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REEF COMMUNITIES AFTER THE 2010 MASS CORAL BLEACHING AT RACHA YAI ISLAND IN THE ANDAMAN SEA AND KOH TAO IN THE GULF OF THAILAND

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ABSTRACT: In April-June 2010, a thermal anomaly developed in the Andaman Sea and in the Gulf of Thailand. Subsequently, mass coral bleaching occurred. To monitor the health of the reefs and changes in reef communities, permanent line transects that have been established since 2007, using a Reef Check method, were used to survey composition of substrates, abundances of indicator fishes, and invertebrates. Two study sites, Racha Yai Island located in the Andaman Sea and Koh Tao located the Gulf of Thailand were selected. The results showed that following the bleaching event, coral mortalities at Racha Yai and Koh Tao were 42.33% and 72.17%, respectively. Unlike Racha Yai Island, at Koh Tao, small and medium size classes of *Tridacna* spp. (<30 cm) were not found in the 2011 survey, while the abundance of parrotfish appeared to decrease with no sightings in 2011.

Key Words: bleaching, coral mortality, Gulf of Thailand, Andaman Sea, long-term survey

INTRODUCTION

During the past five years, bleaching incidents have occurred within specific localities in Thailand (Wilkinson, 2008; Chavanich *et al.,* 2009). For example, in June 2006 and 2007, mass bleaching of soft corals was first reported at Chonburi Province, the upper Gulf of Thailand (Chavanich *et al*., 2009). However, in April-June 2010, a warm water anomaly developed in the Andaman Sea and in the Gulf of Thailand. The highest temperature measured in the upper Gulf of Thailand was 33.9°C (personal observations). Subsequently, mass coral bleaching occurred both in the Gulf of Thailand and in the Andaman Sea (Hoeksema and Matthews, 2011; Department of Marine and Coastal Resources, unpublished data). Bleaching of live coral populations in the Gulf of Thailand and in the Andaman Sea ranged between 30-95% depending on sites (Hoeksema and Matthews, 2011; Department of Marine and Coastal Resources, unpublished data). The 2010 bleaching was expected to be more severe than the 1998 bleaching event since more coral morality occurred after the 2010 bleaching (Department of Marine and Coastal Resources, unpublished data). Temperature is a major contributing factor to coral bleaching, and this is exacerbated by high irradiance during thermal anomalies (Brown, 1997). Other factors such as salinity, and anthropogenic factors can also lead to bleaching of corals (Hoegh-Gulberg and Smith, 1989; Brown, 1997). Areas in the region such as the Andaman and Nicobar Islands were also affected by the bleaching in 2010 (Krishnan *et al.,* 2011).

Bleaching events may lead to coral mortality, and subsequently altered reef community structure (Bellwood *et al.,* 2006; Pratchett *et al.,* 2008). This paper investigated the effect of mass bleaching on corals and reef organisms at selected permanent monitoring sites in the Gulf of Thailand and in the Andaman Sea using long-term data collected between 2007-2011.

MATERIALS AND METHODS

Two study sites were selected based on the availability of Reef Check long-term data. One was Scuba Cat Bay, Racha Yai Island located in the Andaman Sea (07°36'26.3"N, 98°22'39.2"E) and the other was Mango Bay, Koh Tao in the Gulf of Thailand (10°07'33.3"N, 99° 50'09.9"E). Permanent line transects that have been established since 2007 using the Reef Check method (Hodgson *et al.,* 2006) were employed to monitor the health of the reefs and changes of reef communities, and this included surveys of substrate composition, abundance of indicator fishes, and invertebrates. In addition, the proportion bleached area on each coral colony was observed using visual estimation. The data were collected each year in each study site from 2007-2011. At Scuba Cat Bay, the data were collected during June of each year except in 2007 where the data were collected during September. At Mango Bay, the data were collected in October 2007, October 2008, July, 2009, July 2010, and January 2011.

