Conditions of Decapods Infraorders in Dead Coral *Pocillopora* sp. at Pemuteran, Bali: Study Case 2011 and 2016

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Abstract

Decapods are marine organism which have burrowing-life characteristic and tend to live in the hard coral, such as *Pocillopora* sp. Pemuteran district is located in West Bali with high marine biodiversity. In 2016 almost all of the coral reefs in this area have bleached. This research investigates the condition of decapods before and after coral bleaching in Pemuteran. Dead corals, *Pocillopora* sp., were taken from 8-12 meters depth in 2016. All organisms within those corals were collected and identified until infraorder and family level. Comparison was done with data collected in 2011. This study found 12 families with a total of 5 infraorder which are equal to the previous data. The number of individual has increased from 88 into 214 individual. The mean presence increased from 6.2875 ind/fam to 15.2875 ind/fam. While the density also increased from 23.68 ind/L to 42.09 ind/L. Uniformity and dominance indices for all infraorder is low. These results show that there is an increase of the density of decapods after coral bleaching event, but the diversity of decapods was slightly changed.

**KEYWORDS:** Decapods, Dead Corals, Bleaching, *Pocillopora* sp., Pemuteran

1. Introduction

Indonesia is part of coral triangle and also known as the center of marine biodiversity [1-4]. This area alone represents 76 % of global coral diversity [5] and very diverse fishes [4][6]. Understanding biodiversity of marine organisms is very important for management and conservation practices to avoid declining natural populations and extinction [7-8]. However, corals and fishes represent only a fraction of biodiversity associated with coral reefs. There are many organisms associated with coral reefs and can be used as indicators of biodiversity, especially those which lives in the coral reefs cracks and gaps.
such as decapods. It was found that 86% of organisms taken on the dead coral *Pocillopora* sp. were decapods [9].

This crustacean not only has many members, but also has important ecological and economical values [10]. Ecologically, decapod is an important food source for fish and other organisms, and in the form of zooplankton larvae, they are also key components of the marine food chain [11]. In addition, some decapods have been reported to have important economic value, for example crabs [12-13] and crayfish [14].

Increasing human activity in coastal areas gives pressure on marine ecosystems including decapods [15]. The pressure that comes from nature such as global warming also can affects the coral reef ecosystem. In 2016 coral bleaching occurred in Indonesian waters including in Pemuteran, Bali which resulted in coral reefs mass death. Coral bleaching not only affected to coral, but also to associated organism [16-17] such as decapods. This study aimed to compare the conditions of decapods infraorders living in dead coral *Pocillopora* sp. in 2011 and 2016 after coral bleaching at Pemuteran, Bali which is also known as popular tourist destination.

2. Material and Methods
Samplings were conducted on August 2011 and June 2016 in Pemuteran, Bali. See Figure 1.Two dead corals with similar diameter about ±30 cm were taken at a depth of 8-12 m. The method used for retrieval of dead coral in the sea was based on those used by several studies [9][18-19].

![Figure 1. Sampling location at Pemuteran, Bali.](image)

The dead corals were pulled out from the substrate by hammer and chisel. They were put into plastic bags individually and brought to the laboratory for further process. Volume of each dead coral was measured by using water displacement method in a bucket. These dead corals then were broken into small pieces and collected all organisms found. These organisms were sorted base on morphological characters and identified up to family levels including infraorder. Identification of decapods was done based on Crustacean Guide of the World [20]. These organisms then were put in clove oil and were photographed for documentation.
Abundance, relative abundance, diversity index, uniformity index, dominancy index, and density were calculated and categorized based on the formula of Odum [21], Krebs [22], and English et al. [23].

3. Result and Discussion
The results show that total number and density (ind/L) of decapods found in dead corals of *Pocillopora* sp. in 2016 was higher than in 2011. See Figure 2. The number of family decapods found in 2011 and 2016 was the same i.e. 12 family, but with different diversity. The family of Dromiidae and Thalassinidae found in 2011 but not discovered in 2016, while Majoidea and Axiidae found in 2016 but did not appear in 2011. See Figure 3. The number of decapods individual of each family generally increased in 2016 compared to 2011. The highest increase in number was Xanthidae.

![Figure 2](image-url)

**Figure 2**. Total number (a) and density (b) of decapods found in dead corals, *Pocillopora* sp. collected at Pemuteran, Bali in 2011 and 2016
Figure 3. Number of decapods from different family found in dead corals, *Pocillopora* sp. collected at Pemuteran, Bali in 2011 and 2016

There were in total five infraorder found in 2011 and 2016 i.e. Anomura, Brachyura, Macrura, Axiidae, and Gebiidae. However, Axiidae, and Gebiidae were not found in 2011 and 2016, respectively. See Figure 4. The number of individual infraorders generally also increased in 2016 compared to 2011. The highest increment of the number was Brachyura from 22 in 2011 to 106 in 2016.

