Genus-specific bleaching at Con Dao Islands, Southern Vietnam, June 2019

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Coral communities in the shallow waters of Con Dao islands, located on the continental shelf of Southern Vietnam, were monitored in June 2019 when bleaching alert level 1 was announced by NOAA Coral Reef Watch (<https://coralreefwatch.noaa.gov/satellite/index.php>) and the surface seawater temperature was recorded between 30–32°C in the field. We used the ReefCheck transect method (Hodgson et al. 2006) to record cover of bleached corals and non-bleached corals at two depths (shallow: 3–5 m and deep: 6–8 m) at 5 sites (EMS Fig. 1). The study sites were characterised by the dominance of hard corals with their cover more than 50% at 4 sites and around 25% at Cua Ga. Overall, $32.5 \pm 7.5\%$ (mean $\pm$ SE) of hard corals (mean cover = 51.8%, SD = 23.7%) and 100% of soft corals (mean cover = 2.6%, SD = 4.5%) were observed to bleach. Bleaching at genus level was considered for common coral genera with their total cover (%) as follows respectively: *Acropora* (17.3), *Montipora* (9.9) *Porites* (4.2), *Diploastrea* (2.4), *Pachyseris* (1.7), *Pavona* (1.6), *Fungia* (1.1), *Favites* (1.0), *Pectinia* (0.8) and *Galaxea* (0.6). The hard coral genera with most severe bleaching (all at 100% bleached) included: *Fungia* (Fig. 1A), *Pachyseris* (Fig. 1B), *Pavona* (Fig. 1C), followed by *Pectinia* ($93.8 \pm 10.2\%$ bleached; Fig. 1B) and massive *Porites* ($69.9 \pm 15.2\%$ bleached; Fig. 1D). Other coral genera commonly found in Con Dao Islands were moderately bleached such as *Favites* ($30.0 \pm 26.7\%$), *Goniastrea* ($23.8 \pm 26.1\%$), *Montipora* ($10.1 \pm 5.7\%$; Fig. 1A). Two genera *Galaxea* and *Diploastrea* did not suffer bleaching. *Acropora* with most branch and tabulate colonies were less impacted both in deep and shallow waters ($0.9 \pm 1.3\%$ bleached; Fig. 1D–F). Hard corals in deeper waters exhibited a higher susceptibility to bleaching than their shallow counterparts (48% bleached in deeper transects compared with 15% in shallow transects). The findings were consistent with the higher abundance of the five most susceptible genera mentioned above in deeper (total mean cover = 17.5%) than in shallow (2.2%) transects.

An earlier bleaching event at Con Dao islands in October 1998 resulted in 37.8% of hard coral colonies bleached (Vo 2000). The 2019 event had both similarities and differences in impacts. Soft corals were the most susceptible in both events (100% bleached) and *Galaxea* remained consistently unbleached. In 2019, *Pachyseris* and *Fungia* had much higher levels of bleaching than in 1998, when these genera were little affected (7.7% and 8.3% bleached). In contrast, *Diploastrea* had no bleaching compared with 14% bleached in 1998. *Porites* was severely impacted at both events with 57% bleached and many dead massive corals covered by filamentous algae were recorded in October 1998. *Acropora* were among the susceptible genera with 19% bleached colonies together with many dead colonies observed in October 1998 (Vo 2000).

Fig. 1 (A) Severely bleached *Fungia* side by side with less affected *Montipora* (7 m deep); (B) Bleached *Pachyseris* and *Pectinia* corals (7 m deep); (C) Affected *Pavona* corals (8 m deep); (D) Non-bleached tabulate *Acropora* corals growing on severely bleached *Porites* (5 m deep); *Acropora* corals in (E) shallow (4 m deep) and (F) deep (8 m deep) transects without severe bleaching.

The present study highlights apparent shifts in susceptibility of some genera to bleaching from 1998 to 2019, especially of *Acropora*, given its great susceptibility to bleaching events reviewed by Grimsditch and Salm (2006) and based on the previous study in Con Dao islands (Vo 2000). This genus was also severely impacted in 2017 bleaching event in Guam with 36% live coral cover of staghorn *Acropora* lost (Raymundo et al. 2019). Whether these shifts are related to adaptation or acclimation remains as important questions. Further studies on changes of susceptibility of coral genera should aid scientific understanding and adaptive management in Con Dao National Park.

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* ESM Fig. 1 can be downloaded from the J-STAGE website:

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