RESULTS

The results from the long-term surveys showed that the percentage of hard coral cover appeared to decline sharply after the 2010 mass coral bleaching event from 53.75 ± SE 1.19 % to 31 ± SE 10.23 % at Scuba Cat Bay, Racha Yai Island and from 71.87 ± SE 1.54 % to 20 ± SE 6.30 % at Mango Bay, Koh Tao (Fig. 1). Coral mortality following the bleaching at Scuba Cat Bay and Mango Bay, which was calculated based on the percentage loss of hard coral cover, was 42% and 72%, respectively. Overall 94-96 % of the coral colonies at both study sites experienced extensive bleaching. The average proportion of bleaching on each colony at the two sites was between 92 and 97%.

From the 5-year surveys, the abundance of fish varied year by year (Fig. 2). However, at Mango Bay, the number of parrotfish appeared to have decreased since 2009, and no parrotfish were found in 2011 while at Scuba Cat Bay, a number of parrotfish were still observed in 2011 (Fig. 2) The results from the surveys of invertebrate abundance at Scuba Cat Bay showed no effects from the bleaching. The abundance of each invertebrate type was variable depending on the year in question (Fig. 3). Yet, at Mango Bay, the number of the sea urchins (*Diadema* spp.) and giant clams (*Tridacna* spp.) appeared to decrease in 2011 (Fig.3, Fig. 4). In addition, small and medium size classes of *Tridacna* spp. (<30 cm) were not found in the 2011 survey at Mango Bay (Fig. 4).

DISCUSSION

High sea water temperatures between 30-34°C were recorded during April-June 2010 in the Gulf of Thailand and the Andaman Sea (Krishnan *et al.,* 2011; Department of Marine and Coastal Resources, unpublished data). The preliminary surveys by the Department of Marine and Coastal Resources, Thai universities, and non-governmental organizations showed widespread coral bleaching both in the Gulf of Thailand and in the Andaman Sea (Department of Marine and Coastal Resources, unpublished data).

From the Department of Marine and Coastal Resources, unplublished data, *Acropora* spp. and *Pocillopora* spp. were the most susceptible corals to the bleaching and more than 90% of these coral colonies bleached. In this study, *Acropora* spp. and *Pocillopora* spp. also bleached extensively, and most colonies were fully bleached. This is typical of most major coral bleaching events where fast growing branching species tend to be most susceptible (Baird and Marshall, 2002; McClanahan *et al.,* 2004). A relationship between bleaching and water depth was observed for mushroom corals, with a species-specific effect being noted at Koh Tao (Hoeksema and Matthews, 2011). High levels of bleaching occurred at 20 m depth or less (Hoeksema and Matthews, 2011). The sensitivity to bleaching and the mortality after the bleaching varies among coral species depending on their size and their resilience (Obura, 2001; Obura, 2005; Bellwood *et al.,* 2006). From the present surveys, bleaching not only occurred on hard corals, but also on reef organisms associated with symbiotic zooxanthellae, such as giant clams. The young populations of giant clams seemed to

