Resolving the phylogenetic affinities of *Kappaphycus inermis* within the genus *Kappaphycus* (Gigartinales, Solieriaceae) using mitochondrial and plastid markers

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Abstract

Although the phylogeny of the genus *Kappaphycus* has been the subject of a number of published studies, the phylogenetic placement of *Kappaphycus inermis* within the genus has remained unresolved. In this study, we sought to determine the phylogenetic affinities of *K. inermis* with the other congeneric species using mitochondrial (cox1 and cox2–3 spacer) and plastid (rbcL and RuBisCo spacer) markers, using specimens collected from northwestern Philippines. Morphological observations of the collected materials confirmed the presence of key morphological features that distinguish *K. inermis* from the other members of *Kappaphycus*. Molecular analyses based on the organellar genetic markers revealed that *K. inermis* is indeed phylogenetically distinct from *K. alvarezii*, *K. striatus*, *K. cottonii* and *K. malesianus*, a species which was recently erected based on specimens from Malaysia. The Philippine *K. inermis* specimens formed a sister clade to *K. malesianus* (also referred to as “Aring-aring” in Malaysia) in phylogenetic trees inferred from cox1, cox2–3 spacer and rbcL, but not the RuBisCo spacer whose sequence is identical in both *K. inermis* and *K. malesianus*. The analysis also revealed that specimens of unidentified *Kappaphycus* species collected from two other sites in the Philippines and referred to as “Aring-aring” by local farmers/traders were varieties of *K. alvarezii* and *K. striatus*.

Key words: cox1, cox2–3 gene spacer, *Kappaphycus* sp. “Aring-aring”, phylogeny, rbcL, RuBisCo spacer, taxonomy

Introduction

*Kappaphycus inermis* (F. Schmitz) M. S. Doty ex H.D. Nguyen & Q.N. Huynh in Abbott (1995: 233) was originally described as *Eucheuma inerme* by Schmitz (1895: 139) based on dried materials from Dar es Salaam, Zanzibar, Tanzania. Since its original description, the species has been mentioned sporadically in various reports from east Africa (Doty 1988, Silva et al. 1996) to southeast Asia (Doty 1988, Nguyen & Huynh 1995) and from the Gulf of Mexico (Fredericq et al. 2009). In the Philippines, although the distribution of *Kappaphycus* M.S. Doty in Abbott (1988: 171) species has been fairly documented (Silva et al. 1987; Trono 1997), the exact collection sites of Philippine *K. inermis* materials have never been mentioned in the literature.

The taxonomy of *K. inermis* has remained poorly understood. Originally, Weber van-Bosse (1928) placed *K. inermis* (as *E. inerme*) in *Eucheuma* sect. Axifera A. Weber van-Bosse (1928: 404) which included species with a central axis of compact filaments. She distinguished *K. inermis* from the other members of this section by the presence of rough surfaces. Subsequently, *Eucheuma* sect. Axifera was placed into synonymy with *Eucheuma* sect. *Eucheuma* Doty & Norris by Doty & Norris (1985: 55); however, *K. inermis* (as *E. inerme*) was not included in this new section, but instead was transferred by Doty (1988) to the newly erected genus *Kappaphycus*. The study of Santos (1989) confirmed that κ-carrageenan was the dominant form of carrageenan in *K. inermis*, consistent with Doty’s (1988) assignment of this species to the genus *Kappaphycus*.

*K. inermis* was also known to be morphologically similar to *K. striatus* (F. Schmitz) M.S. Doty ex P.C. Silva in P.C. Silva, Basson & Moe (1996: 334) (Weber van-Bosse 1928; Mshigeni 1984). Based on morphological criteria and range of distribution of these two species, Mshigeni (1984) merged them into a single taxon, favoring the
are used by seaweed farmers/traders to refer to different *Kappaphycus* varieties. Development of a publicly available resource that would make possible the consistent naming of varieties based on genetic evidence will provide significant benefits for researchers and seaweed farmers/traders alike.

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