ORIGINAL PAPER

Community structure of scleractinian corals on shallow reef flats at Ko Kula and Ko Rangka Chio, Chumphon Province

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Abstract. Shallow reef flats are common in tropical coastal oceans and have the potential to make a significant contribution to essential ecosystem services for millions of people living in coastal areas globally. Corals on shallow reef flats can adapt to stress environments. Therefore, this study aimed to assess the community structure of scleractinian corals on the shallow reef flat at Mu Ko Chumphon National Park. Ko Kula and Ko Rangka Chi were selected as study sites. The coral communities were examined by using a permanent belt transects method. The covers of live corals, dead corals, rubble, sand, algae and other benthic components were recorded. Shannon's diversity index (H') and Pielou's evenness index (J') were calculated based on the number of individuals for each study site. Our results revealed that a total of 11 coral species were found in this study, and there were significant differences in coral covers at the study sites. The highest cover of benthic components at Ko Kula was algae (42.69±4.18%), while the highest at Ko Rangka Chio was live corals (48.97±4.79%). The Shannon's diversity index (H') and Pielou's evenness index (J') at Ko Kula were significantly higher than those Ko Rangka Chio. The species diversity and community structure of corals on shallow reef flats at Ko Kula and Ko Rangka Chio in the Western Gulf of Thailand were assessed. This study emphasizes the importance of management plans for coral reef conservation in the Gulf of Thailand.

Keywords: Mu Ko Chumphon, *Porites*, coral, shallow reef flat

1. Introduction

Coral reefs are one of the most dynamic, biologically diverse, and complex ecosystems globally, containing hundreds of thousands of organisms, high productivity, and significant social, economic, and cultural impacts on millions of people (Hoegh-Guldberg, 1999; Syms & Kingsford, 2009). They provide shelter and food for a variety of reef organisms and convert inorganic and organic materials and provide essential services to people involved in fisheries and tourism. (Wild et al., 2011; Spalding et al., 2017). Moreover, coral reefs are the sources to discover novel compounds for medicine (Ye et al., 2018; Huang et al., 2018; Hsu et al., 2018).

Coral reef ecosystems have become increasingly vulnerable to anthropogenic and natural disturbances at various spatial and temporal scales (Dunning, 2015). Overfishing, land-based pollution, sedimentation, coastal development, climate change, and biological predation are all having a significant impact on scleractinian coral mortality rates, resulting in widespread coral reef degradation (Crabbe & Smith, 2005; Hughes et al., 2010). Climate change is endangering coral reefs around the world. Thermal stress is caused by warming oceans, which contributes to coral bleaching. Temperatures at the sea surface have risen over the last few decades (Steig et al., 2009; Hoegh-Guldberg et al., 2017). When these events occur at the same time, the stress and damage to reef-building corals will be far more common (Kramarsky-Winter & Loya, 2000). Thermal stress has emerged as the most damaging threat to corals (Spalding & Brown, 2015). Coral thermal adaptation, also known as acclimatization, is how corals increase their thermal tolerances through natural selection (Berkelmans & van Oppen, 2006, La Jeunesse et al., 2010).

Shallow reef flats are common in tropical coastal oceans because they are long-lived, tolerant, and widespread. They have the potential to make a significant contribution to essential ecosystem services for millions of people living in coastal areas worldwide (Falkowski et al., 1993, Moberg & Folke, 1999). The water temperature in shallow reef areas can vary dramatically (Craig et al., 2001). Tides can significantly impact flow, waves, and other physical factors in shallow coastal areas (Becker et al., 2014, Anthony et al., 2004). The frequency and extent of exposure to such stressors affect the rate and pattern of reef geomorphological development. Changes in sea level, for example, have an impact on the amount of space available for coral growth (Kennedy & Woodroffe, 2002). Despite the fact that shallow reef flats have a various of extreme conditions, some coral populations in shallow reef flats can adapt to stressful environments such as exposure during low tide, high temperature, and light intensity. Therefore, the purpose of this study was to assess the community structure of scleractinian corals on the shallow reef flats at Ko Kula and Ko Rangka Chio, Chumphon Province.