![Graph showing number of infraorders found in dead corals](image)

Figure 4. Number of individual decapods from different infraorder found in dead corals, *Pocillopora* sp. collected at Pemuteran, Bali in 2011 and 2016

The relative abundance of the decapods infraorders Anomura, Brachyura, and Axiidae increased from 2011 to 2016, however in Macrura and Gebiidae infraorders experienced a decrease (Figure 5). Axiidae and Gebiidae lower than other family because they generally life with burrowed into the sand or mud [24] and they were rarely found in reefs or cavities of sessile animal such as sponges and coral [25]. While Diversity index ($H'$) of decapods on each infraorder has different values. Brachyura in 2016 and Macrura in 2011 are included in medium category ($1 < H' < 3$) and the others are low category ($H' < 1$). See Table 1.

![Graph showing diversity index of decapods](image)

Figure 5. Relative abundance of decapods from different infraorder found in dead corals, *Pocillopora* sp. collected at Pemuteran, Bali in 2011 and 2016
Table 1. Diversity index (H) of decapods infraorders found in dead corals, *Pocillopora* sp. collected at Pemuteran, Bali in 2011 and 2016

| No | Infraordo | Diversity (H') | Uniformity (E) | Dominance (C) |
|----|-----------|----------------|---------------|--------------|
|    |           | 2011 | 2016 | 2011 | 2016 | 2011 | 2016 |
| 1. | Anomura   | 0.57 | 0.66 | 0.22 | 0.18 | 0.02 | 0.02 |
| 2. | Brachyura | 1.01 | 1.30 | 0.33 | 0.28 | 0.02 | 0.09 |
| 3. | Macrura   | 1.22 | 0.85 | 0.31 | 0.21 | 0.16 | 0.05 |
| 4. | Axiidae   | 0.00 | 0.14 | 0.00 | 0.08 | 0.00 | 0.00 |
| 5. | Gebiidae  | 0.07 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
|    | Average   | 0.58 | 0.59 | 0.17 | 0.15 | 0.04 | 0.03 |

The diversity index value is influenced by the diversity of individuals obtained in each year. The average value of the decapods infraorder diversity index in 2011 was 0.58 and in 2016 is 0.59. The average index of diversity has increased, but the value is included low category. When the value of diversity index \( H' < 1 \) means that organism community is not stable or the waters quality is heavily polluted. The diversity is not only a synonym of the number of species, but also character of community which is determined by the number of species and evenness of individual abundance of each species [21].

Uniformity index is composed of individuals of each species in a community [21]. The value of uniformity index of all decapods infraorders in 2011 and 2016 includes in the low category. The average value of the uniformity index in 2011 was 0.17 and the 2016 is 0.15. There was a decrease in the value of uniformity index, but both are still included in the low category \( 0.00 < E < 0.50 \), it indicates if the community under stressed because of the individual richness ownedby each infraorder is much different.

The dominancy index of each decapods infraorder in 2011 and 2016. The average dominance index of each Decapod’s infraorders in 2011 was 0.037 and in 2016 was 0.031, the value of both indices showed a low dominance values \( 0.00 < E < 0.05 \). The density index of decapods found generally increased except for Gebiidae which was experiencing decrease in 2016. The highest increase occured in Brachyura as presented on Figure 6.

Figure 6. Density of decapods infraorders found in dead corals, *Pocillopora* sp. collected at Pemuteran, Bali in 2011 and 2016
The results of this study indicate an increase in the number and density of decapods present in dead corals in conditions after bleaching in 2016. These findings differ from the general opinion that bleaching will damage the coral ecosystem, including its associated organisms [17]. The increase in the density can be caused by several factors such as the recruitment, mortality, or movement (migration) [26]. All three factors are also influenced by environmental conditions, especially water quality and substrate conditions where decapods live. The results of the study [9] show that the abundance of decapods on living corals is actually lower than that of dead corals, as the availability of holes and gaps in dead corals is even greater. This condition provides the availability of a place for the decapods to live in it. Bleaching causes coral mortality, which actually provides a place of life for the decapods.

While the influence of temperature rise that causes the occurrence of bleaching, resulted in changes in the type of decapods that can live on the dead coral. A slight temperature change can cause a great impact on the vitality, growth and reproduction rate of sea organisms [16]. Infraorder Axiidae appears in 2016 after bleaching, indicating that the conditions are more suitable for life. In contrast, Gebiidae found in 2011, although with a small amount, was not found after bleaching.

4. Conclusion
There is an increase in total number and density of decapods in 2016 after coral bleaching event, possibly is caused by the occurrence of more places for decapods to live. However, there was a slight change on the diversity as well as decrease in evenness and dominance indices with no dominance individual organism.

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