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Selective zircon accumulation in a new benthic foraminifer, Psammophaga zirconia, sp. nov.

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Benthic foraminifera are single-celled eukaryotes that make a protective organic, agglutinated or calcareous test. Some agglutinated, single-chambered taxa, including Psammophaga Arnold, 1982, retain mineral particles in their cytoplasm, but the selective mechanism of accumulation is not clear. Here, we report the ability of a foraminiferal species to select and accumulate zircons and other heavy minerals in their cytoplasm. In particular, the use of Scanning Electron Microscope coupled with an Energy Dispersive X-ray microanalysis system (SEM–EDS) enabled a representative overview of the mineral diversity and showed that the analysed Psammophaga zirconia sp. nov. individuals contained dominantly crystals of zircon (51%), titanium oxides (27%), and ilmenite (11%) along with minor magnetite and other minerals. The studied specimens occur in the shallow central Adriatic Sea where the sediment has a content of zircon below 1% and of other heavy minerals below 4%. For that reason, we suggest that: (i) P. zirconia may be able to chemically select minerals, specifically zircon and rutile; (ii) the chemical mechanism allowing the selection is based on electrostatic interaction, and it could work also for agglutinated foraminifera. In particular, this aptitude for high preferential uptake and differential ingestion or retention of zircon is reported here for the first time, together with the selection of other heavy minerals already described in members of the genus Psammophaga. They are generally counted among early foraminifera, constructing a morphologically simple test with a single chamber. Our molecular phylogenetic study confirms that P. zirconia is a new species, genetically distinctive from other Psammophaga, and occurs in the Adriatic as well as in the Black Sea. Finally, the presence of eukaryotic soft-walled monothalamous microfossils, capable of building a fine aluminosilicate case, in the Precambrian geological record, makes them useful as a valuable record of the early evolution of foraminifera, suggesting that biological agglutination was already present in this group. P. zirconia is a new documented example among foraminifera capable of highly intriguing preferential mineral uptake, showing that this behavior could have emerged very early in their evolution.