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Considerations on the taxonomy of the Phylum Tardigrada

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Abstract

An analysis of the taxonomy of the Tardigrada is offered, based on the latest checklist version. A total of 1167 species from 113 genera were counted, but marine species are misrepresented on account of being understudied. Moreover, many poor descriptions and synonyms remain in this constantly growing list. We advocate more accurate future taxonomic work, aiming for an official list of species that better represents true values of biodiversity.

Macrobiotus hufelandi Schultze, 1834 is the founding species of the Phylum Tardigrada and the group's taxonomic list is constantly receiving new members, with several new species being added every year. A checklist was created by Guidetti & Bertolani (2005) in order to provide a single and complete database for all known species of tardigrades, as well as standardizing the description criteria. However, this effort calls for constant attention to keep the list updated by registering all the new species descriptions, which is evidenced by the fact that the currently available checklist is already in its 21st version (Degma *et al*., 2009–2012). Here we can find a total of 1167 species representing 113 genera (Table I), 12 subfamilies, 24 families and four super families, four orders and three classes; one of which (Mesotardigrada) is represented by a single species (*Thermozodium esakii*) and is quite controversial (Nelson, 2002). Other uncertainties are noted in the positioning of the families Beornidae and Necopinatidae, each containing only one species, the genus *Apodibius*, or the veracity of *Oreella vilucensis* (nomen dubium). The flood of recently published or in-press descriptions of new species (e.g. Fujimoto & Miyazaki, *in press*; Hansen *et al*., 2012; Kaczmarek *et al*., 2012a,b; Meyer & Hinton, *in press*; Miller *et al.,* 2012a; Pilato *et al*., 2012; Zawierucha *et al*., *in press*) and new genera (Hansen *et al*., 2012; Miller *et al.,* 2012b; Vicente *et al*., *in press*), continues unabated - a sign that tardigrade biodiversity may still have a great deal of richness to reveal.

Table I lists tardigrade genera and we can see that some are substantially richer than others. The genus *Echiniscus* is the most speciose, with 163 species, closely followed by *Macrobiotus*, with 153 species. These two genera alone contain 27% of all known tardigrade species and combined with *Isohypsibius*, *Diphascon* and *Minibiotus*, nearly half (49%) of the known tardigrade taxa. However, this list is more than just a portrait of the actual Tardigrada biodiversity; it also reflects a curious hidden bias. Sampling effort has been greater in terrestrial environments than marine. The relatively few numbers of described marine species, therefore, could be related to this fact. Only at ninth place do we find a marine genus, *Batillipes*, with 27 species. At the generic level, marine tardigrades are, nevertheless, richer in terms of diversity (Appeltans *et al*., 2012). It is incredibly simple to sample terrestrial habitats for tardigrades, since we find them on virtually any piece of moss or lichen, anywhere. Thus, terrestrial tardigrades have been a preferred target for all of those willing to study these animals. In time, this has led to the strong terrestrial bias and the limited number of marine species that are registered today. We therefore call for more effort to be put into the study of marine tardigrades, in order to provide a clearer picture of the Phylum's biodiversity.

Until now, species are usually only described on morphological and morphometric data based on a limited number of characters. To date, only one species, *Macrobiotus vladimiri* Bertolani, Biserov, Rebecchi and Cesari, 2011, has been described using combined morphological and molecular information, i.e. integrative taxonomy (Pardial *et al.*, 2010). A few other species have also been considered using integrative taxonomy and barcoded with mtDNA *cox1* gene (Cesari *et al*., 2009, 2011; Bertolani *et al*., 2010, 2011a,b; Vicente *et al*., *in press*). Combine this limited use of integrated taxonomy with a small number of specialized taxonomists and we have the potential for many incorrect descriptions. At times,

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