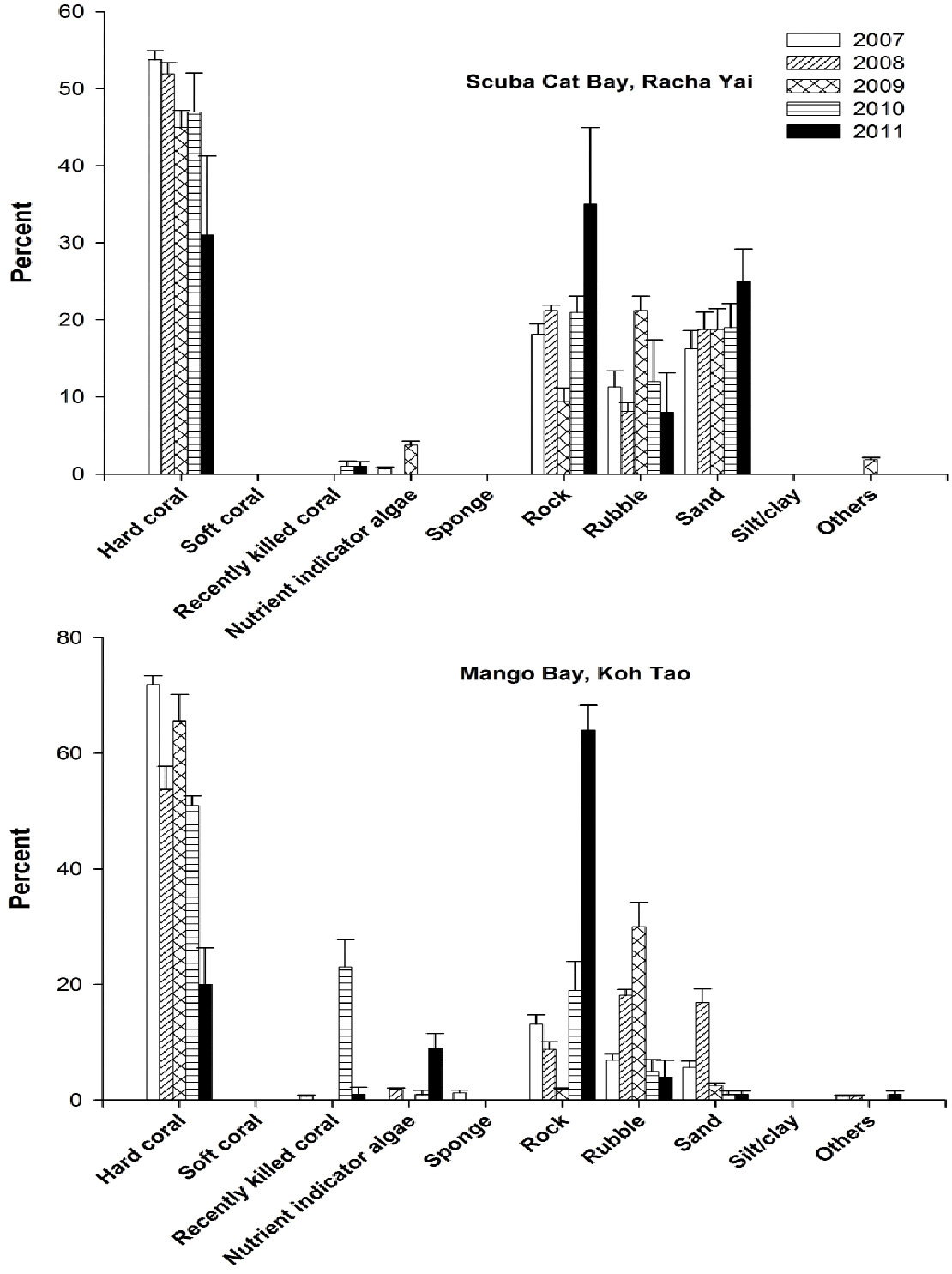

Figure 1. Average percent cover of substrates from 2007-2011 at Scuba Cat Bay, Racha Yai Island and Mango Bay, Koh Tao. Means ± SE are shown.

