Deep-Sea Research II 58 (2011) 68–73

Contents lists available at ScienceDirect

Deep-Sea Research II

journal homepage: www.elsevier.com/locate/dsr2

Cumacean (Peracarida, Crustacea) endemism and faunal overlap in Antarctic deep-sea basins

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ARTICLE INFO

Article history:
Received 2 October 2010
Accepted 2 October 2010
Available online 30 October 2010

Keywords:
Cumacea
Antarctica
Deep sea
Biogeography

ABSTRACT

At least 155 morphotypes of Cumaceans have been determined from samples collected by various expeditions over the past 15 years. Among them, only 38 species were previously described, while at least 116 morphotypes (75%) represent species new to science. The faunal overlap of Antarctic Cumacea (Peracarida) is calculated between various deep-sea basins, between the deep sea and the shelf, and between different shelf areas of Antarctica and the Sub Antarctic islands. The degree of endemism is high (about 80%) for the Antarctic Cumacea, but within the Antarctic regions faunal overlaps are detectable. Maximal faunal overlap (about 50%) is found among the Antarctic shelf regions, but the deep-sea basins of the Antarctic Peninsula region and the Weddell Sea have also a high (about 30%) species overlap. Including the new findings of Cumacea from the various deep-sea basins, the overlap between the Antarctic shelf and the deep sea is only 18%.

1. Introduction

The assessment of Antarctic biodiversity and biogeography is of particular importance in the context of global environmental changes. Biogeography is closely linked to biodiversity and it is concerned with the geographic distribution of species and taxa in our biosphere. Knowledge of biodiversity and biogeography is central to any attempt to conserve species and their habitats. Moreover, this information can help to identify the origin of species in certain areas and their phylogenetic relationship, which consists of coastal or shelf areas, and more than 90 % is deep sea. The fauna living in the vast areas of the deep-sea, which represent 90% of the ocean floor, are very poorly known, especially in the Antarctic where there has been a notable lack of intensive biological sampling effort. Without doubt, the Antarctic deep sea still harbours many unknown taxa, despite the fact that many nations have intensified their Antarctic research activities during the last 20 years (after Brandt et al., 2003).

Main focus of the present analysis will be the peracarid order Cumacea (Crustacea). Eighty-one cumacean species are known for the Antarctic regions. Most of them are endemic to Antarctic waters and described mainly for the shelf or the continental slope of the Scotia Arc (Zimmer, 1907a,b, 1909); Antarctic Peninsula and South Shetland Island region (Blazewicz and Jazdzewski, 1995; Mühlenhardt-Siegel, 1994, 1996, 1999; Blazewicz-Paszkowycz and Heard, 2001; Corbera, 2000; Corbera et al., 2009), Weddell Sea (Gamô, 1959; Ledoyer, 1993; Petrescu and Wittmann, 2003), Kerguelen (Zimmer, 1913; Ledoyer 1974,1977), East Antarctica (Calman, 1918; Lomakina, 1968; Ledoyer, 1969; Gamô, 1987) and Ross Sea (Calman, 1907, 1917; Jones 1971; Blazewicz and Heard, 1999; Rehm et al., 2007; Rehm and Heard 2008; Rehm, 2009).

In the most recent attempt to define biogeographic provinces in the deep Atlantic based on cumacean distribution patterns, Watling (2009) distinguished eight provinces, seven of them in the northern hemisphere and the last "province" combining the Angola, Cape, Brazil and Argentine Basin. He stated "these latter are not well-sampled for most groups but appear to be separated from each other" (Watling, 2009), a reflection of the very low sampling effort in the South Atlantic. Previously, Gage et al. (2004) had presented a large-scale biodiversity pattern for deep-sea Cumacea with diversity as a function of latitude, with a maximal diversity at 20° N, but only northern Atlantic was the focus of statistical analyses due to the paucity of data from the southern Atlantic. These authors have suggested similar controlling factors for the low cumacean diversity at high latitudes as suggested for the isopods, gastropods and bivalves: relatively recent extinction due to the ice ages, and isolation from warmer water by submarine ridges. They also concluded that the large scale pattern of macrofauna in the deep ocean reflects regional history as well as ecology. In both cases, the Atlantic part of the Southern Ocean was not even considered due the lack of data.

An attempt to improve the knowledge of the deep-sea fauna of the South Atlantic was started with the DIVA I expedition to the Angola Basin in the year 2000 with the German research vessel "*Meteor*". The cumacean material from this expedition was

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doi:10.1016/j.dsr2.2010.10.010

analysed resulting in 42 new species, whereas only one species was previously known (Mühlenhardt-Siegel, 2003, 2005a,b,c,d,e). These results from a single expedition enlarged the number of known species of the south-eastern Atlantic from 32 to 74 species. One of the main objectives of subsequent ANtarctic benthic DEEP sea biodiversity (ANDEEP) cruises was "…to assess the importance of the Antarctic as a region where shallow water species may enter the deep sea …" (Fahrbach 2006) during the period between 2002 (ANDEEP I and II) and 2005 (ANDEEP III). As the investigation of the deep-sea cumaceans resulted in more than 70% new and mostly endemic species (Mühlenhardt-Siegel, 2003, 2005a,b,c,d,e), a high number of new Antarctic endemic deep-sea species was expected.

