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The Zoogeography of Marine Tardigrada

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Abstract

This monograph describes the global records of marine water bears (Phylum Tardigrada). We provide a comprehensive list of marine tardigrades recorded from around the world, providing an up-to-date taxonomy and a complete bibliography accompanied by geographic co-ordinates, habitat, substrate and biogeographic comments. A link is provided to an on-line interactive map where all occurrences for each species are shown. In total we list 197 taxa and their 2240 records from 39 oceans and seas and 18 Major Fishing Areas (FAO). It is hoped this work will serve as a reference point and background for further zoogeographic and taxonomic studies on marine tardigrades.

Key words: Arthrotardigrada, biogeography, Eutardigrada, FAO areas, Heterotardigrada, species distribution, species list, water bears

Introduction

Members of the phylum Tardigrada are micrometazoans, generally ranging in size from 50 µm to 1 mm (although according to Guil (2008) one specimen has recently been found that reached 2 mm), with four pairs of lobopodous legs usually terminating in claws or digits. Ecdysozoans that comprise a sister group to the arthropods (Garey *et al.* 1996, 1999, Garey 2001), tardigrades are ubiquitous in marine, freshwater and terrestrial interstitial communities (Nelson & Marley 2000). They are most famous for their ability to withstand environmental extremes via cryptobiosis (for review see Wełnicz *et al.* 2011, Guidetti *et al.* 2012, Rebecchi 2013), but except for a very few intertidal tardigrades this capability does not exist in marine species (see *e.g.* Clausen *et al.* 2014, Jørgensen & Møbjerg 2014). Tardigrades are a rather poorly studied taxon (e.g. Guil & Cabrero-Sañudo 2007) and research on marine tardigrades is severely limited (Vicente & Bertolani 2013), even though they are phylogentically important as the basal group for the phylum (Jørgensen *et al.* 2010).

There are 197 species and subspecies of marine tardigrades described out of a total of 1220 currently known species in the phylum (Guidetti & Bertolani 2005, Degma & Guidetti 2007, Vicente & Bertolani 2013, Degma *et al.* 2009-2014). Degma *et al.* (2009-2014) list 198 marine species, but changes to that list are required for the genus *Angursa* as discussed below. Thus, marine tardigrades make up only 16% of currently known species. The marine tardigrades include all heterotardigrades in the order Arthrotardigrada, the genera *Echiniscoides* and *Anisonyches* in the family Echiniscoididae (order Echiniscoidea) as well as four eutardigrade species in the order Parachela (*Thulinius itoi* Tsurusaki, 1980; *Halobiotus arcturulius* Crisp & Kristensen, 1983; *H. crispae* Kristensen, 1982; *H. stenostomus* (Richters, 1908)) that have been secondarily adapted to the marine environment. Described from all seas, marine tardigrades are part of the meiobenthos and occur in intertidal and subtidal areas down to the abyss (to 4690 m below sea level (bsl), Thiel 1966). Most species are interstitial, but some are algal associates and others are associated with barnacles and other invertebrates.

Research on marine tardigrades is limited due to their rarity and extremely small size, but it is also hindered by the lack of centralised information on species distributions and the absence of centralised, up-to-date diagnostic tools. This paper is an attempt to correct the first problem. The only comprehensive key to tardigrades is outdated