

Coral diversity and coral reef environment in Brunei Darussalam

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Abstract

This article reviews the coral diversity and coral reef environment in Brunei Darussalam, in comparison with the other regions in the South China Sea (SCS). Extensive surveys on corals had not been conducted in Brunei Darussalam for a long time but the recent efforts of coral identification have revealed that approximately 400 species of scleractinian corals inhabit in Brunei seawaters, which is close to the highest diversity in the SCS. The most dominant coral family in species number was Acroporidae, which accounted for 30% of the coral species inventory. Using the published data on coral diversity in the SCS, multivariate analyses showed that the number of coral species in any tested coral family (Acroporidae, Agariciidae, Fungiidae, Lobophylliidae, Merulinidae, and Poritidae) in a region is significantly correlated with the total number of coral species for that region, indicating that the coral diversity in any family reflects the coral diversity in the whole ecosystem. Although a high coral diversity was confirmed in Brunei Darussalam, several threats to corals have been reported. Regular monitoring of the coral reef status is required to promptly detect undesirable environmental changes in the future.

Index Terms: coral diversity, South China Sea, environmental changes, conservation

1. Distribution of coral reefs in Brunei

Brunei Darussalam (hereafter Brunei) is located at the northwest coast of Borneo and has many submerged patch reefs (*Figure 1*). The total area of coral reefs in Brunei is estimated to be approximately 100 km².^{1,2,3} Most of the reefs develop 4–30 km offshore from the coast and have a depth of more than 5 m.² Coral reefs have not developed extensively on the coast, which is most likely due to high turbidity of seawater caused by suspended particles.

Pelong Rocks (Pulau Pelong-Pelongan) are a series of small islets stretching 500 m north and south (*Figure 1*). Because of the relatively short distance from the coast (ca. 4 km), Pelong Rocks are the most accessible coral reef in this country. The reef has a reef flat with the depth of 3–7 m and the sea bottom is mainly covered with sand, rubble, and hard corals. Two Fathom Rocks is located approximately 8 km off the coast and has three uplifted seafloor regions over an area of 5

km². Two of them are shallower (4 m) than the other one (10 m). Pulau Punyit is a rocky island of 100 m long and 30 m wide, which is located 600 m off the coast of Brunei Cliff.

2. Coral diversity in Brunei Darussalam

The first extensive surveys on Brunei's coral reefs was conducted in the 1980s.² The researchers studied the diversity of hard corals at Pelong Rocks, Two Fathom Rock, and Pulau Punyit and found 88 coral species in total. The highest diversity (number of coral species) was recorded at Pelong Rocks (60 species) and the lowest diversity was at Pulau Punyit (19 species). The low coral diversity at Pulau Punyit was considered to be due to low visibility of seawater, which was caused by sediment suspension. Acroporidae and Merulinidae were the most dominant coral families found in their study. The coverage of corals occupied 3–40% of the seafloor at Pelong Rocks and Two Fathom Rock, depending on the survey transect, while no survey on coverage was