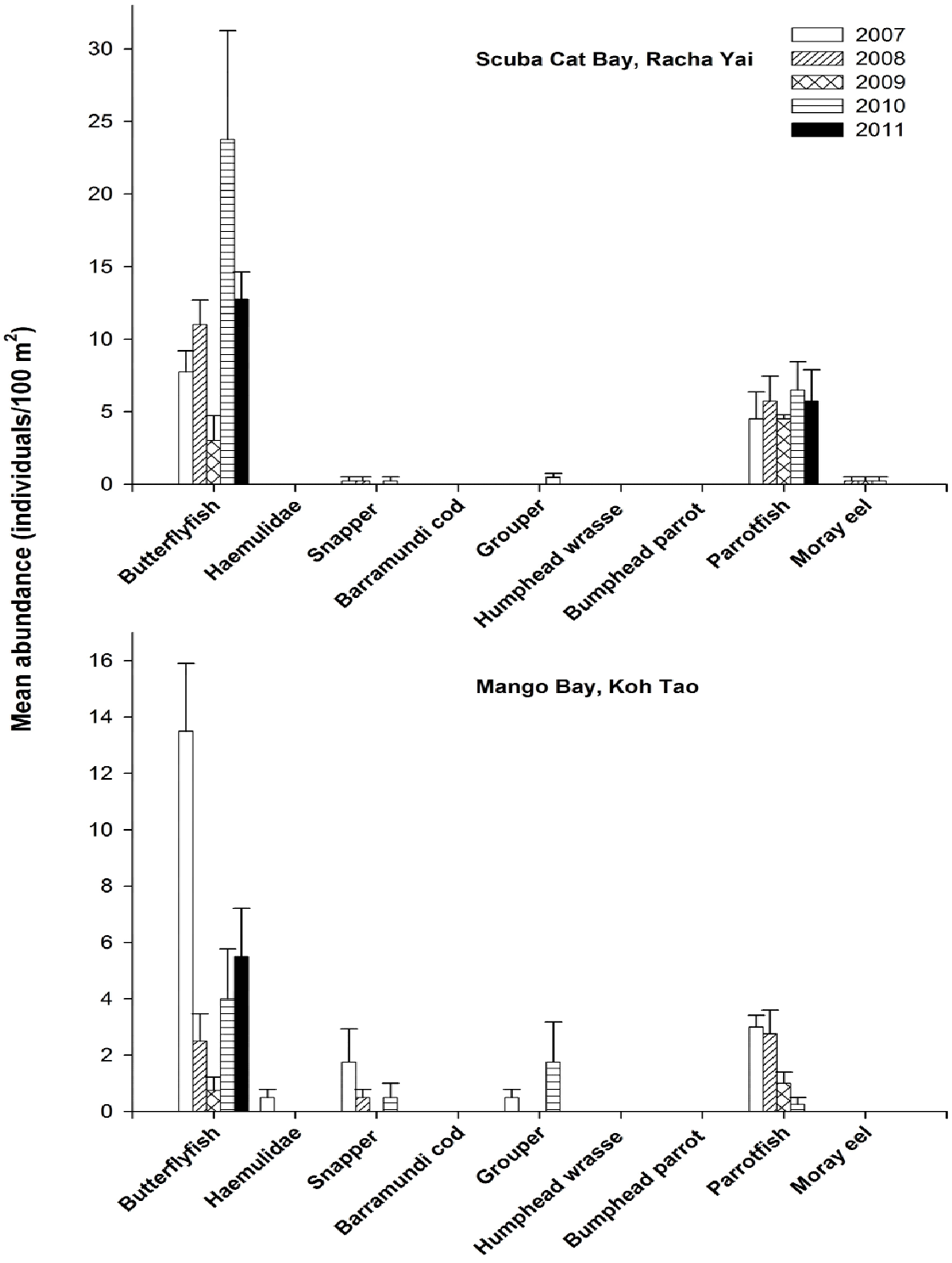

Figure 2. Abundance of indicator fish species (individuals per 100 m^2) from 2007-2011 at Scuba Cat Bay, Racha Yai Island and Mango Bay, Koh Tao. Means ± SE are shown.

