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RESULTS OF THE DIVA-1 EXPEDITION OF RV "METEOR" (CRUISE M48/1)

A method for comparing within-core alpha diversity values from repeated multicorer samplings, shown for abyssal Harpacticoida (Crustacea: Copepoda) from the Angola Basin

Armin Rose[a,*], Sybille Seifried[b], Elke Willen[b], Kai Horst George[a], Gritta Veit-Köhler[a], Karin Bröhldick[b], Jan Drewes[b], Gisela Moura[c], Pedro Martínez Arbizu[a], Horst Kurt Schminke[b]

[a]*Department of DZMB, Research Institute Senckenberg (FIS), Südstrand 44, D-26382 Wilhelmshaven, Germany*
[b]*AG Zoosystematics and Morphology, Institute for Biology, Faculty 5, University of Oldenburg, D-26111 Oldenburg, Germany*
[c]*Erlenweg 40, D-26129 Oldenburg, Germany*

Abstract

A methodology for comparing repeatedly sampled multicorer stations as to significant differences in alpha diversity of selected cores is presented. This is demonstrated for Harpacticoida of the Angola Basin which were sampled during the DIVA-1 campaign of RV "Meteor" in the year 2000 (M48/1).

Two replicatedly sampled multicorer stations were compared as to their species-level alpha diversity values of all adult Harpacticoida in single cores. This was done by a newly developed procedure: based on a rank-ordered alpha diversity matrix, using each a species richness, evenness, and dominance diversity index, a minimum spanning tree test (MST-test) was performed to test for significant diversity differences between the replicates of stations 325 (depth: 5448 m) and 346 (depth: 5389 m). The Canberra Metric was used as a measure of dissimilarity between multicorer deployments. With this procedure, any choice of combination of diversity indices can be made, according to the desired emphasis on certain aspects of diversity. This freedom of choice, together with the possibilities to test for significant diversity differences and to visualize this test, are desirable features of the presented procedure for diversity comparisons. Testing for diversity differences may be useful in the context of conservational purposes when politicians need clear statements from scientists.

Due to sufficient replicates, for the first time a significant diversity difference between two abyssal (>2000 m depth) multicorer stations was detectable. Station 346 (eight replicates) was significantly more diverse in harpacticoid species than station 325 (seven replicates). Regional-scale differences in food availability are assumed to be of importance for the different patterns of diversity at stations 325 and 346.

The slope of the line of regression in a species/individuals plot on single-core level was not far from 1 ($R^2 = 0.990; y = 0.877x$), indicating that most species were represented by singletons and the rest only by very few specimens.

The data supported scale-dependent differences of harpacticoid diversity in the Angola Basin. Local-scale (between replicates) differences in harpacticoid within-core species diversity were lower than regional-scale (between stations) differences.

*Corresponding author. Tel.: +49 4421 9475116; fax: +49 4421 9475111.
E-mail address: arose@senckenberg.de (A. Rose).

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At least 134 species of Harpacticoida were found at the two stations, of which the subgroups of Pseudotachidiidae, Argestidae, Ameiridae, and Ectinosomatidae turned out to be richest in species and individuals.

Keywords: Diversity comparison method; Minimum spanning tree test; Alpha diversity; Productivity; Scale dependency; Deep sea; Harpacticoid copepods; Meiofauna

Introduction

The total number of marine species is still unknown. Estimations range from 500,000 species (May 1992; Gray 1996), to 5 million species (Poore and Wilson 1993), to more than 10 million species (Grassle and Maciolek 1992; Lambshead 1993; doubted by Gray 1994 and Gray et al. 1997). Many estimates have been derived from local data rendering extrapolations to global scale at least doubtful (Lambshead and Boucher 2003). Furthermore, some of these estimates rely on macrofauna data only and do not take into account meiofaunal diversity, which in fact is high, at least at small scales. In detail, meiofaunal abundance per unit area is much higher than for macrofauna, leading to a higher meiofauna richness within a particular patch (Snelgrove and Smith 2002); but this does not tell much about the proportions on larger scales. Some publications (e.g. Rex 1983; Stuart et al. 2003) indicate a higher macrofauna diversity at intermediate depths (2000–3000 m), but for meiofauna this has to be evaluated more thoroughly. Whilst meiofaunal densities seemed to decrease with depth in some studies (Vincx et al. 1994: Northeast Atlantic; Vanhove et al. 1995: Weddell Sea), other authors found no simple relationship between these two parameters (Herman and Dahms 1992: Weddell Sea; George (1999) for Harpacticoida only: Magellan Region, high Antarctic). All these somewhat contradictory results and assumptions indicate that marine biodiversity is far from being understood. Above all, more studies on the organismal diversity in the deep sea are needed to improve the situation, not least since this huge habitat constitutes about 50% of the earth's surface.

For this reason, the DIVA-1 expedition of RV "Meteor" (M48/1) started in July 2000 to investigate the abyss of the Angola Basin for latitudinal diversity gradients. First results of this expedition show that there is indeed quite a considerable diversity in many groups of organisms (Polychaeta, Tanaidacea, Isopoda, Cumacea, Kinorhyncha, Loricifera, Tardigrada) collected from the deep-sea bed (depth about 5400 m) of the Angola Basin (see other contributions to this volume).

A striking example for another diverse taxon from this region are the harpacticoid copepods which make up about 98.7% of all sampled copepods. Thistle (2001) gave an interesting statement as to the overall diversity of Harpacticoida in the deep sea: "harpacticoids are not only successful in the deep sea, they are unusually so when compared to the macrofauna taken as a whole".

Despite their importance in benthic assemblages, studies on the diversity of copepod communities in the deep sea are still scarce. Here, we present one of very few quantitative investigations on the species level diversity of Harpacticoida of all subgroups sampled from abyssal regions (>2000 m depth). Former studies were those of Coull (1972), who compared diversity and affinities of harpacticoid assemblages from different depths, Montagna and Carey (1978), who investigated Harpacticoida from the Beaufort Sea in the Arctic Ocean, and Thistle (1983a), who compared two deep-sea soft bottom communities as to the time-stability hypothesis as a predictor of diversity.

The scarcity of quantitative studies on species level is somewhat surprising, as comparatively high abundance and diversity make the deep-sea meiobenthos (of which Harpacticoida are a very diverse and abundant part) ideally suited to quantitative studies and suggest that this group plays an important role in ecological processes (Vincx et al. 1994). Former qualitative or quantitative studies on abyssal Harpacticoida either concentrated on single or few subgroups of this species rich taxon (e.g. Bodin 1968; Por 1969; Dinet 1974; Becker and Schriever 1979; Becker et al. 1979; Reidenauer and Thistle 1983; Schriever 1983; Thistle and Eckman 1988; Huys and Thistle 1989; Huys 1993; Moura and Pottek 1998; George 1999; George and Schminke 2002), or were restricted to supraspecific taxa (e.g. Dinet 1973; Rachor 1975; Thiel 1982; Thiel 1983; Herman and Dahms 1992; Tietjen 1992; Vincx et al. 1994; Vanhove et al. 1995; Vanaverbeke et al. 1997; George and Schminke 2002). The high logistic effort of sampling in the abyss (here defined by depth below 2000 m, according to Friedrich 1965) as well as the difficulty to cope with the task of species identification for all Harpacticoida subgroups resulted in the low number of comprehensive investigations. Consequently, many specialists for single or several harpacticoid subgroups had to combine forces in order to make this study possible.

Although so far most species obtained from the DIVA-1 expedition still remain undescribed and could