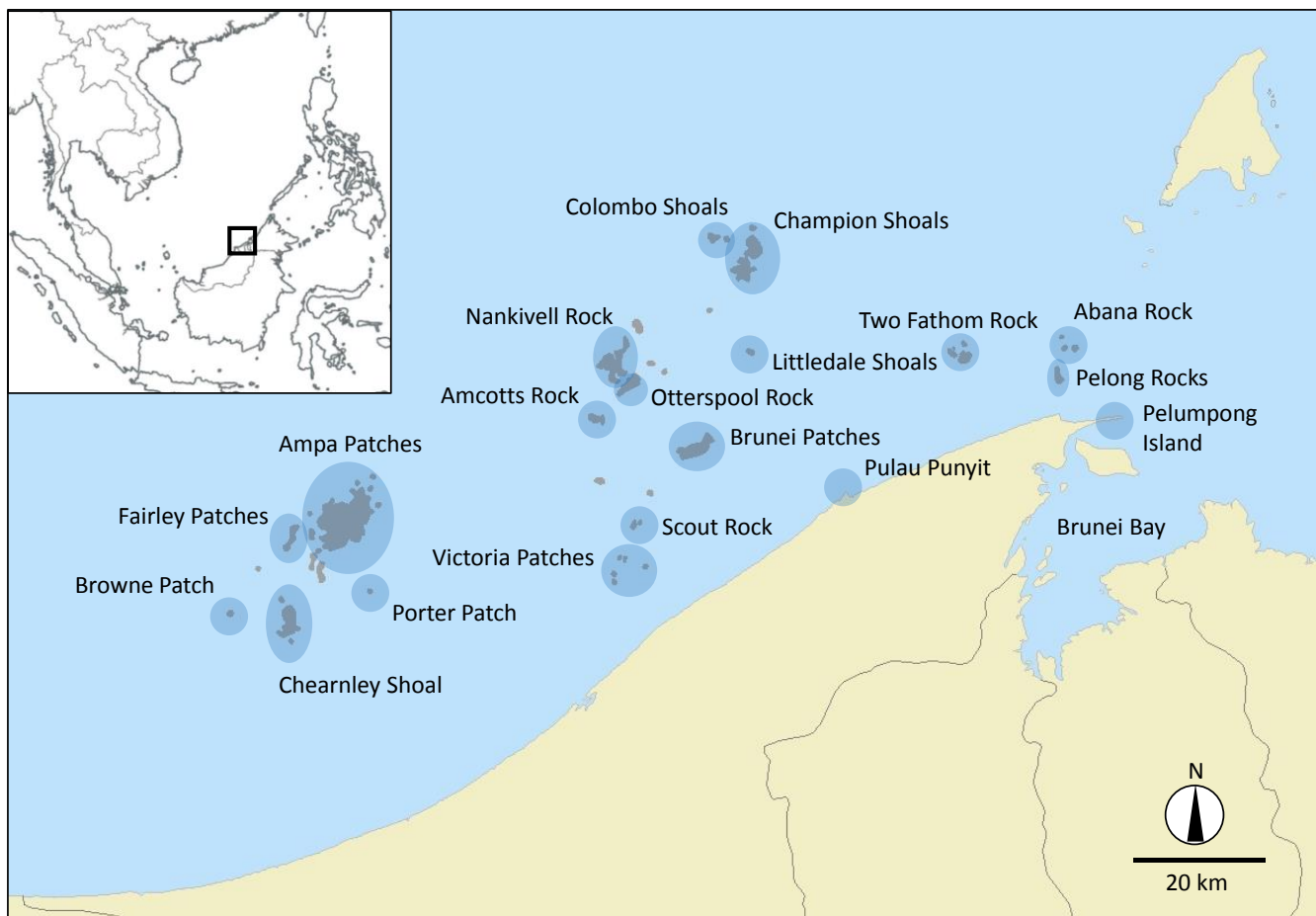


Figure 1. The location of Brunei Darussalam on Borneo (upper left) and major coral reefs in the country. The reef locations and original map was provided by UNEP-WCMC (<http://www.reefbase.org/>).

performed at Pulau Punyit due to poor coral cover and high turbidity.²

Though the total number of coral species in Brunei was lower than those in Singapore or Peninsular Malaysia at the time of the study^{4,5}, this did not mean that the coral diversity was actually lower than those regions, considering that the study areas were limited to the three sites.² Because the studied three sites are located relatively near from the coast, it was expected that offshore reefs could have a higher diversity of corals.

More extensive surveys on Brunei's coral diversity have been conducted and published recently.^{3,6,7,8} In addition to many offshore coral reefs, a coral community was also discovered at the mouth of Brunei Bay, Pelumpong Island (**Figure 1**). In total, 404 coral species have been reported from the 14 families.^{3,8} The family with the highest number of species was Acroporidae,

which had 119 species and accounted for 30% of the total number of coral species. The second and third largest families were Merulinidae (87 species, 22%) and Fungiidae (35 species, 9.0%), respectively (**Figure 2**). Comparing to the surveys in the 1980s, the dominant families of corals, i.e., Acroporidae and Merulinidae, have apparently not changed during the last two decades. However, this cannot be certain because earlier survey coverage was not comparable to recent, more intensive surveys.

The coral diversity seems to show differences among the sites in Brunei. For example, the diversity of Fungiidae (mushroom corals) was relatively high at Brunei Patches (Hornet Reef), Pelong Rocks, and Porter Patch, while it was low at Otterspool Rock, and Colombo and Champion Shoals.⁷ The number of coral species found at Pelumpong Island (34) was apparently lower than

the other sites, which is likely due to lower salinity and higher turbidity affected by Brunei River.⁶