2. Materials and Methods

2.1 Location of study sites

The study sites are located at the Ko Kula (10° 15' 35.87" N, 99° 15' 20.99" E) and Ko Rangka Chio (10°19'30.31" N, 99°17'56.81" E), in Mu Ko Chumphon National Park, the Western Gulf of Thailand (Figure 1). Mu Ko Chumphon National Park is a marine protected area under the Department of National Parks, Plant and Wildlife Conservation for management. The field study was conducted on shallow reef flats that the depth of coral communities ranged from 0.5 to 1.5 meters.

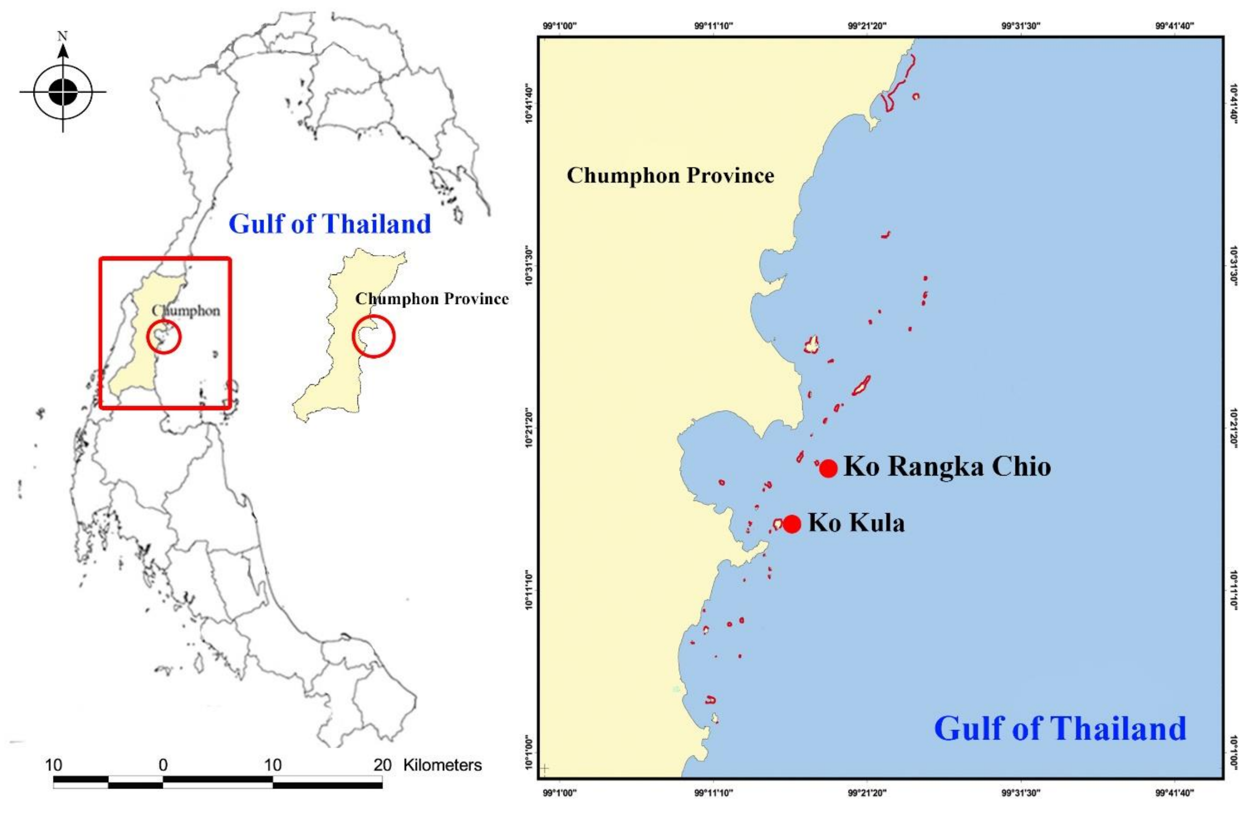


Figure 1. The location of study sites at Ko Rangka Chio and Ko Kula

2.2 Data collection

The coral communities were examined along permanent belt transects, 30x1 m with three replicates. At each permanent belt transect, photographs were taken using a digital camera with 50x50 cm^2 of quadrat along permanent belt transects for data recheck in the laboratory. We observed and evaluated live coral cover as colony area/unit area, and counted coral colonies (≥5 cm in diameter), and then identified to the species level according to Veron, 2000. Covers of dead corals, rubble, sand, algae, and other benthic components were recorded.

