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Morphological and Molecular Phylogenetic Analysis of the Sea Spiders
(Arthropoda, Pycnogonida) and Taxonomic Study of Tropical Australian
forms



Thesis submitted by
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in February 2002

For the degree of Doctor of Philosophy
School of Tropical Biology & School of Marine Biology and Aquaculture
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Claudia P. Arango

23rd May 2002

Date

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ABSTRACT

Pycnogonida is a subphylum of marine arthropods showing unique characteristics. Their position within the Arthropoda is not yet clear, but strong evidence has suggested they may be the extant sister taxon to all other arthropods. The phylogenetic affinities among the extant families of pycnogonids: Ammotheidae, Colossendeidae, Callipallenidae, Nymphonidae, Phoxichilidiidae, Pycnogonidae, Austrodecidae, Rhynchothoracidae, and the position of problematic genera such as *Endeis*, *Pallenopsis* and *Tanystylum*, are uncertain. Traditionally, it has been assumed that an evolutionary trend of gradual reduction of numbers of segments of the appendages, mainly involving chelifores, palps and ovigers (head appendages) has taken place within the group. Modern cladistic techniques have not been applied to resolve phylogenetic conflicts of the sea spiders. I approached the problem of the uncertain higher-level phylogenetic affinities of pycnogonids to propose hypotheses of relationships based on cladistic analysis of morphological characters, thereby testing the hypothesis of a reduction trend. Additionally, I used a preliminary molecular approach to confront the morphological results. This is one of the first attempts to use molecular data in the study of systematics of pycnogonids. Phylogenetic relationships among the main lineages of extant sea spiders were studied using cladistic analysis of 36 morphological characters and 38 species from all the recognized families. A preliminary exemplar method was employed, and different assumptions of multistate character transformations were used to trace the evolution of the head appendages. Fragments of nuclear ribosomal DNA (18S and 28S) were sequenced to reconstruct the phylogenetic relationships among six higher taxa of sea spiders. Hypotheses of relationships were obtained from separate and combined analyses of these data sets under both maximum parsimony and maximum likelihood criteria. Trees derived from the molecular data set were compared with those from the set of 36 morphological characters previously analysed. Estimates of phylogeny were found to be significantly different between the molecular and the morphological data set and possible causes for incongruence, such as the coding of inapplicable characters in morphology and a very reduced set of taxa in the molecular analysis, are discussed. The position of Colossendeidae was a major cause of conflict, being supported as a relative of Ammotheidae by morphological characters but appearing closely related to Callipallenidae and Nymphonidae with DNA data. With the molecular characters, *Austrodecus* is identified as a basal taxon for the rest of the pycnogonids included, differing from its close relationship to ammotheids shown by morphology. Using morphological data, the family Ammotheidae appeared as paraphyletic as did Callipallenidae. *Pallenopsis* was related to *Anoplodactylus* according to DNA but not morphology. Although

no clear pattern of overall relationships among sea spiders is yet defined, several patterns useful for future systematic work have been noted. New sets of characters and compilation of data from all available sources will probably provide a better picture. Ontogenetic transformation could give some insights into character evolution, and knowledge of ecological traits is needed to complement morphological observations. A collection of fresh material of numerous species of sea spiders from the Great Barrier Reef and other localities of Queensland was useful for the phylogenetic analyses and also contributed to the knowledge of the marine fauna of Australia. Thirty-three species of tropical shallow-water sea spiders collected from the Queensland coast, the Great Barrier Reef and the Coral Sea are reported here. Among these were six undescribed species in the genera *Austrodecus*, *Anoplodactylus* and *Pycnogonum*, and other nine species, mostly of Indo-West pacific distribution not previously recorded for Australia.

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LIST OF PUBLICATIONS

Based on the work of this thesis, the following papers have been accepted or submitted to scientific journals for publication :

- Arango CP. 2001. Sea spiders (Pycnogonida) from the Great Barrier Reef, Australia, feed on fire corals and zoanthids. *Memoirs of the Queensland Museum* 46:656.
- Arango CP. 2000. Three species of sea spiders (Pycnogonida) from Santa Marta, Colombian Caribbean. *Boletin de Investigaciones Marinas y Costeras* 29:59-66.
- Arango CP. In press. Morphological phylogenetics of sea spiders (Arthropoda, Pycnogonida). *Organisms Diversity and Evolution*.
- Arango CP. In press. Sea spiders from the Great Barrier Reef area: New species, new records and ecological annotations. *Journal of Natural History*.
- Arango CP. Molecular approach to the phylogenetics of Pycnogonida (Arthropoda) using nuclear ribosomal DNA and morphology. Submitted to *Molecular Phylogenetics and Evolution*.
- Arango CP and Brodie GD. In press. Observations of predation on the tropical nudibranch *Okenia* sp. by the sea spider *Anoplodactylus longiceps* Williams (Pycnogonida, Arthropoda). *The Veliger*.
- Lee A. C. and Arango CP. Two new species and other records of sea spiders (Pycnogonida, Arthropoda) from tropical North Queensland, Australia. Submitted to *Memoirs of the Queensland Museum*.

Statement on sources

I declare that this thesis is my own work and has not been submitted in any form for another degree or diploma at any university or other institution of tertiary education. Information derived from the published or unpublished work of others has been acknowledged in the text and a list of references is given.

Claudia P. Arango

23rd May 2002
Date