Revealing Hidden Diversity in Menjangan Besar Island, Karimunjawa: Reef-Associated Decapods as a Proxy of Biodiversity Estimation

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Abstrak

Mengungkap Keanekaragaman Tersembunyi di Pulau Menjangan Besar, Karimunjawa: Estimasi Biodiversitas Menggunakan Dekapoda yang Berasosiasi dengan Terumbu Karang

Kepulauan Indonesiamemiliki sejumlahArea Perlindungan Laut dan Taman Nasional yang merupakan tempat tinggal bagi organisme laut dengan tingkat keanekaragaman yang tinggi. Karimunjawa sebagai salah satu Taman Nasional, dikenal mempunyai keanekaragaman terumbu karang yang tinggi dan merupakan salah satu kawasan yang digunakan sebagai area studi keanekaragaman laut. Penelitian ini bertujuan untuk mengestimasi keanekaragaman organisme pada habitat terumbu karang yang terdapat di kawasan pesisir Karimunjawa. Metode sampling semi-kuantitatif digunakan untuk mengestimasi keanekaragaman terumbu karang, dengan menggunakan anggota kelompok dekapoda sebagai perwakilan. Enam belas terumbu karang mati (dead coral head) dari anggota Pocillopora, di koleksi dengan ukuran yang sama pada kedalaman 10 meter di kawasan Pulau Menjangan Besar, Karimunjawa. Seluruh dekapoda yang dikumpulkan, diidentifikasi sampai tingkat famili dan menunjukkan terdapat 11 famili dari total 203 individu. Nilai statistik dari kekayaan spesies (Chao1 and ACE) menunjukkan hanya 11 famili dekapoda yang dapat ditemukan di kawasan tersebut. Hasil kurva rarefaksi menunjukkan nilai yang mencapai titik kesetimbangan setelah karang mati ke-empat belas, yang mengindikasikan bahwa penambahan koleksi sampel tidak akan mengubah estimasi keanekaragaman yang ditemukan. Index keanekaragaman Shanon-Wiener juga menunjukkan nilai keanekaragaman yang rendah dengan nilai 1.9. Hasil penelitian ini dapat digunakan sebagai dasar pemahaman bagi keseluruhan keanekaragaman terumbu karang yang terdapat pada suatu kawasan dan sebagai dasar pengetahuan untuk tujuan pengamatan ekosistem terumbu karang bagi perlindungan dan konservasi.

Kata kunci: *keanekaragaman, terumbu karang, dekapoda, Indonesia, Karimunjawa.*

Abstract

The Indonesian archipelago, with its higher number of Marine Protected Areas (MPA) and National Parks, is a home to a high diversity of marine organisms. Karimunjawa is an Indonesian National Park that is well known for its diverse coral reefs and therefore is an important place to study marine biodiversity. In the present study, the biodiversity of reef organisms was estimated in the coastal marine habitat of Karimunjawa. A semi-quantitative sampling method was used to estimate reef biodiversity using decapod group as a representative. Sixteen similar sized dead coral heads of Pocillopora were sampled from 10 m depth at Menjangan Besar Island, Karimunjawa. All decapods were sorted and identified to the family level, yielding 11 families from total 203-collected individuals. Species richness statistics (Chao1 and ACE) suggest that only 11 families of decapods can be found

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in this area. Rarefaction curves approached an asymptote after sampling fourteen heads, indicated that sample addition will not alter the estimate diversity found in this location with Shanon-Wiener diversity index of 1.9 indicated low diversity. Our findings may provide a basic understanding of the overall biodiversity of a reef area and a basic knowledge in monitoring coral reefs ecosystems for protection and conservation.

Keywords: biodiversity, coral reefs, decapod, Indonesia, Karimunjawa.

Introduction

The Indonesia Archipelago is known as an area with a high number of marine biodiversity in its coral reefs (Myers *et al.,* 2000; Veron, 2000; Roberts *et al.,* 2002; Briggs, 2005). Located in Coral Triangle Area, Indonesia has the total of 2122 species of reef fishes. Previous studies confirmed its position as the country with the richest number of reef fishes (Allen and Adrim, 2003; Allen, 2008). In addition to this, studies on other taxa also supported Indonesia as the area with the center of origin of world marine biodiversity (Hoeksema, 2007; Barber *et al.,* 2006; Malay and Paulay, 2010).

Biodiversity as a variety and abundance of species in a defined unit of study, including diversity within species, between species and of ecosystem (Maguran, 2009), is an important factor to represent the wealth of coral reefs. Traditionally, coral and fish were used as surrogates in biodiversity assessments because they are taxonomically well known and easy to identify. However, these two groups only represent a small fraction of reef-associated diversity and may not capture the diversity of all organisms. The highly complex structure of coral reefs may also be a problematic factor when aiming to find and estimate the hidden diversity of reef organisms (Plaisance *et al*., 2009), especially organisms that live within cracks and crevices of coral reefs.