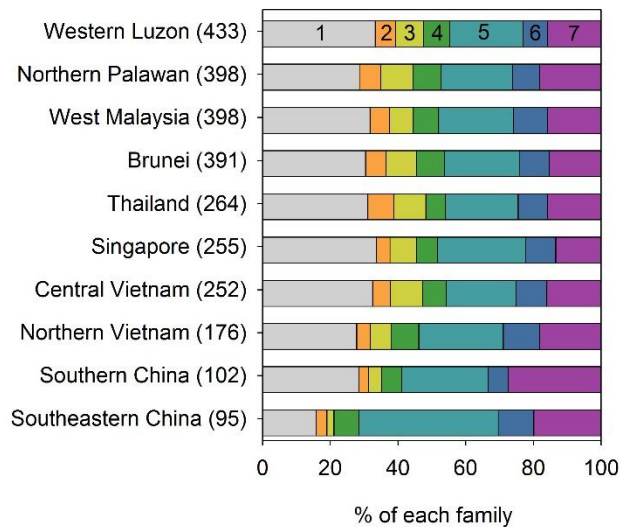


Figure 2. The proportion percentages of each coral family in the regions in the South China Sea. 1: Acroporidae, 2: Agariciidae, 3: Fungiidae, 4: Lobophylliidae, 5: Merulinidae, 6: Poritidae, 7: Others. The number in parantheses shows the total number of coral species found in the region. The original data are obtained from Huang et al.⁸

3. Comparison in the South China Sea

When the coral diversity is compared with the other regions in the South China Sea (SCS), the composition of the Brunei's coral species was most similar to those of Luzon Island and Palawan Island in the Philippines and was significantly distinct from the other regions.⁸ The southern coastline of China (e.g., Hong Kong, Hainan) had the lowest number of coral species (151 species) in the SCS and had the lowest similarity compared to Brunei, Luzon, and Palawan Islands (BLP). When the family compositions were compared between these two distinct regions, using the data summarized by Huang et al.,⁸ the families Fungiidae (8.3–9.5%) and Agariciidae (6.0–6.3%) accounted for higher percentages in BLP than the southern and southeastern coastline of China (**Figure 2**). On the other hand, the family Merulinidae accounted for lower percentages in BLP. One of the major causes for the difference between these two regions could be the latitude, which changes annual average seawater temperature.⁸

Another cause for the difference in coral diversity in the SCS could be the effect of terrigenous waters: the coastal areas in Brunei and the Philippine islands receive less river water inputs from the land than those in the Asian continental coastline, which results in distinct coastal seawater conditions and coral diversity.⁸ Tropical rivers in Southeast Asia often contain high concentrations of nutrients and terrigenous sediment particles.⁹ Coral metabolisms and coral reef ecosystem structures are affected by terrigenous waters from various perspectives.¹⁰ For example, high turbidity of seawater (sedimentation) reduces the survival rate of juvenile corals.¹¹ Nutrient enrichment alters the balance of a symbiotic relationship between a coral animal host and its endosymbiotic algae.¹²

Using the previously published data summarized by Huang et al.,⁸ the present review found that the number of coral species in any tested coral family group (Acroporidae, Agariciidae, Fungiidae, Lobophylliidae, Merulinidae, and Poritidae) in a region was significantly correlated with the total number of coral species in the region (**Figure 3**). This indicates that the number of coral species in any family group is strongly and positively related to the whole coral diversity in the region. In other words, the coral diversity in a region can be speculated from the number of coral species in any family. For example, according to the linear regression, the number of Acroporidae species increases by 33 when the total number of coral species in the region increases by 100.

4. Threats to corals in Brunei Darussalam

Because most corals in Brunei inhabit reefs off the coast, they seem not to be affected by terrigenous freshwater discharge of rivers. Nonetheless, some threats to corals have recently been reported in Brunei.¹³ The first threat is high seawater temperature, which is a global concern for conserving coral reefs.¹⁴ Under intolerable temperature conditions, many corals lose the endosymbiotic algae and consequently become bleached.¹⁵ Because a coral animal host acquires organic matter from the endosymbiotic algae through photosynthesis, the loss of this symbiotic