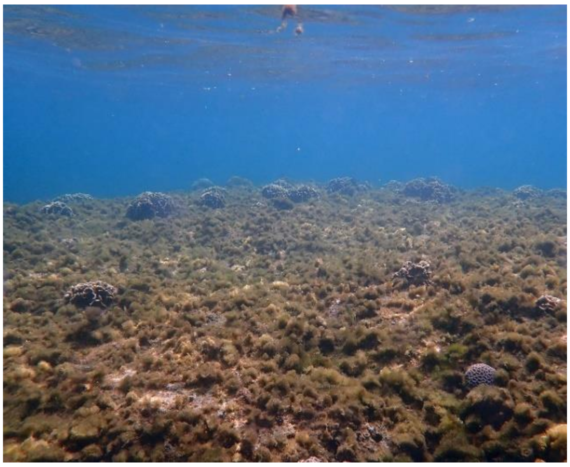
2.3 Data analysis

The covers of live coral, dead coral, rubble, sand, algae, and other benthic components were expressed in percentage. The difference in substrates' coverage and the coverage of coral compositions were tested by using Tukey's HSD in the R program. At each study site, Shannon's diversity index (H') and Pielou's evenness index (J') were calculated based on the number of individuals for each study site. Two Sample t-test in the R program was used to test the difference of Shannon's diversity index (H') and Pielou's evenness index (J') between study sites.

3. Results

There were significant differences in coral covers at the study sites. At Ko Kula, the highest cover of benthic components was algae (42.69±4.18%) (Figure 2 and 3), while the live corals were quite low (9.67±0.95%). On the other hand, the live corals showed the highest coverage (48.97±4.79%) at Ko Ranka Chio, and algae were not found, as shown in Figures 2 and 4.

A total of 11 coral species were found at Ko Kula (Figure 5), while seven coral species were found at Ko Rangka Chio (Figure 6). The most abundant coral at Ko Kula was *Pavona frondifera* (70.50±0.89%), with a significant difference (p=0.05). At Ko Rangka Chio, *Porites lutea* was found to be the most abundant coral (77.60±5.14%) with a significant difference (p=0.05). The Shannon's diversity index (H') was significantly different among study sites (p<0.001). The Pielou's evenness index (J') was also significantly different among study sites (p<0.01), as shown in Figure 7.



Ko Kula

Ko Ranka Chio

Figure 2. Coral reef communities at the study sites

4. Discussion

Our findings are consistent with a diverse assemblage of 225 hard coral species found in the intertidal zone of the Bonaparte Archipelago in northwestern Australia. Tidal fluctuations were up to 8 m, long subaerial exposure times (>3.5 hrs), prolonged exposure to high temperatures, and fluctuating turbidity levels are examples of physical extremes (Richards et al., 2015).

Coral reefs play an essential role in marine ecosystems, biological diversity, and sea productivity. A coral reef benefits coastal communities worldwide, including Thailand, but coral bleaching caused by marine heatwaves and climate change poses a significant threat to the persistence of corals and contributes to the global decline of corals. (Hughes et al., 2017; Hughes et al., 2018). Coral reefs in the Gulf of Thailand were harmed in 1998 and 2010 by mass coral bleaching events (Sutthacheep et al., 2013). The critical thing to remember is that coral can adapt to high temperatures, intense light, and climate change (Torda et al., 2017). Coral used to have millions of years to adapt to climate change during the ice ages, but the current seawater temperature change has occurred in less than a decade. Corals can spread over a wide area due to latitude and seasonal temperature variations, and they are heat-resistant when temperatures rise above the highest summer temperature in coral habitats. As a result, corals are extremely vulnerable to rising seawater temperatures, and the frequency of marine heatwaves has increased. (Palumbi et al., 2014; Chakravarti et al., 2017; Torda et al., 2017; Hughes et al., 2018; Matz et al., 2018; Oliver et al., 2018)

