high diversity of frenulates (polychaeta: siboglinidae) in the gulf of cadiz mud volcanoes: a DNA taxonomy analysis

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Siboglinids are tube-dwelling annelids that are important members of deep-sea chemosynthetic communities, such as hydrothermal vents, cold seeps and whale-falls. As adults, they lack a digestive system and depend entirely on endosymbiotic bacteria for nutrition. Most species have long thin bodies that span REDOX boundaries in the marine sediment, absorbing oxygen with an anterior gill-like organ and reduced compounds (e.g. hydrogen sulphide) through their posterior body. The taxonomy and systematic position of Siboglinidae was under debate for many years but current data place these animals, formerly known as the phyla Pogonophora and Vestimentifera, within the polychaete clade Siboglinidae, and most researchers recognize four main lineages within Siboglinidae: Frenulata, Vestimentifera, *Sclerolinum* and *Osedax*. The lack of sampling of frenulates has been one of the biggest issues in the study of siboglinid evolution. Sampling constraints, a shortage of taxonomic expertise, and the fact that for a long time specimens were fixed in formaldehyde, which is incompatible with most molecular biology techniques, have all contributed to the current situation of Frenulata being the least-studied group of siboglinids.

The discovery of diverse chemosynthetic communities in mud volcanoes in the Gulf of Cadiz, often dominated by frenulates, and explorations ran by several research programmes have provided excellent opportunities to sample these fascinating worms. Because the long tubiculous bodies were often broken during sampling, and therefore difficult to identify morphologically, we employed DNA taxonomy to assess their diversity. Using COI sequences we were able to distinguished 15 evolutionary lineages, 11 of which may be new to science. The remarkable diversity of Frenulata found in the Gulf of Cadiz is unprecedented and most likely results from the environmental heterogeneity associated with the bathymetry and geochemical settings of the mud volcanoes. This study provided the largest set of DNA sequences of Frenulata species that will be of utmost importance to future phylogeny, taxonomic and biogeographical studies. Moreover, it shows how important it is to explore poorly known deep-sea regions to fully understand the biodiversity and biogeography of the deep-sea, which we are far from accomplishing.