Ascidians Outbreak: A Threat For Coral Reefs in Panjang Island, Jepara

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Abstract

Eutrophication and sedimentation have become a major threat to coral reefs in nearby areas with anthropogenic activities. These threats are often accompanied by shifting ecosystems from coral-rich to fast-growing algae-dominated water, and high prevalence of coral disease. In Panjang Island, Jepara, we observed the outbreak of photosynthetic ascidians along with a high sedimentation at the eastern part of the island. The ascidians were seen overgrowing most substrates including corals, macroalgae, dead-coral-algae, and rubbles in April to May 2019. In July and August 2019, observation and data collection using quadrant transect were conducted to monitor the outbreak. The result showed that ascidians were still present in the area, despite becoming pale and smaller. This report shows that the outbreak of these photosynthetic ascidians was not persistent, however, the effect on coral reef health should not be overlooked.

Keywords: Ascidians, outbreak, coral reefs, Indonesia

INTRODUCTION

Space competition in coral reefs has become a major problem following the increasing nutrient run-off from anthropological activities in the coastal area, as well as environmental change in a local, regional and global scale. Other than the competition with algae (Bakker *et al* 2017), space competition with other marine benthic animals such as ascidians was recently reported. In Carribean, the ascidian *Tridemnum solidum* was reported to overgrow scleractinian corals (Rodríguez-Martínez *et al*., 2012). Ascidian outbreak was also reported from the Pacific in American Sãmoa, where *Diplosoma simile* threaten the existence of scleractinian corals in the area (Vargas-Ángel *et al*., 2009). We observed the distinct presence of photosymbiotic 'green gum drop' ascidians *Diplosoma* sp. (Su *et al* 2013 and Hirose *et al* 2014) overgrowing corals in the water of Panjang island, located 2 Km off Jepara coast, Central Java, Indonesia in April 2019. Diplosoma ascidians are known to harbour *Prochloron*, a photosymbiontic cyanobacteria (Hirose and Nozawa, 2010), therefore often found living in shallow water. Numerous research have been conducted in Panjang island, Jepara, from the bioecology (Suryono *et al*., 2021), physical oceanography and geomorphology (Sugianto *et al*., 2019) and biodiversity (Sabdono *et al*., 2021) and coral reef restoration (Munasik *et al*., 2021). However, a phenomena where ascidian is rapidly growing in the island has never been reported before.

We do not know the nature of these ascidians' occurrence, whether it is an outbreak or an ecosystem shift, as in algae. Understanding the photosymbiotic 'green gum drop' ascidians relationship with environment dynamics, as well as monitoring, is important to identify local disturbance that could potentially decrease coral coverage in a short time. Therefore, we aim to record the occurrence of photosynthetic ascidian in Panjang island over a time period of five months and discuss the consequences we need to face as the environment is changing.

MATERIAL AND METHOD

Preliminary observations took place at Panjang Island, located 2 km off Jepara coast

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Central Java, Indonesia in April and May 2019. The observation was conducted in the southwestern and the eastern part of the island (Figure 1). The timed swim was around one hour for each site, covering an area of approximately 500 m^2. Coral reefs at the depth of 0.5 – 3 m were observed and various substrates competing with or overgrown by ascidians were photographed using an underwater camera (Nikon W300).

Outbreak monitoring

Monitoring was conducted in July and August 2019 following the preliminary observations following a modification of IUCN protocol for the Resilience Assessment of Coral Reefs (Obura and Grimsditch, 2009). In July, a permanent transect mark was installed at the eastern site. A floating buoy was added to mark the beginning and the end of the 50 m transect (Figure 1, A and B), parallel to the shoreline. Monitoring was not conducted at the southwestern part of the island because only one type of ascidian was found on rubble, and the number was very low.

Quadrant transect (0.5 x 0.5 m) with a partition of 10 x 10 cm (25 squares in each quadrant transect) was photographed along the 50 m line transect, with the interval of 10 m (0, 10, 20, and so on). Five random squares from each quadrant photos were then analyzed. The substrates were categorized into hard corals (HC), sponge, sediment, ascidian (Asc), crustose coralline algae (CCA), macroalgae (MA), and seagrass. The percentage of each substrate was estimated and the average value was calculated from a total of 6 transects (30 squares) from each site.