To overcome this issue, studies to find a standardized method to estimate diversity has been conducted in few reefs located in Indo-Pacific regions (Plaisance *et al*., 2009; Knowlton *et al.*, 2010; Plaisance *et al.*, 2011). In those studies, crustacean fauna was used as a proxy to estimates overall reef biodiversity because it's the second most diverse group of marine metazoans. Crustacean is also a good representative of marine reef biodiversity because most of the reefs diversity is made up of small, cryptic species and species from poorly known groups. This semi-quantitative sampling methods proposed by Plaisance *et al.* (2009) using decapods and dead coral heads is an implemented methods for estimating biodiversity in Indonesia's reefs.

Karimunjawa as one of Indonesia's National Parks is also known as tourism destination. Encompasses of 27 islands with ecosystems of coral reefs, sea grass and seaweed beds, mangroves and beach forest (BTNJ, 2010; http://tnkarimunjawa.dephut.go.id), Karimunjawa is a good habitat of diverse marine organisms. However, the purpose of increasing economy through tourism may impact the diversity of local marine habitat (Purwanti *et al.,* 2008). In order to overcome this issue, the biodiversity in those areas needs to be recorded and protected. Although the diversity studies on fish (Sugianti and Mujiyanto, 2013) and corals (Suryanti *et al*., 2011) had beed conducted in Karimunjawa which indicated a certain level of diversity, this result still not covered the biodiversity at cryptic level.

Aim of this study is to answer the question regarding hidden diversity of cryptic species in the reefs of Karimunjawa. This research used decapods fauna, which were collected on *Pocilopora* dead heads as a proxy to estimate biodiversity. As a pilot study, only Menjangan Island was choosenas a sampling location due to the characteristic of this location as a tourism and conservation areas, and also the high percentage of dead coral heads found in this location compare to others. This data may use as a basic knowledge in monitoring coral reefs for protection and conservation in Karimunjawa's area.

Materials and Methods

Sixteen dead coral heads with similar-size, a size of a 20 l bucket, were collected from the reef of Menjangan Besar Island, Karimunjawa (Figure 1) and collected from the depth of 5–10 m. Dead coral head were selected from family Pocilloporidae and chosen from the heads that colonized by encrusting flora and fauna but still attached to the reef at the base. The heads were bagged and gently broken from the bottom with a hammer and a chisel and quickly placed in a 20-liter bucket underwater. This sampling collection and processing following the method described in Plaisance *et al.* (2011).

The size of each dead head photographed and length, width, and height were measured; the volume was measured based on water displacement. Each branch of coral head was detached carefully with a hammer and a chisel and examined closely for motile invertebrates.

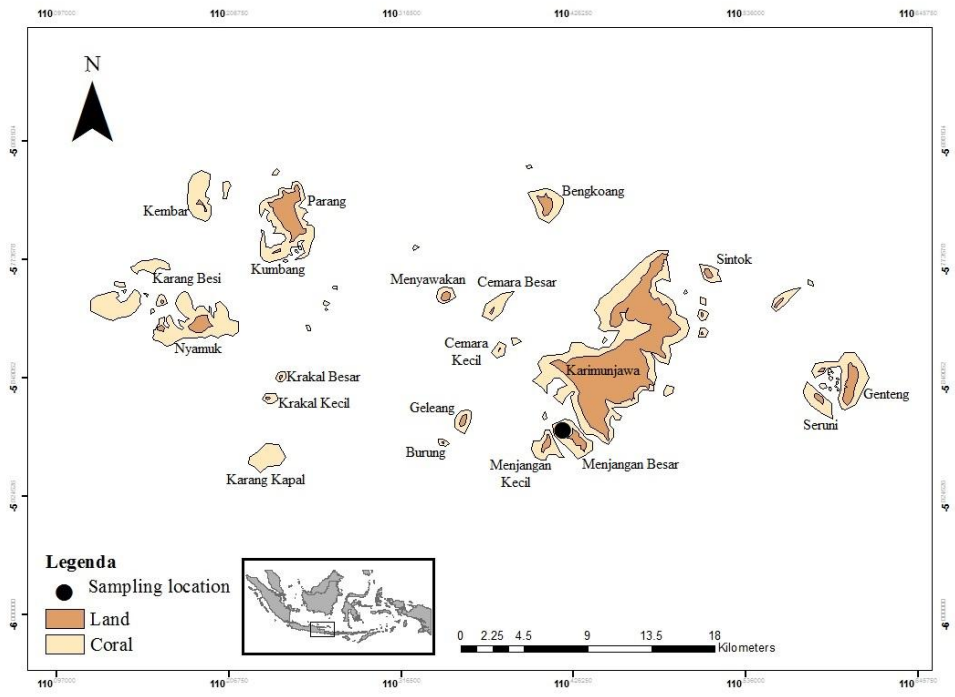


Figure 1. Sampling site in Menjangan Besar Island, Karimunjawa

The remaining rubbles were placed in the bucket of seawater. After all the branches and the base has been broken apart and examined, the fragments were broken into smaller pieces and examined a second times for the remaining creatures. The seawater, in which the dead heads and coral fragments had been kept, was then filtered through a 2 mm sieve. The remaining organisms captured in the sieve were collected for identification.