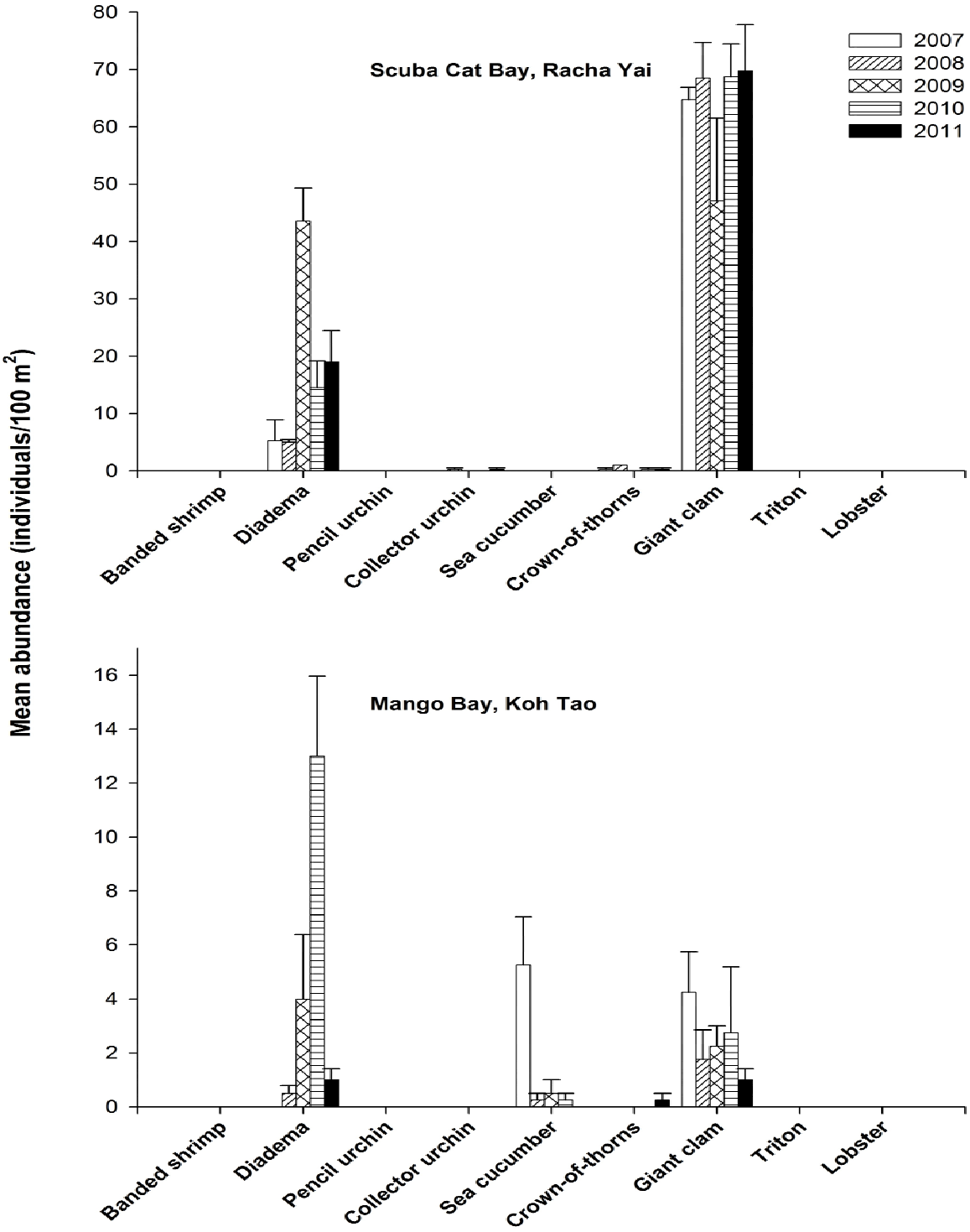

Figure 3. Abundance of reef invertebrate organisms (individuals per 100 m^2) from 2007-2011 at Scuba Cat Bay, Racha Yai Island and Mango Bay, Koh Tao. Means ± SE are shown.