2. Material and methods

The majority of the material examined was obtained during the Antarctic ANDEEP I and II (January to April 2002) (Fütterer et al., 2003) and ANDEEP III (January to April 2005) (Fahrbach, 2006) expeditions of the RV "*Polarstern*" (Fig. 1). Several additional samples from Antarctic deep-sea basins were available from the RV "*Polarstern*" ANT XIV/2 (Nov./Dec. 1996), and XV/3 (Jan-March 1998) expeditions. Different deep-sea regions of the Southern Ocean were investigated, mainly off the Antarctic Peninsula (11 samples), western and eastern Weddell Sea (16 and 15 samples, respectively), South Sandwich Trench (4 samples), Lazarev Sea (1 sample) and southern Cape Basin (2 samples). The western and eastern regions of the Weddell Sea are not defined by a bathymetric barrier, but rather by their separation. The depth range was between 1123 and 6224 m in ANDEEP I and II, and between 1047 and 4928 m in ANDEEP III.

Bottom samples were collected with several gear (i.e. epibenthic sledge, Agassiz trawl, box- and multi corer) from different Antarctic deep-sea regions. The epibenthic sledge, equipped with epi- and supranet of 500 μm mesh size, was towed on the bottom at 0.5 m sec^{-1} for approximately 10 minutes (Brenke, 2005). Collections from ANT XIV and XV were fixed in 4% formalin-sea water solution, and preserved after sorting in 70% ethanol. The material of the ANDEEP expeditions was fixed in 96% ethanol immediately after the catch, with the ethanol replaced after 30 minutes, then stored in −30° C. Fixation in 96% ethanol was necessary for molecular genetic work, but unfortunately causes the cumaceans to become extremely brittle resulting in frequent detachment of the walking legs and exopods.

In total 7026 specimens of deep-sea Cumacea were sorted from the samples of the ANDEEP I to III and ANT XV/3 expeditions. All specimens were determined to species level. The new species "morphotypes" will have to remain in open nomenclature until publication of their formal descriptions, with all materials deposited at the Zoological Museum, Hamburg.

3. Results

The most successful sampling gear for Cumacea was the epibenthic sledge; the box- and multi corers, and Agassiz trawl were much less useful because of the limited sampling area.

At least 155 morphotypes were determined from the samples (Table 1). Among these, only 38 species were previously described, while at least 116 morphotypes (75%) represent species new to science. From the 38 known species, seven were reported for regions north of the Antarctic Polar Front. The species *Hemilamprops* cf. *brenkei* Mühlenhardt-Siegel, 2005a is known from the Angola Basin. *Hemilamprops merlini* Mühlenhardt-Siegel, 2005a, *Divacuma tuerkayi* Mühlenhardt-Siegel, 2003 and *Makrokylindrus meteorae* Mühlenhardt-Siegel, 2005c were initially described for the Angola Basin, then found again during the ANDEEP expeditions in the adjacent Cape Basin. Further new records are from the Weddell Sea, the Antarctic Peninsula and the South Sandwich Trench. *Hemilamprops merlini* was also found again in the Bellingshausen Sea (Corbera et al., 2009). In contrast, two species were known from regions far north of Antarctica: *Paralamprops tuberculatus* Roccatagliata, 1994 is described for a deep-sea basin in the northeastern Atlantic and *Makrokylindrus hadalis* Jones, 1969 was described earlier for the Java Trench.

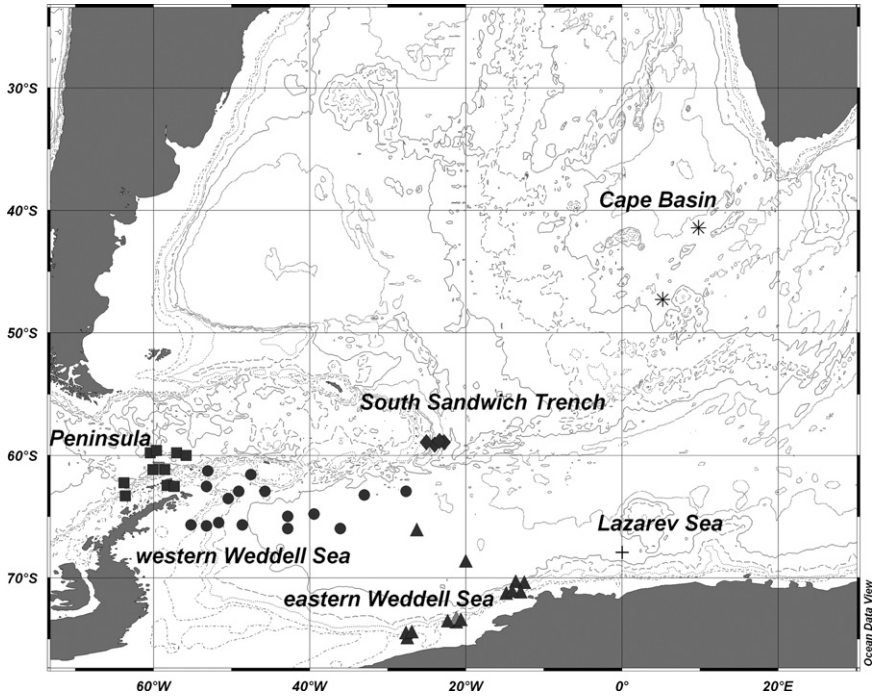

Fig. 1. Areas of investigation. Stations in the region "Peninsula" marked as squares, "western Weddell Sea" as dots, "eastern Weddell Sea" as triangles, "South Sandwich Trench" as rhomboids, "Cape Basin" as stars, "Lazarev Sea" as cross.