RESULT AND DISCUSSION

During preliminary observation, two types of photosynthetic ascidian (*Diplosoma gumavirens* Hirose *et al.,* 2009 and *Diplosoma* sp.) were found in Panjang island. Only *Diplosoma gumavirens* was found in the southwest in a small number, mostly growing on rubble, while *Diplosoma gumavirens and Diplosoma* sp. were found abundant in the eastern part of the island (Figure 2). We found the two types of *Diplosoma* covering various substrates such as hard corals (Figure 2 and 3), macroalgae, and even seagrass. On massive *Porites*, a change in coral pigmentation was observed along with the tissues in contact with the ascidian (white arrow, Figure 2A, Figure 3B, 3E, and 3F).

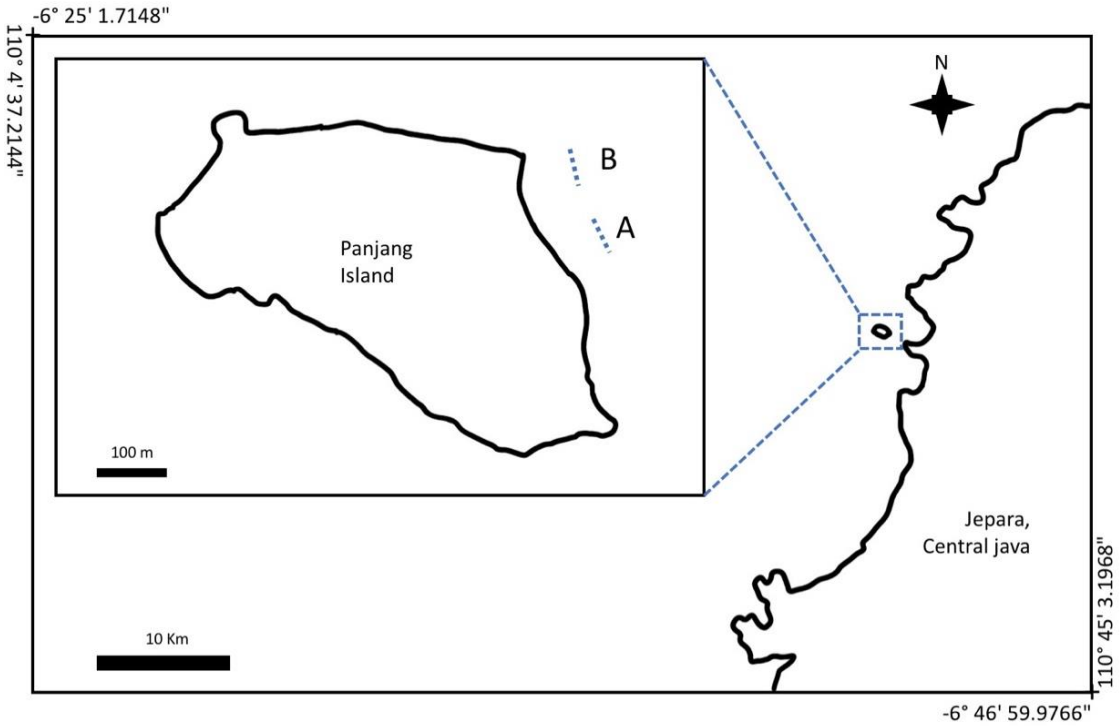

Figure 1. Sampling location at Panjang Island, Jepara, Central java. Transect A and B are 50 m each.