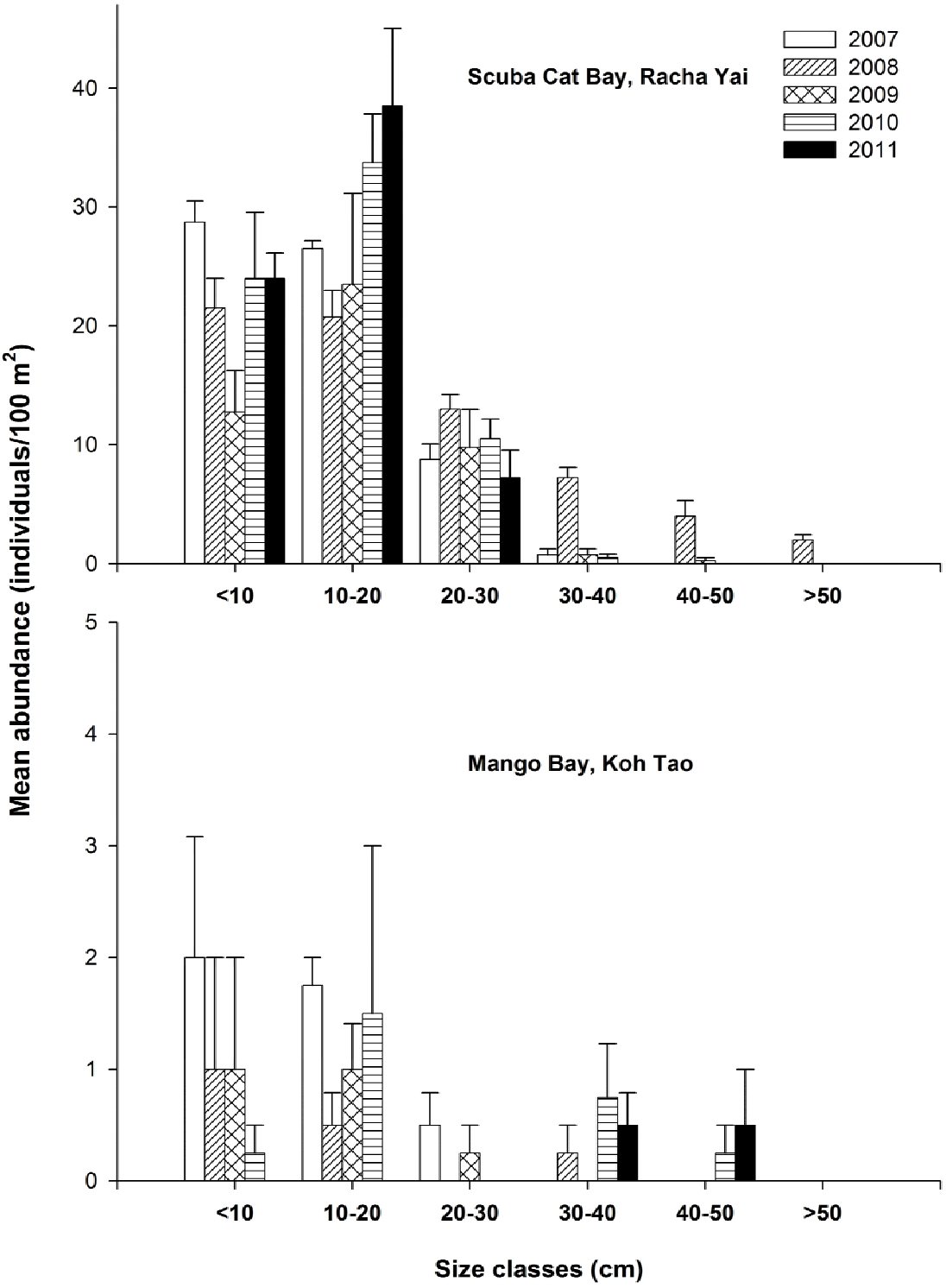

Figure 4. Abundance of giant clams (*Tridacna* spp.) in each size class at Scuba Cat Bay, Racha Yai Island and Mango Bay, Koh Tao. Means ± are shown.

be affected by the bleaching. Small and medium size classes of *Tridacna* spp. were not found in the 2011 survey at Mango Bay (Fig. 4).

Reduction in live coral cover can also affect reef fish populations (Feary *et al.,* 2007). The susceptibility to live coral loss varied between fish species (Jones and Syms, 1998). Feary (2007) showed that coral habitat specialist fish species had low levels of migrations between degraded and live corals. In addition, obligate specialist corallivorous fish showed the highest decline in their populations when coral mortality occurred (Graham, 2007). From the present study, the abundance of parrotfish at Mango Bay appeared to decrease after 2009, and no parrotfish were found in 2011 at Mango Bay after the 2010 bleaching event while parrotfish at Scuba Cat Bay were still observed. In addition, Pratchett *et al.* (2006) showed that abundance of *Chaetodon* butterflyfishes declined after coral bleaching. However, in this study the butterflyfish seemed to be unaffected by the reduction in live coral cover (Figs. 1 and 2). Butterflyfishes that are facultative and non-coral feeders are likely to be less affected by the decline of live coral cover (Pratchett *et al.,* 2006).

This study aimed to evaluate changes in reef communities over time and in particular post the 2010 bleaching. More in-depth studies and long term monitoring are needed to determine the recovery of the reef communities after the bleaching. In addition, more studies on the effect of bleaching on reef organisms, other than the hard corals, will help in understanding the outcome of the bleaching event on population dynamics of other key organisms in the reef ecosystem.

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