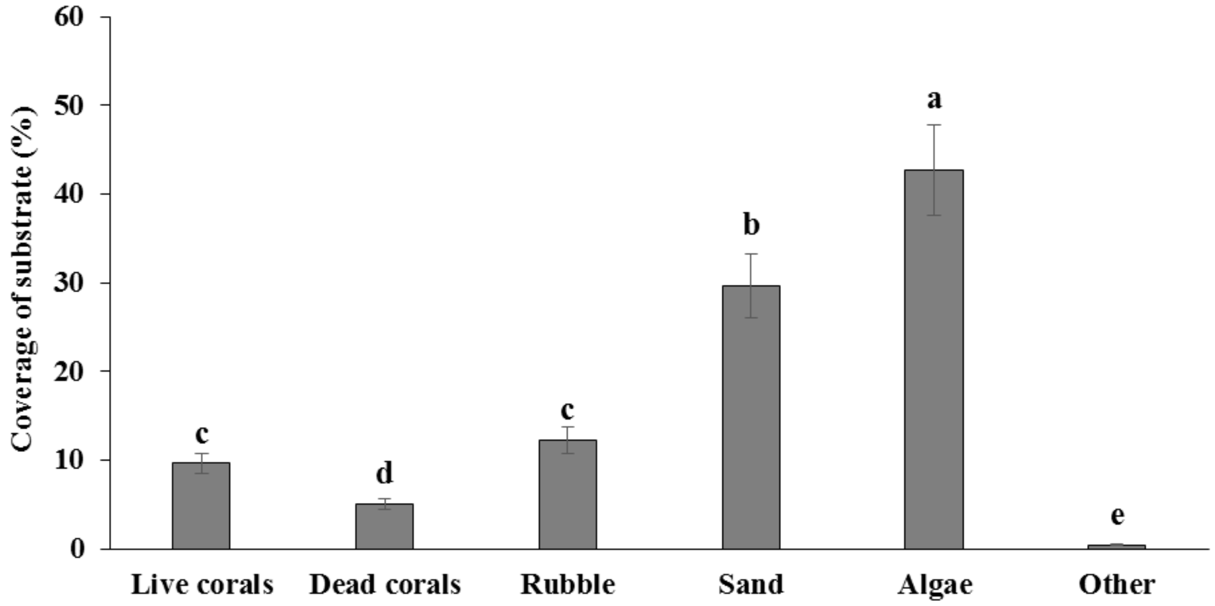


Figure 3. Average percentage cover of live corals, dead corals, rubble, sand, algae, and other benthic components at Ko Kula

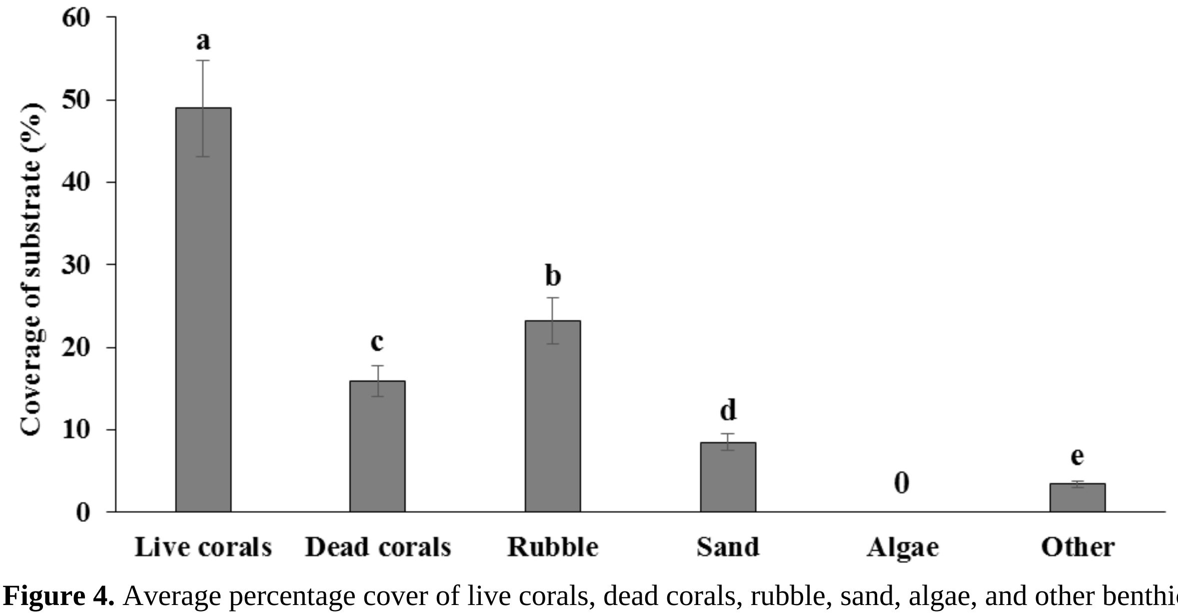


Figure 4. Average percentage cover of live corals, dead corals, rubble, sand, algae, and other benthic components at Ko Ranka Chio