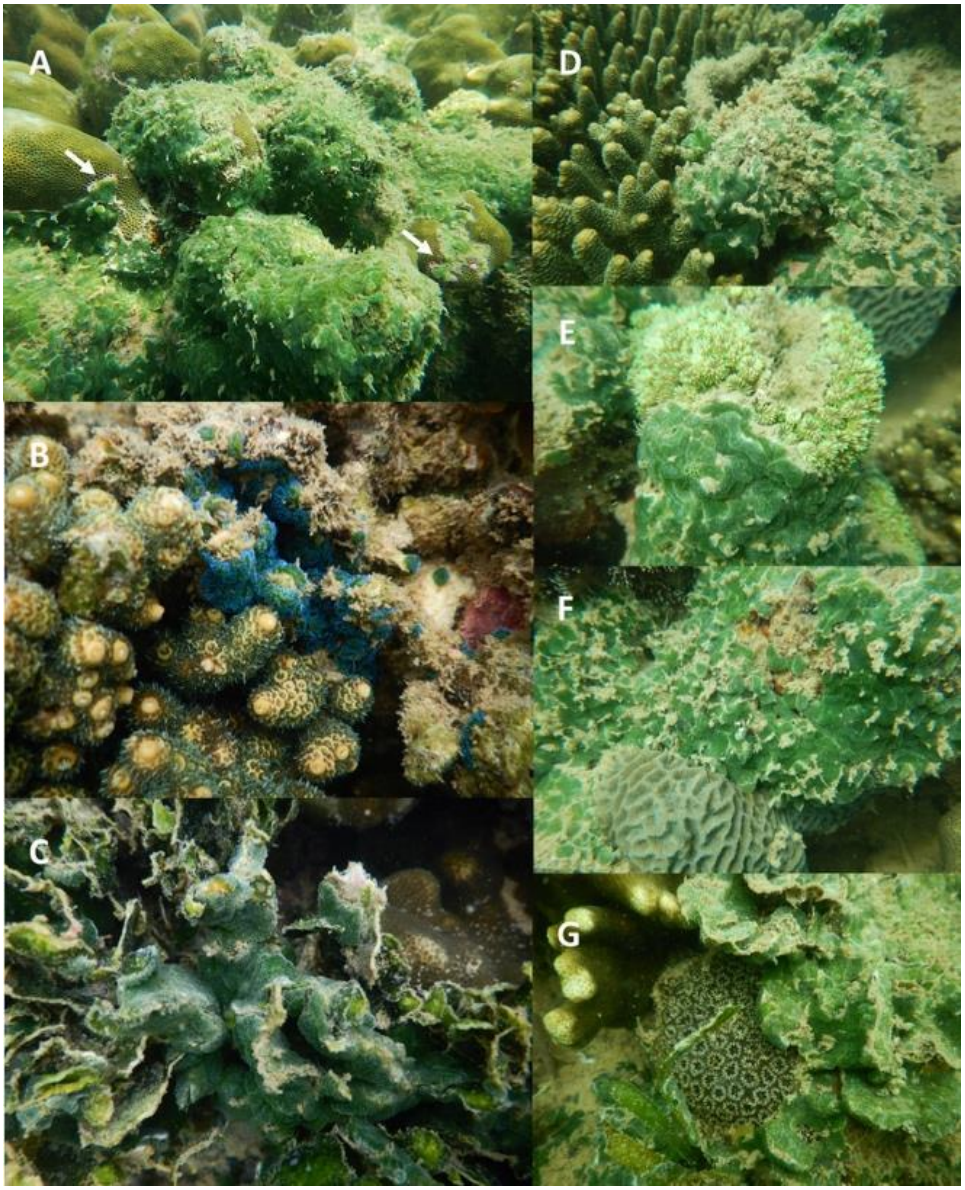

Figure 2. Ascidians overgrowing corals and another substrate in Panjang Island, Jepara, in April and May: **A**, Porites coral overgrown by Diplosoma sp. showing a change in pigment coloration; **B**, *Diplosoma gumavirens* overgrowing *Acropora*; **C**, *Diplosoma* sp. overgrowing *Halimeda* macroalgae; **D**, *Diplosoma* sp. overgrowing *Acropora* along with high sedimentation; **E**, *Diplosoma* sp. overgrowing *Galaxea* coral; **F**, *Diplosoma* sp. overgrowing *Goniastrea* coral; **G**, *Diplosoma* sp. overgrowing massive corals and seagrass.

D'Angelo *et al*. (2012) stated that corals show a change in tissue pigmentation as an innate immune response to disturbance such as when branching corals are broken and then recovers, or when *Porites* corals are wounded by parrotfish or burrowing animals. In this study, the *Porites* corals seem to change their coloration at the contact borders with ascidian as a defence mechanism.

Diplosoma sp. was also found covering macroalgae such as *Halimeda* (Figure 2C) and *Sargassum* (Figure 3A). Macroalgae have become abundant in Panjang island following the increase of nutrient input from nearby land. Similar to macroalgae, photosynthetic ascidian in Panjang island is getting a chance to grow rapidly in the shallow area with rich nutrients and sunlight. However, the

consequences of competition between macroalgae and ascidian for the ecosystem still need to be explored.

