Deep-Sea Research I 106 (2015) 126–135

Contents lists available at ScienceDirect

Deep-Sea Research I

journal homepage: www.elsevier.com/locate/dsri

# Changes in abundance and community structure of nematodes from the abyssal polymetallic nodule field, Tropical Northeast Pacific

Dmitry Miljutin [a,*], Maria Miljutina [a], Monique Messié [b]

[a] Senckenberg Nature Research Society, Senckenbergam Meer, German Centre for Marine Biodiversity Research, Südstrand 44, 26382 Wilhelmshaven, Germany

[b] Monterey Bay Aquarium Research Institute, 7700 Sandholdt Rd, Moss Landing, CA 95039, USA

ARTICLE INFO

*Article history:*
Received 21 February 2015
Received in revised form
6 October 2015
Accepted 16 October 2015
Available online 20 October 2015

*Keywords:*
Deep-sea
Density
Diversity
Mining
Nematode community
Polymetallic nodules
Temporal variation

ABSTRACT

Deep-sea fields of polymetallic nodules in the Clarion-Clipperton Zone (CCFZ, tropical NE Pacific) are currently being investigated to assess their potential for commercial mining. During such mining, benthic communities will be inevitably disturbed or destroyed. Therefore, assessments of their standing stock and composition may be helpful for the future evaluation of possible impacts of commercial nodule exploitation. Analysis of nematode communities (at genus level) inhabiting the French license area of the CCFZ were studied based on data from the cruises NODINAUT (2004) and BIONOD (2012). The total nematode density was ca. 1.5-fold higher in 2012 as compared with 2004. This reflected a 2–2.5 times higher density of non-selective deposit-feeders (i.e. possessing a small buccal cavity without armature) in 2012 compared with 2004, whereas no significant differences between sampling periods were observed in the density of the other feeding groups. Consequently, whilst the list of the most abundant genera was identical, their relative abundances changed significantly. The relative abundance of the genus *Thalassomonhystera* was two times greater in 2012 than in 2004, whereas the relative abundances of the genera *Acantholaimus* and *Theristus* were significantly lower in 2012 (10% and 4%, respectively) than in 2004 (28% and 9%). Nematode diversity (including values of diversity indices and total number of recorded genera) was significantly lower in 2012 in comparison with 2004. Although our data do not take into account seasonal and shorter temporal scales of variability in nematode assemblages, we report here that a certain fraction of variations observed between the two sampling periods could be associated with differences in primary production. Future studies should aim to better characterise temporal variability in nematode communities of the CCFZ at seasonal and interannual scales.

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## 1. Introduction

Polymetallic nodules cover millions of square kilometres of the deep-sea bottom and are considered a potential source of commercially important metals including Mn, Ni, Cu, and Co. Dense deposits of polymetallic nodules suitable for commercial mining have been found in the Pacific, Atlantic, and Indian Oceans (Seibold and Berger, 1993; Cronan, 2001; Baker et al., 2001; Wedding et al., 2015; https://www.isa.org.jm/mineral-resources/55). Currently, 14 national and international entities have concluded contracts with the International Seabed Authority for exploration in the Clarion-Clipperton Fracture Zone (CCFZ) in the NE sub-equatorial Pacific, and in the Central Indian Ocean Basin (CIOB). The nodules occur as more or less spherical concretions and are concentrated in the superficial 5–10 cm sediment layer only. It is expected that commercial mining will affect the upper sediment layers on many thousands of square kilometres of the sea bed (Glover and Smith, 2003). Consequently, it is inevitable that benthic organisms, which predominately inhabit the uppermost sediment layer and use nodules as a hard substratum, will be disturbed or even destroyed during mining activities (Glover and Smith, 2003; Ramirez-Llodra et al., 2011).

The free-living nematodes, the most abundant component of metazoan meiobenthos, are the most suitable candidates for assessing mining impacts on benthic communities because of their high density and diversity in the deep-sea. To date, studies have been published on free-living nematode communities inhabiting nodule fields in the Peru Basin in the SE Pacific (Bussau, 1993; Bussau et al., 1995; Thiel et al., 1993), the CCFZ (Snider et al., 1984; Spiess et al., 1987; Renaud-Mornant and Gourbault, 1990; Radziejewska et al., 2001a,b; Lambshead et al.,. 2003; Miljutina et al., 2010; Miljutin et al., 2011) and the CIOB (Singh et al., 2014). Also, there has been a review on the Pacific studies by Radziejewska (2014).

* Corresponding author. Fax +49 44219475111.
*E-mail address:* dmiljutin@senckenberg.de (D. Miljutin).

http://dx.doi.org/10.1016/j.dsr.2015.10.009
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It has been shown that polymetallic nodules are themselves a habitat for specific nematode assemblages inhabiting the nodule surface and the interstitial space inside their crevices and internal cavities (Thiel et al., 1993). In addition, rates of recolonisation and recovery of nematode communities in deep-sea nodule fields following benthic disturbance experiments may vary widely (from several years to at least several decades) in different regions (Borowski, 2001; Vopel and Thiel, 2001; Radziejewska et al., 2001a,b; Radziejewska, 2002; Miljutin et al., 2011).

In terms of nematode communities, one of the most studied nodule sites is the French license area in the CCFZ. A pilot study at this site was undertaken during cruise NIXO-47 (RV "Jean Charcot", IFREMER, France) in May 1986 to investigate undisturbed nodule-bearing and neighbouring nodule-free sites. It reported average total nematode densities of 65 and 69 ind/10 $cm^2$ for nodule-bearing and nodule-free locations, respectively (Renaud-Mornant and Gourbault, 1990). Monhysteridae (among families), and *Syringolaimus* sp. and *Molgolaimus* sp. were the most abundant taxa (Renaud-Mornant and Gourbault, 1990).

