et al. (2019), which may be very high. We are not only missing the biomass present in the pelagic C cycle (Calbet and Landry, 2004) but also the potential C captured by the suspension-feeding organisms that thrive in tropical hard-bottoms. This factor is important, because it may change our perception of the importance of the heterotrophic portion of the benthic suspension feeders in tropical reefs in certain circumstances (Rossi et al., 2020). Owing to the fact that tropical waters may be rapidly changing in terms of reduction of productivity because of water stratification (Doney, 2006), the effects on benthic communities in the diminishment of microzooplankton may be non-negligible (Rossi et al., 2019).

In conclusion, in tropical oligotrophic regions, plankton nets with smaller mesh openings, such as 120 µm, should always be used to estimate the copepod abundance because of the dominance of small organisms in the trophic web. The disregarding these narrower nets will fail to produce a precise scenario representing the plankton communities, their contributions to other trophic levels and the blue carbon estimates worldwide, especially in warm nutrient-poor regions. Small-sized copepods are an important link between classical and microbial food webs (Melo et al., 2014; Rossi et al., 2019). Through the microbial loop, heterotrophic bacteria transform dissolved organic carbon into particulate organic carbon ready to be incorporated by the next trophic level as these microorganisms are predated.

One of the main outcomes of this work is to highlight that not only the abundance of copepods may be underestimated because of the improper use of net mesh size, but also diversity and species richness. Additionally, present data suggest that the presence of small-sized organisms (at an order of magnitude more than larger ones) requires a shortening of the collection interval. Small-sized species have short life cycles, and this has a consequence on the calculation of the biomass production rate. Not only are small species more abundant than larger ones at any given moment, but also, they renew their generations faster than do the larger species, corresponding to an additional increase in the produced biomass per time unit. A more intense sample collection should provide a correct indication of the role of small-sized zooplankton (not an overlookable fraction) in the final biomass available for successive trophic levels, as well as in calculations of the blue carbon stored in sediments and on the marine animal forests, the largest biome on Earth (Rossi et al., 2019).

CRediT author statement

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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