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Three new species of *Phyllodesmium* Ehrenberg (Gastropoda: Nudibranchia: Aeolidoidea), and a revised phylogenetic analysis

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Abstract

Mimicry and camouflage are an important protective measure for nudibranch gastropods. In the genus *Phyllodesmium*, species have evolved elaborate morphological traits that allow them to be very cryptic among their coral prey. In this study, three new species of *Phyllodesmium* from the Philippine islands are described: *Phyllodesmium tuberculatum* **n. sp.**, *Phyllodesmium pinnatum* **n. sp.**, and *Phyllodesmium karenae* **n. sp.** The first two, *P. tuberculatum* and *P. pinnatum*, are highly cryptic on their prey and were already included in a phylogenetic analysis by Moore & Gosliner (in press). The third species (*P. karenae*) is newly discovered and has not yet been observed on its prey. A revised morphological phylogenetic analysis is presented that includes this species, as well as three species that were recently described by Burghardt et al. (2008a). In addition, the current analysis excludes a previously presumed new species, which was referred to as *Phyllodesmium* sp. 3 by Moore & Gosliner (in press), because it was determined to be an abnormally preserved specimen of *P. jakobsenae.* The newest species, *P. karenae*, has an unusual dental morphology, no branching of the digestive diverticula, and no zooxanthellae present in the cerata. It fell into the basal part of the phylogeny, as was expected based on previous general trends showing the derived status of symbiotic species. The three species described by Burghardt et al. (2008a), two of which are associated with xeniid corals, appear in a highly unresolved part of the phylogeny including other xeniid-associated species. One of these, *P. koehleri*, is not associated with xeniid corals but is indistinguishably intermixed within this clade. Decay analysis values for most nodes are low, indicating that support for this topology is lacking. It is recommended that the addition of less ambiguous characters, such as genetic sequences, be considered for further phylogenetic analyses.

Key words: zooxanthellae, symbiosis, evolution, biodiversity

Introduction

Within various groups of mollusks, mimicry and camouflage are vital adaptations that increase the likelihood of survival (Gosliner & Behrens 1990; Gosliner 2001). For nudibranch gastropods, which have lost the protective shell of their snail relatives, adaptations that minimize predator encounters are important. In aeolid nudibranch groups, the ability to preserve, and later use, undischarged nematocysts from cnidarian prey deters would-be predators (Kepner 1943; Edmunds 1966). In other groups, bright aposematic coloration serves as an advertisement of toxicity, while others might opt to avoid a conflict altogether by becoming nearly invisible to their prey (Gosliner & Behrens 1990; Gosliner 2001).

In the genus *Phyllodesmium*, mimicry has evolved beyond color similarity and camouflage to a unique level of disguise. Species in this genus show diverse and remarkable variations in external morphology that, when set against the backdrop of their coral prey, confer near invisibility to passing predators. In addition, species in this genus have evolved a unique symbiosis with coral-derived zooxanthellae, which they preserve out of consumed coral tissue and show different levels of effective symbiosis (Burghardt et al. 2005; Burghardt et al. 2008b; Burghardt & Wägele 2006). This is not altogether unusual for opisthobranchs,

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