



Phylogenetic relationships in the genus *Astropecten* Gray (Paxillosida: Astropectinidae) on a global scale: molecular evidence for morphological convergence, species-complexes and possible cryptic speciation

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Abstract

With over 150 described species, *Astropecten* Gray (Paxillosida: Astropectinidae) is one of the most species-rich genera among sea stars. This diversity is remarkable, because most species of *Astropecten* have a long-lived planktotrophic larval stage, which would be expected to lead to a low speciation rate. The taxonomy of this genus is complex and not well resolved, and phylogenetic relationships have only been addressed in the beginning of the last century. In order to resolve general taxonomic issues, identify speciation patterns and estimate species diversity within the genus *Astropecten*, we inferred a molecular phylogeny of 117 specimens of *Astropecten* belonging to 40 species from around the world using mitochondrial DNA (mtDNA) sequences of 12S rRNA, 16S rRNA and cytochrome oxidase subunit I (COI). We compared the resulting molecular phylogeny to a previously published morphological one by Döderlein and investigated the possibility of morphological convergence in species from different geographic regions. Finally, we also aimed at identifying potentially problematic descriptions and/or signs of cryptic speciation in *Astropecten*. The global molecular phylogeny exhibited three main clades, each containing specimens of the same geographic region: 1. the Indo-Pacific; 2. the Neotropics; and 3. the eastern Atlantic and Mediterranean. Phylogenetic inferences based on mtDNA indicate that morphological and ecological convergence has taken place in *Astropecten*, resulting in allopatric non-sister taxa with similar morphologies and habitat preferences. The comparison to Döderlein's morphological phylogeny reveals congruence on the whole but many discrepancies on a local scale, indicating that meaningful morphological characters are not easily identified and categorized in *Astropecten*. Our results also reveal that *A. polyacanthus* Müller & Tröschel and *A. indicus* Döderlein are species-complexes; cryptic speciation may have occurred within each of these morphospecies. Furthermore, several variants, previously presumed to be conspecific, exhibit genetic distances large enough to justify recognizing them as separate species.

Key words: global phylogeny, Asteroidea, mitochondrial DNA, echinoderm, marine invertebrates

Introduction

Marine organisms with long-lived planktotrophic larvae are thought to rarely undergo speciation due to their enormous capacity for dispersal and large effective population sizes (Palumbi 1992, 1994; Riginos and Victor 2001). Thus, it is unusual to find echinoderm genera with planktonic larvae that contain more than 20 species. However, this trend is not universal among all echinoderms, and estimating probability of speciation from the duration of the larval stage alone can be misleading. Also, as has been shown in several studies using genetic markers, levels of gene flow and extent of species range cannot always be predicted from larval duration (e.g., Sponer and Roy 2002; Waters *et al.* 2004; Paulay and Meyer 2006; Wilson *et al.* 2007).

An exception to the pattern of low species diversity in echinoderms with mostly long-lived planktonic larval stages is the sea star genus *Astropecten* Gray (Paxillosida: Astropectinidae) with approximately 150 species described to date (Say 1825; Gray 1841; Müller and Troschel 1842; Perrier 1875/6; Agassiz 1877; Sladen 1889; Ludwig 1897; Fisher 1906; Koehler 1909, 1910, 1924; Fisher 1911, 1913; Verrill 1914, 1915;