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Phylogenetic relationship of commercially important *Kappaphycus* Doty and *Eucheuma* J. Agardh in Malaysia

The genera *Kappaphycus* Doty and *Eucheuma* J. Agardh are important sources of carrageenan in Malaysia, offering lucrative revenues to the carrageenan industry, economy, and the local community. The extensive range of morphotypes and the lack of distinct morphological characteristics led to the application of molecular systematics in elucidating this taxonomic confusion. Local varieties of *Kappaphycus* and *Eucheuma*, identified using putative external morphology, were analyzed using the mitochondrial *cox2-3* spacer and plastid *RuBisCO* spacer molecular markers. Phylogenetic analysis of these and non-local specimens indicate that *Kappaphycus* and *Eucheuma* are genetically distinct. Three main genotypes of *Kappaphycus alvarezii* were identified, of which two are extant in Hawaii. Morphological and colour variations are not supported by molecular data, indicating that most of the local names are not genetically based. Both the *cox2-3* spacer and *RuBisCO* spacer generated phylogenetic trees with similar topology except in variation of nodal supports. The two markers showed clear separation between *Kappaphycus* and *Eucheuma* and the existence of three Malaysian *Kappaphycus* cultivars. *Cox2-3* spacer data is more variable and provides better resolution than the *RuBisCO* spacer, showing that *Kappaphycus* is more diversified with a larger number of genotypes, strains, and species which are unique to Southeast Asia. *Kappaphycus* sp. “*Aring-aring*” appeared to be phenotypically and genotypically different from other *Kappaphycus* congeners,

whereas *Kappaphycus striatum* exhibited two different genotypes. Our data indicate that *Eucheuma denticulatum* is the dominant species in Malaysian waters and also suggested paraphyly in *Eucheuma* which will require further studies. The application of molecular taxonomy on Malaysian *Kappaphycus* and *Eucheuma* proves useful, offering valuable insights into the taxonomy and distribution of these commercially important Rhodophytes.