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Halymenia johorensis sp. nov. (Halymeniaceae, Rhodophyta), a new foliose red algal species from Malaysia

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Abstract A new *Halymenia* species, *Halymenia johorensis* sp. nov., from southern Peninsular Malaysia is proposed based on plastid-encoded large subunit of ribulose-1,5-bisphosphate carboxylase/oxygenase (*rbc*L) gene analyses and detailed morphological observations. The new species is characterized by having (1) elliptical, oblong, or irregularly shaped blades, incised with some perforations, arising from a narrow-cuneate stipe attached to a discoid holdfast; (2) blades with a cartilaginous and gelatinous texture, a smooth to rugose surface, and irregularly dentate and cleft margins; and (3) isodiametric outer cortical cells and rounded to stellate inner cortical cells. *Rbc*L sequence analyses have shown *H. johorensis* to be genetically distinct from other *Halymenia* species. Although *H. johorensis* is sister to *Halymenia plana*, these two species can be distinguished both molecularly and morphologically. Further studies are necessary to investigate the phylogenetic relationships and species diversity in this genus.

Keywords *Halymenia johorensis* · Malaysia · New species · *rbc*L · Rhodophyta · Taxonomy

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Introduction

The marine red algal genus *Halymenia* C. Agardh is one of several species-rich red algal genera in the family Halymeniaceae and includes 79 taxonomically accepted species (Guiry and Guiry 2016), widely distributed in tropical and subtropical regions (Gargiulo et al. 1986; Hernández-Kantún et al. 2012; Tan et al. 2015). Agardh (1817) established the *Halymenia* based on the generitype, *Halymenia floresii* (Clemente) C. Agardh, from Cádiz, Spain.

Generic concepts of *Halymenia* are based largely on the structure of auxiliary cell ampullae, as proposed by Chiang (1970), and the presence of anticlinal medullary filaments (Abbott 1967). However, several authors believe that vegetative features are more diagnostic than reproductive characters, which overlap greatly among genera of Halymeniaceae (Abbott 1967; Guimarães and Fujii 1998; Hernández-Kantún et al. 2012). Vegetative features used to delineate species of *Halymenia* include habit, thallus size, blade margin, order of branching, presence or absence of a midrib in the basal region, presence or absence of a stipe, presence or absence of marginal proliferations, presence or absence of papillae or spines on thallus surface, blade thickness, cortex thickness, shape of inner cortical cells, inner cortical cell size, and presence or absence of refractive ganglionic cells (Guimarães and Fujii 1998; De Smedt et al. 2001; Ballantine and Ruiz 2004; Hernández-Kantún et al. 2012; Tan et al. 2015; Azevedo et al. 2016).

To date, six species of *Halymenia* have been reported from Malaysia, including three foliose species, *H. dilatata* Zanardini, *H. maculata* J. Agardh, and *H. malaysiana* P-L Tan, P-E Lim, S-M Lin & S-M Phang (Kawaguchi et al. 2002; Tan et al. 2015; Phang et al. 2016). Kawaguchi et al. (2002) confirmed the existence of two foliose species (*H. dilatata* and *H. maculata*) and one branched species

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