



Zootaxa 3763 (1): 001–062
www.mapress.com/zootaxa/

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Monograph

ISSN 1175-5326 (print edition)

ZOOTAXA

ISSN 1175-5334 (online edition)

<http://dx.doi.org/10.11646/zootaxa.3763.1.1>

<http://zoobank.org/urn:lsid:zoobank.org:pub:7CB889F3-E981-40E1-8BAE-47C845B9377E>

ZOOTAXA

3763

Annotated zoogeography of non-marine Tardigrada. Part I: Central America

ŁUKASZ KACZMAREK¹, ŁUKASZ MICHALCZYK² & SANDRA J. MCINNES³

¹*Department of Animal Taxonomy and Ecology, Faculty of Biology, A. Mickiewicz University, Umultowska 89, 61-614 Poznań, Poland; e-mail: kaczmar@amu.edu.pl*

²*Department of Entomology, Institute of Zoology, Jagiellonian University, Gronostajowa 9, 30-387 Kraków, Poland; e-mail: LM@tardigrada.net*

³*British Antarctic Survey, Madingley Road, Cambridge, CB3 0ET, UK; e-mail: s.mcinnes@bas.ac.uk*



Magnolia Press
Auckland, New Zealand

Accepted by Z.Q. Zhang: 8 Nov. 2013; published: 5 Feb. 2014

ŁUKASZ KACZMAREK, ŁUKASZ MICHALCZYK & SANDRA J. MCINNES
Annotated zoogeography of non-marine Tardigrada. Part I: Central America
(*Zootaxa* 3763)

62 pp.; 30 cm.

5 Feb 2014

ISBN 978-1-77557-334-0 (paperback)

ISBN 978-1-77557-335-7 (Online edition)

FIRST PUBLISHED IN 2014 BY

Magnolia Press

P.O. Box 41-383

Auckland 1346

New Zealand

e-mail: zootaxa@mapress.com

<http://www.mapress.com/zootaxa/>

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ISSN 1175-5326 (Print edition)

ISSN 1175-5334 (Online edition)

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Abstract

Dividing the world into nine regions, this first paper describes literature records of the limno-terrestrial tardigrades (Tardigrada) reported from Central America. Updating previously published species lists we have revised the taxonomy and provided additional habitat, geographic co-ordinates, and biogeographic comments. It is hoped this work will serve as a reference point and background for further zoogeographic studies.

Key words: biogeography, new records, species list, tardigrades, taxonomy

Introduction

Whilst often referred to as one of the ‘minor’ or ‘lesser known’ phyla, the Tardigrada comprises a group of animals with an almost ubiquitous worldwide distribution. These micrometazoans average 500 μm as mature adults with a few larger taxa reaching over 2 mm and juveniles/larvae *ca.* 100 μm . Tardigrades are bilaterally symmetrical with five distinct ‘pseudosegments’: the head and four body segments, each bearing a pair of lobopod limbs most often terminated with claws. They are found in a variety of habitats from tropical rain forests to arid polar deserts, and from mountain tops to the abyssal ocean depths.

Initially identified in the 18th Century, tardigrades have been studied throughout the 20th Century, with modern interest focusing on the anabiotic adaptations of these mysterious animals (*e.g.* Welnicz *et al.* 2011). The early work was largely based on morphology with few physiological studies and latterly more discussion on evolutionary and systematic status. Recently, Marley *et al.* (2011) revised the higher subdivisions of the order Parachela and Pilato & Binda (2010) the families within this order. There has been additional ‘species complex’ revisions and new or revised taxonomic criteria, which is gradually including molecular data (*e.g.* Bertolani & Rebecchi 1993; Claxton 1998; Guidetti *et al.* 2000; Guidetti & Bertolani 2001; Jørgensen & Kristensen 2004; Guidetti *et al.* 2005; Jørgensen *et al.* 2010; Michalczyk *et al.* 2012a; 2012b). The monographs by Ramazzotti (1962a; 1972; 1974) with the final edition III (Ramazzotti and Maucci 1983) and its English translation (Beasley 1995) are still the main starting point for most taxonomic studies on tardigrades. A checklist of the currently known Tardigrada taxa (Guidetti & Bertolani 2005; Degma & Guidetti 2007) is regularly updated on the Internet (Degma *et al.* 2012). There is also a recently launched online tardigrade taxonomy data repository, the Tardigrada Register (Michalczyk & Kaczmarek 2013).

The first global biogeographic synthesis of non-marine tardigrades (McInnes 1994) provided limited species bio-distribution ranges within the confines of geopolitical borders, but remains the starting point for all subsequent studies on any aspect of taxonomy and biogeography. These baseline data have increased by over 70%, while distribution data can now be pinpointed to less than a degree of latitude and longitude. This literature and data explosion of the last two decades has prompted us to embark on an updated and enriched biogeography of the Tardigrada. The sheer quantity of data necessitates that this will be published as a series of nine papers, covering: Central America, South America, North America, Polar Regions, Europe, Africa, Asia, Australia, and Oceanic Islands. Each paper will be defined in detail with this, the first section, being the non-marine tardigrades of Central America (Figs 1–2).

anthropogenic or animal vectors, prevailing trade winds and ocean currents, especially the North Atlantic surface gyre flowing from Africa to the Americas. The transport of dust and aerosols from Africa to Central America (Prospero 1999; Trapp *et al.* 2010), as well as vegetation rafts borne on ocean currents (Renner 2004), may provide tardigrade dispersal opportunities. The alternative scenario is that we are observing species with inadequately sampled widespread distributions. The verification of introduced species requires good regional baseline data, where ‘new’ taxa could be attributed to transport enhanced dispersal. Unfortunately, the Central American tardigrade fauna cannot, as yet, support this type of analysis.

Tardigrades are small, potentially easily transported as eggs and tuns, and potentially ubiquitous. Even so, the current paradigm suggests that few species are cosmopolitan and most have more local distributions (*e.g.* Bertolani & Rebecchi 1993; Pilato & Binda 2001). This indeed corroborates the relatively high levels of apparent “endemism” in the data (Table 1). However, regionally focused surveys will always enhance local endemism (*e.g.* Cuba) and this is augmented by focusing on particular habitats which may not necessarily overlap with other adjacent regions. This suggests many currently ‘endemic’ species are indeed more widespread and that even small-scale surveys will yield significant numbers of new species.

To conclude we have catalogued 100 tardigrade taxa from over thirty papers covering only three countries of the Central American isthmus and nine Caribbean islands. While this accounts 85% of the total regional landmass area, this is actually less than a third of the Central American countries and islands. We suggest that there is significant potential to expand the regional tardigrade data where a significant portion (perhaps even the majority) of the fauna is endemic but remains undiscovered.

Acknowledgements

The authors would like to thank the numerous colleagues who have kindly supplied their papers on tardigrades as they are published. We are especially grateful to Professor Barbara Węglarska (Poland) and the late Professor Clark Beasley (USA) for sharing their immense tardigrade literature with us. We also thank Magda Biszczuk (British Antarctic Survey, UK) for supplying the figures.

This work was partially supported by the Polish Ministry of Science and Higher Education via the “Juventus Plus” programme (grant: IP2010 015570, Invertebrate biodiversity in temporary ponds of Costa Rica—verification of the “Great American Biotic Interchange” hypothesis) to Ł.K.

We are also grateful to two reviewers (Dr Peter Degma and one anonymous) and Dr Philip Pugh for their critical reviews of the manuscript.

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