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Flexammina islandica gen. nov. sp. nov. and some new phylotypes of monothalamous foraminifera from the coast of Iceland

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Abstract

Monothalamous (single-chambered) foraminifera comprise a poorly known group, the diversity of which is strongly underestimated according to environmental DNA surveys. The gross morphology of monothalamids offers few distinguishing features; their organic-walled or agglutinated tests are often very delicate and make isolation difficult. Here, we use an integrated taxonomic approach, including morphological and molecular analysis, to examine the diversity of monothalamids in a shallow subtidal area on the coast of Iceland. We report nine new phylotypes of single-chambered foraminifera distinguished by SSU rDNA sequences. Among them, we establish a new genus *Flexammina* and a new species *Flexammina islandica*, possessing a very pliable, finely agglutinated test capable of extreme shape transformations. According to molecular data, *F. islandica* belongs to the monothalamid clade M, which also includes the well-known genus *Allogromia*. In addition, we provide brief descriptions and illustrations of nine other monothalamous foraminifera isolated from the same area. Three of them are closely related to some unidentified environmental sequences and serve as the first microscopic documentation of these anonymous lineages.

Key words: marine protists, foraminifera, monothalamids, SSU rDNA, molecular phylogeny, Iceland

Introduction

Shallow-water benthic foraminifera have been the scope of continuous investigation over the last few decades. In comparison to calcareous and agglutinated multi-chambered taxa, single-chambered foraminifera, or 'monothalamids' (Pawlowski *et al*. 2013) only recently were recognized as important taxonomic group, with a number of studies documenting their diversity in shallow-water settings (Altin *et al*. 2009, Goldstein *et al*. 2010, Gooday *et al*. 2011, Majewski *et al*. 2005, Pawlowski & Majewski 2011, Sinniger *et al*. 2008, Voltski *et al*. 2014). In addition to these studies based on morphological and molecular analysis of isolated specimens, recent years have seen the emergence of environmental DNA (eDNA) studies, which enable the assessment of foraminiferal diversity based on metabarcoding approach (Habura *et al*. 2004, 2008, Pawlowski *et al*. 2011, Bernhard *et al*. 2013, Lejzerowicz *et al*. 2013). With the advent of the next-generation sequencing (NGS) technologies, the eDNA studies revealed a huge richness of monothalamous lineages (Lecroq *et al*. 2011, Pawlowski *et al*. 2011, Pawlowski *et al*. 2014). However, this purely molecular approach provides no visual information about organisms living in a given environment, which would allow making the diversity more 'tangible' and available to taxonomic databases. This is especially important in the case of taxonomic groups with the vast proportion of non-described species, such as monothalamids, whose ecology and evolution are extremely poorly understood.

Here, we report the results of a molecular and morphological study of some monothalamous foraminifera isolated from the subtidal zone on the coast of Iceland. One new species has been formally described, leading to the emergence of a new foraminiferal genus. Other new monothalamids comprise a number of small, inconspicuous forms with a subspherical or flask-shaped agglutinated test, designated by informal term 'saccamminids', and delicate organic-walled morphospecies collectively called 'allogromids'. All these forms are illustrated and briefly annotated; however, more material is required for their formal description as a new species.

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