Following the preliminary observation, monitoring in July and August shows a changing shape and colors of *Diplosoma* sp. In the previous months, the *Diplosoma* shows distinct green color, round or elongated colonies with a diameter of 0,5 – 1 cm. In July and August, as the sedimentation in Panjang island increased, the *Diplosoma* sp. are becoming smaller and pale (Figure 3E & 3F). This might be caused by a decreasing light intensity available for photosynthesis. Similar phenomena was observed in Singapore (Su *et al*., 2013), where the water has become turbid due to coastal development, resulting in a decreasing suitable habitat for photosynthetic ascidians. However, *Diplosoma gumavirens* did not show any changes in either coloration or size. The two types of ascidians might have different tolerance to changing light environments. Photosynthetic ascidians coverage decreased from 4.17 ± 1.78 % in July to 1.70 ± 1.17 % in August at site A and from 3.17 ± 0.76 % in July to 2.00 ± 0.67 % in August at site B (Table 4). *Diplosoma* sp. which was found covering various substrate in the area seems to be growing faster with abundant nutrients and clear water then become unhealthy once the light intensity decrease during turbid months (Figure 4).

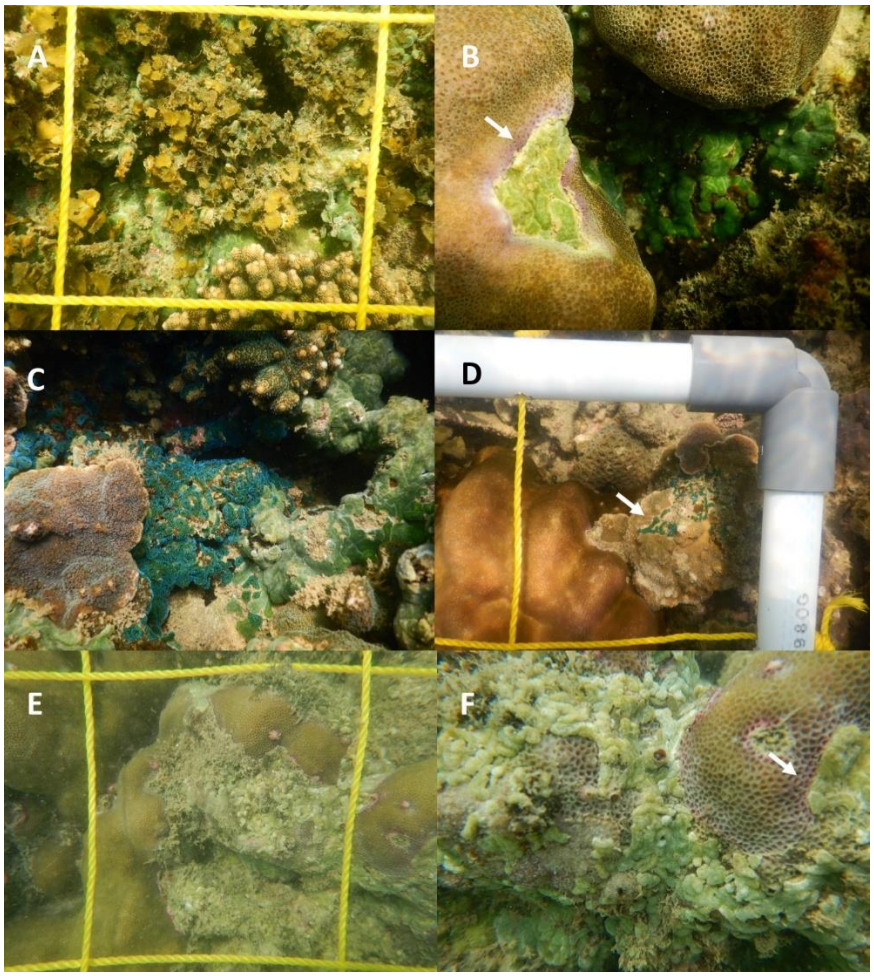

Figure 3. Monitoring results in July (**A**-**D**) and August (**E**-**F**) show that *Diplosoma* are still found overgrowing corals and other substrates. **A**, *Diplosoma* sp. overgrowing Sargassum macroalgae; **B**, *Diplosoma* sp. overgrowing *Porites* coral with a change in pigment coloration; **C**, Two types of *Diplosoma* overgrowing corals; **D**. *Diplosoma gumavirens* overgrowing encrusting *Montipora* showed in quadrant transect; **E** & **F**, remaining massive *Porites* after invasion by *Diplosoma* sp. showing a change in pigment coloration.