Naturally, heat-resistant coral populations are found in coral reefs with a constantly changing natural environment or high-temperature variations, such as the basin leeward coral reef and tidal currents in the coral reef (Schoepf et al., 2015). A long-term study of stress-resistant corals from thermally extreme reefs in northwest Australia. Show that despite acclimation to 3-6 °C cooler, more stable temperatures over nine months, these corals have an amazing ability to maintain their heat tolerance and health (Schoepf et al., 2019). Corals that live in naturally extreme temperature environments can shed light on the mechanisms that underpin coral resistance to thermal stress (Hume et al., 2013). Given the significance of understanding how corals will eventually respond to current ocean warming rates, it is critical to study the growth of reef-building corals in as wide a range of naturally extreme temperature environments as possible (Purcell, 2002).

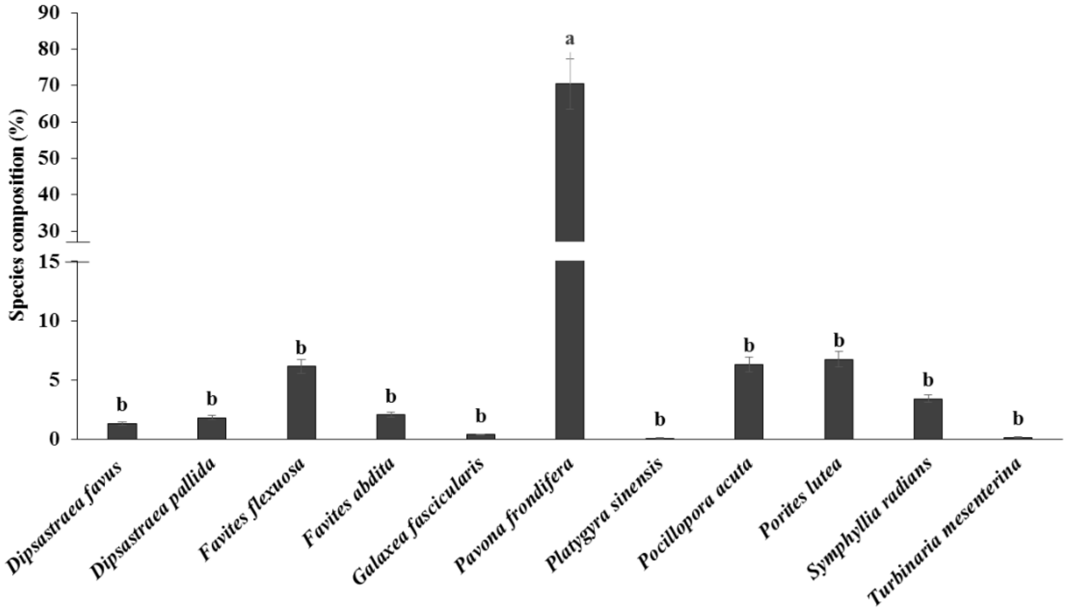


Figure 5. Species composition of corals at Ko Kula

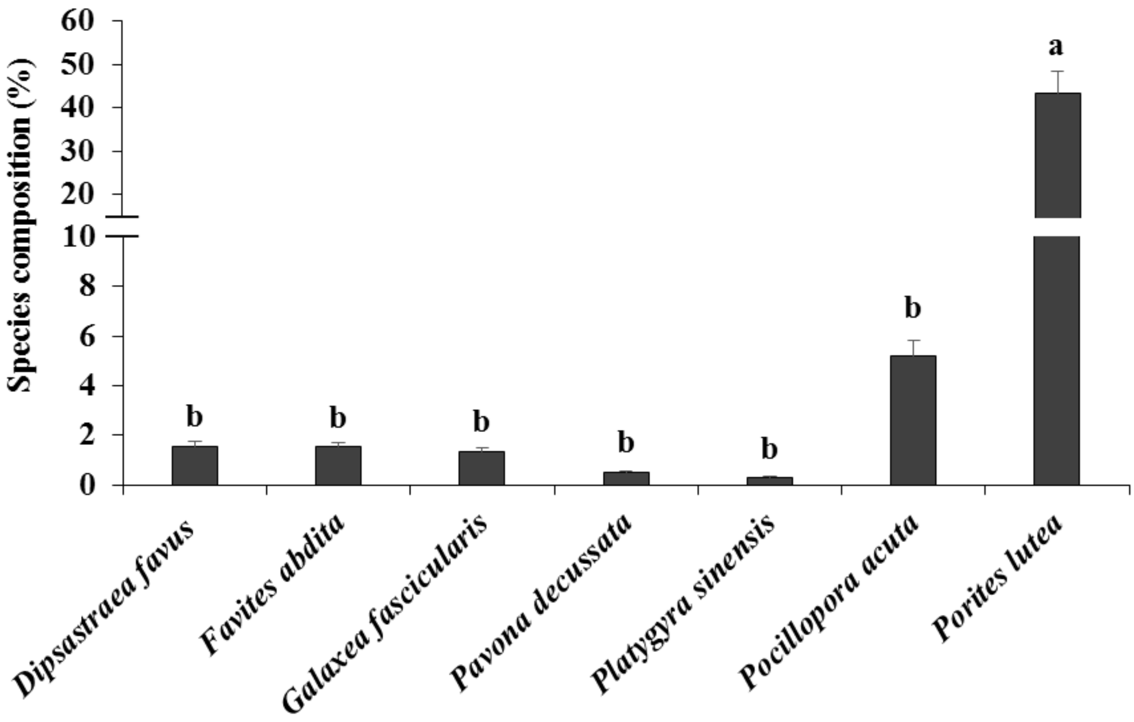


