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Integrative Taxonomy and Phylogenomics of Pyuridae Ascidians (Ascidiacea: Stolidobranchia) from the Northeast Atlantic and Mediterranean Sea

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Abstract

Ascidians (Ascidiacea: Tunicata: Chordata) are a highly derived group of marine sessile filter-feeders that include important members of benthic communities in terms of diversity, distribution, and ecological relevance. Among these, the solitary ascidian family Pyuridae encompasses important habitat-formers, non-indigenous species, and species of commercial interest, of which at least 38 are reported from the Northeast Atlantic and the Mediterranean Sea. Although the ascidian fauna of this region is considered well-characterised, the diversity and evolution of pyurid taxa are still widely debated at the local and global scales. The limited application of integrated studies in the past has hindered a stable classification, leaving their evolutionary history poorly understood.

In view of these knowledge gaps, the present thesis aimed to investigate the diversity, ecology, and evolution of Pyuridae ascidians with an integrative approach. After a first introductory Chapter on the topic's background, in the second Chapter the majority of genera and species known from the area were included for preliminary species delimitation analyses. Species boundaries and a preliminary phylogeny of the family were inferred from four markers (*cox1*, *16S rRNA*, *18S rRNA*, and *28S rRNA* genes) and used to test the accepted species hypotheses.

In the third Chapter, specific cases of taxonomic inconsistencies were examined to stabilise the classification. The three subchapters deal with the taxonomy of the genera *Microcosmus*, *Pyura*, and *Heterostigma*, with a particular emphasis on their morphology and diagnosis. Among those, three new species of *Microcosmus* and two species complexes in the genus *Pyura* were discovered. A dedicated focus on the behavioural ecology of a new species of *Heterostigma* was included, due to the peculiar adaptations observed in this atypical sand-living pyurid.

Lastly, in the fourth Chapter, the evolutionary history of the family was addressed through a robust phylogenomic framework based on BUSCO loci extracted from newly assembled whole genomes and mitochondrial genomes, to clarify the relationships and diversification patterns of these solitary ascidians.

This PhD thesis therefore represents an integrative effort to advance the knowledge on Pyuridae from the NE Atlantic and Mediterranean, providing new multiple insights on the taxonomy, phylogeny, and biology of these ascidians.