Tabel 1. Percent coverage of substrate (mean ± SE). HC: hard coral, Asc: photosynthetic ascidian, CCA: crustose coralline algae, MA: macroalgae

Substrate	July-A	August-A	July-B	August-B
Sponge	11.33 ± 5.14	3.00 ± 2.10	0	0
HC	5.00 ± 1.75	13.97 ± 4.89	29.63 ± 6.17	21.43 ± 5.75
Sediment	31.17 ± 4.98	43.83 ± 6.64	60.63 ± 5.99	56.97 ± 5.76
Asc	4.17 ± 1.78	1.70 ± 1.17	3.17 ± 0.76	2.00 ± 0.67
CCA	1.00 ± 1.00	0.50 ± 0.37	1.07 ± 0.47	3.77 ± 0.77
MA	21.83 ± 5.94	13.83 ± 4.18	5.50 ± 1.94	15.83 ± 3.88
Seagrass	25.50 ± 7.41	23.17 ± 7.32	0	0

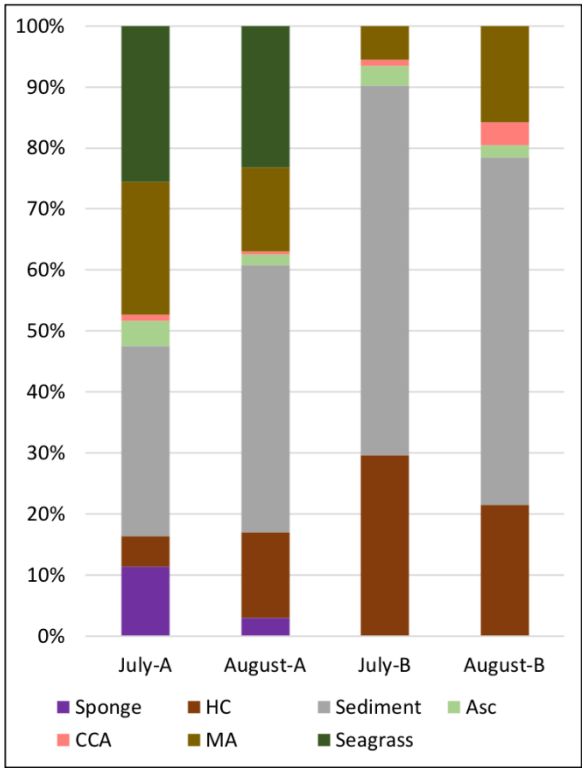

Figure 4. Percent cover of various substrates found in the shallow reef of Panjang island. The substrate in Panjang Island, Jepara, with domination of sedimented surface, macroalgae, and corals.

On a side note, the high level of sedimentation on this island should not be overlooked. The presence of photosynthetic ascidians was often accompanied by particles similar to sediment, however the properties of these sediments should be investigated further, since higher nutrients also increase the suspended bacteria (Bak *et al*., 1996) and possibly another microbiome in the water and sediments. The presence of sediments along with low coverage of CCA (Table 1 and Figure 4) give less chance for corals larvae to settle, resulting in challenges for the coral population to recover from disturbances. This study was conducted in a time frame of 5 months, starting in April 2019, when Panjang island and Java sea in general is in a shifting period from western monsoon to eastern monsoon and the water is generally calm (Supriharyono, 1998). Meanwhile, July and August is the eastern monsoon and the eastern part of the island generally receives more wind (windward) and the water is often mixed and become more turbid. The outbreak

that occurred in 2019 might be seasonal, triggered by a rich nutrient availability after the western monsoon and clear water during the calm period in March-April.

Since fast-growing ascidian seems to be a strong competitor in shallow reef areas and could kill corals in a relatively short time (Figure 3E and 3F), the effects of such occurrence need further investigation. A broader monitoring site and longer time period of the survey will help reveal whether the outbreak occurs annually and whether corals in Panjang island could recover after the outbreak.

CONCLUSION

Ascidian outbreaks potentially reduce coral cover in a short time. From these observations, important questions remain for further studies, including how rapid is the ascidian growth in Panjang island; what environmental factors are favorable for ascidian outbreak; what substances are in charge of defense in photosynthetic ascidians; and, are the sediment covering most of the area bringing other properties such as heavy metal, or are they rich in pathogenic microbiomes.

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