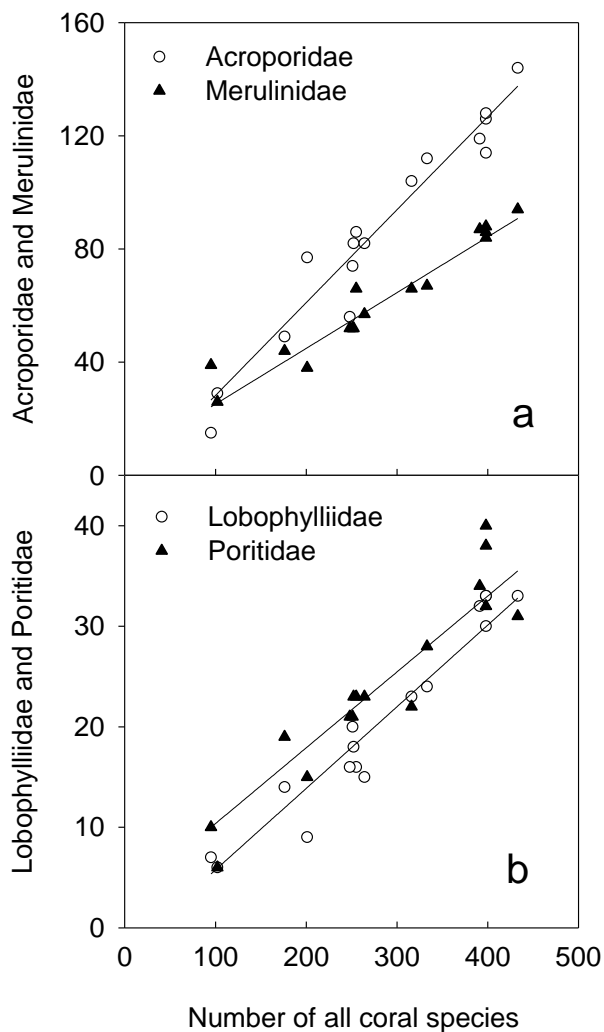


Figure 3. The correlation between the total number of coral species and the number of each family (a: Acroporidae and Merulinidae, b: Lobophylliidae and Poritidae) in various regions in the South China Sea. The two parameters were significantly correlated for all of the coral families ($p < 0.0001$) and the straight lines show linear regressions. The original data are obtained from Huang et al.⁸
 Acroporidae: $y = 0.328x - 4.57$ ($r^2 = 0.999$)
 Merulinidae: $y = 0.197x + 5.50$ ($r^2 = 0.997$)
 Lobophylliidae: $y = 0.0812x - 2.35$ ($r^2 = 0.994$)
 Poritidae: $y = 0.0754x + 2.83$ ($r^2 = 0.987$)

partner means the depletion of energy for the coral host.¹⁶ There was no record of major coral bleaching events in Brunei before 2010. In July 2010, a serious coral bleaching event was reported at Littledale Shoal, even though most corals inhabit at the depth of more than 5 m, where the seawater temperature is usually lower than the sea surface temperature.¹³ However, the bottom seawater temperature at this site was slightly

above 30°C when the bleaching was observed.¹³ Concurrently, coral bleaching was also observed over extensive areas in the Indian Ocean and Southeast Asia in response to high seawater temperature¹⁷. These observations demonstrated that even the deeper Brunei reefs are susceptible to the effects of seawater warming at a relatively extensive regional scale.

Another threat to Brunei corals is predation by other marine animals. The crown-of-thorns starfish *Acanthaster planci* is a major coral-eating echinoderm, which is becoming quite common in many coral reefs of the world. *A. planci* was first found in Brunei and during an outbreak episode, the live coral cover was reduced by 50% at Littledale Shoal.^{1,13} The muricid gastropod *Drupella* spp. were also reported to prey on corals in Brunei and the number seemed to be increasing.¹³ The causes of outbreaks of these coral-eating animals are not fully elucidated yet. One of the proposed causes explains that nutrient enrichment at coastal areas due to human activities enhances the production of phytoplankton, which is a food source for the larvae of *A. planci*, and leads to high growth and survival rates of the starfish (but see ref. [1]).¹⁸

Though most of the coral reefs in Brunei develop more than 4 km off the coast, some corals inhabit close to the coast near Brunei Bay. Pelumpong Island and Pulau Punyit are two such sites (**Figure 1**). In particular, corals near Pelumpong Island might be affected by terrigenous waters in Brunei Bay, which usually have high turbidity and nutrients, and low salinity and pH.¹⁹ As the coastal terrestrial areas connected to Brunei Bay become urbanized, more human-derived substances such as nutrients might be discharged into the bay and subsequently offshore coral reefs.

5. Summary and future studies

In summary, recent extensive surveys confirmed a high coral diversity in Brunei Darussalam. The species composition was similar to the other east parts of the SCS such as Palawan Island. Brunei is presently excluded from the northwestern boundary of the Coral Triangle²⁰ but after the extensive surveys of the family Fungiidae, it was

suggested that the boundary might need to be reconsidered.⁷

Studies required for the future management and conservation of Brunei coral reefs would be regular monitoring of the reef status. At the time of writing this article, there was little available published data on regular monitoring and evaluation of the coral reef environment over the long term. Both global and local environmental changes might have altered coral reef seawater conditions in the country as discussed above. Attention also needs to be paid to fishing activities because overfishing causes reduction in the grazing pressure on benthic algae and consequently changes the ecosystem structure. The enhanced growth of benthic algae might outcompete corals and decrease the resilience of corals to other stresses.²¹ The conditions of the Brunei coral reef environment need to be monitored and evaluated carefully from these various perspectives.

Acknowledgements

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