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Molecular diversity and assemblages of coral symbionts (Symbiodiniaceae) in diverse scleractinian coral species

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ABSTRACT

The scleractinian coral-associated symbiotic algae Symbiodiniaceae plays an important role in bleaching tolerance and coral resilience. In this study, coral-associated Symbiodiniaceae communities of 14 reef sites of Perhentian and Redang Islands Marine Parks (Malaysia, South China Sea) were characterized using the high-throughput next-generation amplicon sequencing on the ITS2 rDNA marker to inventory the Symbiodiniaceae diversity from a healthy tropical reef system and to generate a baseline for future studies. A total of 64 coral-Symbiodiniaceae associations were characterized in 18 genera (10 families) of scleractinian corals using the SymPortal analytical framework. The results revealed the predominance of Symbiodiniaceae genera *Cladocopium* (average 82%) and *Durusdinium* (18%), while *Symbiodinium*, *Breviolum*, *Fugacium*, and *Gerakladium* were found as minor groups (<0.01%). Of the 39 *Cladocopium* and *Durusdinium* major ITS2 sequences, 14 were considered dominant/sub-dominant, with C3u as the predominant type (63.3%), followed by D1 (15%), C27 (10.1%), and C15 (6.9%). A total of 19 and 13 *Cladocopium* and *Durusdinium* ITS2-type profiles were detected across the coral species, respectively. Symbiodiniaceae diversity and richness recorded in this study were higher when compared to other reefs in the proximity. With the increasing coral-Symbiodiniaceae associations archived, the database would provide a baseline to assess the changes of Symbiodiniaceae communities in the coral hosts and to explore the potential adaptive roles of this coral-algal association.

1. Introduction

Coral reef ecosystems are particularly vulnerable to climate change (Camp et al., 2018) as ocean warming and thermal stress anomalies would cause the scleractinian corals to bleach rapidly by expulsing their algal symbionts (Brown, 1997; Fitt et al., 2001). Photosymbiosis between Scleractinia hosts and the microscopic photosynthesizing marine dinophytes in the family Symbiodiniaceae is believed to develop during the Triassic period when the Scleractinia underwent rapid expansion and adaptive radiation across shallow marine environments (Stanley and Swart, 1995; Stanley, 2006; Simpson et al., 2011; Frankowiak et al., 2016). Global climate stressors and local anthropogenic disturbances are believed to disrupt the symbiotic relationship between coral polyps and the symbiodinian algae, affecting the ecological states of equilibrium of coral reefs.

Thermal tolerance in coral hosts varies among genera and species, and the diversity of Symbiodiniaceae assemblages plays an important role in overall coral bleaching susceptibility (Hume et al., 2015; Silverstein et al., 2015). When a coral host is associated with highly thermotolerant symbiodinian algae, it raises the bleaching threshold by 1–2 °C and protects its holobionts from thermal stress (Berkelmans and Van Oppen, 2006; Abrego et al., 2008; Silverstein et al., 2017). Although the shift in dominant Symbiodiniaceae towards more thermotolerant species is observed (Grottoli et al., 2014), this novel association does not always persist (Lajeunesse et al., 2010b; Hume et al., 2020). The original symbiont composition is restored when the environmental conditions return to normal (Howells et al., 2020; Hume et al., 2020). A recent study has revealed the unexpected coral survival pathway through prolonged heatwaves, where bleached corals recovered through the proliferation of heat-tolerant symbiodinian algal communities that are

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