Figure 6. Species composition of corals at Ko Rangka Chio

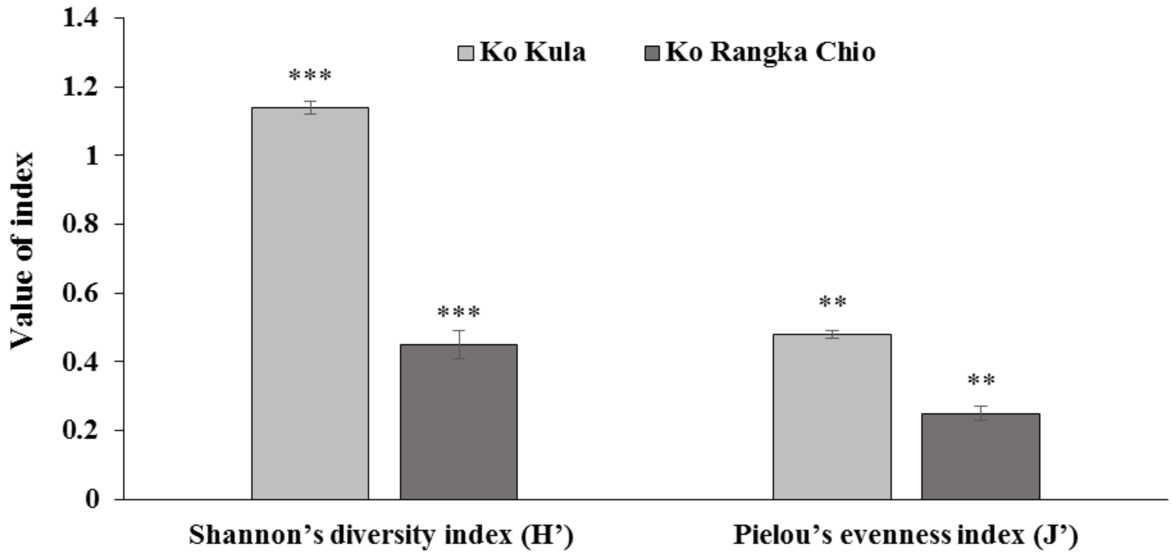


Figure 7. Shannon's diversity index (H') and Pielou's evenness index (J') at each study site

Some coral species can adapt to being exposed to high temperatures and light intensity during low tide. They have the potential to provide coral breeders in the face of global climate change. The study of coral species diversity and population structure on shallow reef flats, particularly in the western Gulf of Thailand, is critical. Shallow reef flats are an essential component of coral reefs, but no studies on coral communities in shallow reef flats have been conducted. The species diversity and community structure of corals on shallow reef flats at Ko Kula and Ko Rangka Chio in the Western Gulf of Thailand are assessed. This study highlights the importance of management plans for coral reef conservation in the Gulf of Thailand. The corals on shallow reef flats should be intensively examined for better understanding of coral reef ecosystems.

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