Later, in May 2004 (i.e. the same season but 18 years later), samples were collected during the NODINAUT cruise (RV "L'Atalante", IFREMER, France) in an undisturbed area ca. 90 km away from the original study site. Differences in the nematode community were recorded: average total nematode densities were 69 and 137 ind/10 $cm^2$ for nodule-bearing and nodule-free locations, respectively, and the genera *Thalassomonhystera*, *Acantholaimus*, and *Theristus* were most abundant (Miljutina et al., 2010).

In 2012, another cruise (BIONOD, RV "L'Atalante") was carried out in the French license area in the CCFZ. The samples were again taken from the same undisturbed locality as in the NODINAUT cruise, continuing the study of changes in nematode density and community structure.

The goal of the present study was to characterise the nematode community structure in the CCFZ abyssal plain in two different sampling periods, characterised by different levels of the primary production in the upper layers of the water column in 2004 and 2012, in order to provide a reference for future studies aimed at assessing the effects of deep-sea mining on abyssal communities.

## 2. Material and methods

### 2.1. Study area

The study area is located in the easternmost part of the French licence area in the CCFZ (Fig. 1A), at an average depth of about 5000 m and ca. 2200 km off the North American continental coast. This region is characterized by an asymmetrical succession of North–South oriented crests and valleys, between 100 and 300 m high and spaced 5 to 10 km apart. The seabed is covered by, on average, around 12 kg/$m^2$ of polymetallic nodules varying from 2 cm to > 15 cm in diameter (Du Castel, 1985; Hoffert, 2008). The sediments in these nodule areas are very fine-grained (< 2 μm) radiolarian oozes or deep-sea red clays (Du Castel, 1985; Khripounoff et al., 2006). The thickness of ooze varies locally from zero to several metres, depending on variations in the velocity of bottom currents (Le Suavé et al., 1990; Skornyakova and Murdmaa, 1992). The overlying water temperature is ca. 1 °C, the mean bottom current is 3.5–4.0 cm/sec, and the sedimentation rate is ca. 5 mm per 1000 years (Khripounoff et al., 2006; Veillettee et al., 2007). The nodule-bearing field was located in the western part of the study area, at a depth of 4947–5000 m, with nodules characteristically 5–10 cm in diameter. The nodule-free field was mainly in the eastern part of the study area at a depth of 4983–5046 m (Fig. 1B).

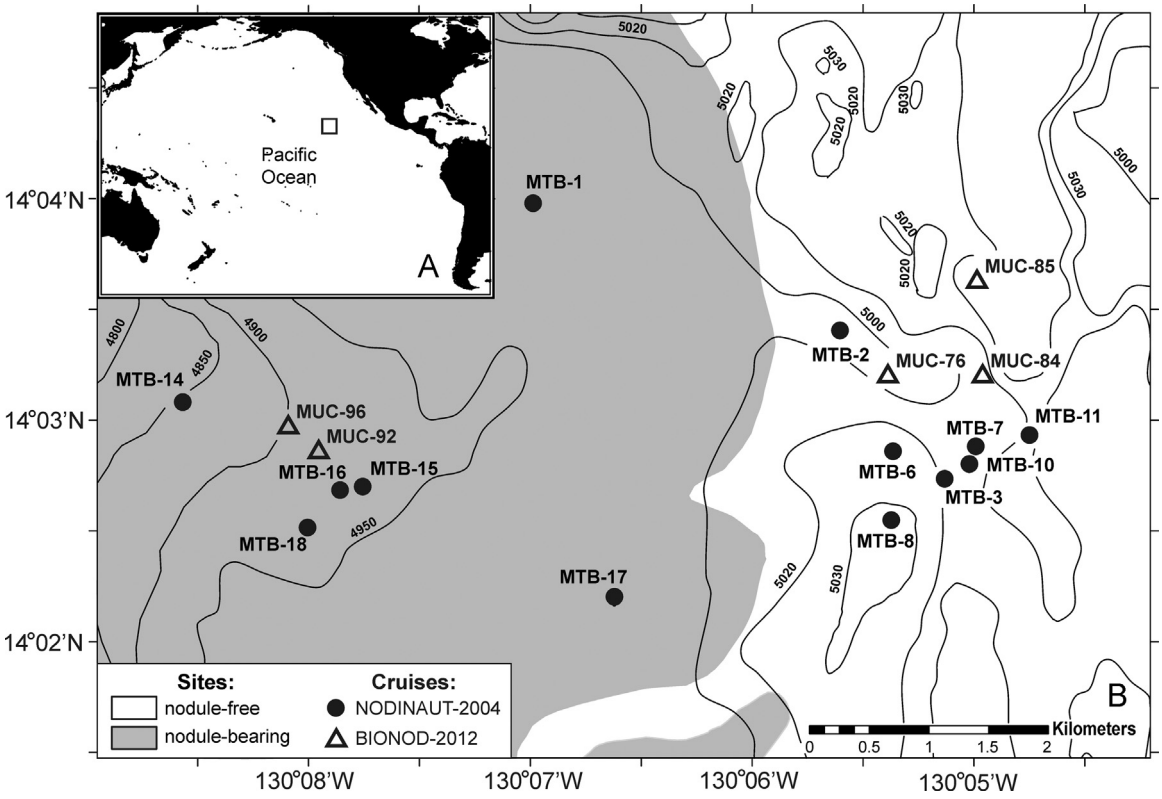


**Fig. 1.** Study area: (A) location of study area (marked with a square) and (B) detailed map of stations sampled during the NODINAUT (2004) and BIONOD (2012) research cruises.

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