Each decapod specimen was identified to the family level, and abundance of each was also recorded. Decapods collected from each dead heads were identified and photographed. Richness and abundance data were used to measure the diversity using EstimateS v.9.1.0 (Colwell, 2013). The computation of Shanon-Wiener index, Chao1 and ACE estimates was done for each of one through sixteen heads sampled, with a randomized order of samples without replacement for 100 runs. Rarefaction curve was also computed using sample data.

Result and Discussion

Dead coral head was a semi-quantitative sampling method proposed by Plaisance *et al.* (2009). This method allowed us to estimate the diversity of all crustaceans found on a reef, reside the fact that it is challenging to get the standardized quantitative sampling of a reef. Diversity estimation on a reef was hard because of the heterogeneous, rigid, and complex structure of a reef (Markmann and Tautz, 2005). Previous study using this methodhad been conducted in some of the Pacific and Indian Ocean's Islands and discovered a large number of species within a small total area (Plaisance *et al.*, 2009; 2011). Compared to those previous researches, from 16 dead coral heads collected, 203 individuals of decapod from 11 different families were found. Among all of the families, 36.4 % were from shrimp groups and 63.6 % were crab. Four families of shrimp found were Axiidae, Palaemonidae, Alpheidae, and Hippolytidae; while seven families from crab group (including anomuran and brachyuran) were Diogenidae, Pilumnidae, Porcellanidae, Xanthidae, Trapeziidae, Galatheidae, and Majidae.This data indicated a low richness of decapods fauna found in the location of study, with only five families of brachyuran crab were found among 93 families listed (Ng *et al.*, 2008).This was also true for other groups of decapods we had collected; such as caridean and anomuran crabs, which also showed a low richness.

Abundance data were also indicated a low value, which showed in Figure 2a. Palaemonidae showed as the most abundance family found among all of the dead head (36% of the abundance of other families). While Xanthidae, Galatheidae, Alpheidae and Hippolytidae showed moderate number of abundance with the percentage of 15%, 11%, 10%,

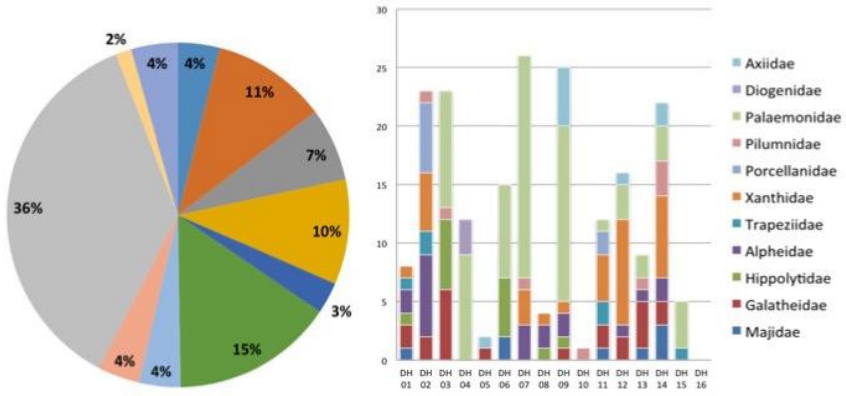
and 7% respectively. The least number of individuals found were from Diogenidae (2%). Comparison of the abundance and richness data (Figure 2b.) showed maximum number of family found in one dead head were 7 and the minimum was 0. From 16 dead head collected, we didn't find any decapod fauna in dead head number 16, which indicated that the distribution of decapods family did not disperse evenly across reefs.

Shanon-Wiener and rarefaction curves were analyzed in order to see the diversity index and estimate the completeness of sampling effort and also the reliability of diversity estimates (Figure 3.). Shanon-Wiener diversity index (*S-W*) showed minimum value of 1.9, which compared to other dead heads data collected in Pemuteran, Bali on 2012 (unpublished data), this value showed a lower diversity. S-W diversity index in Pemuteran, Bali was 2.35 with the indication of high number of richness and abundance. This may conclude that the diversity of reefs crustacean found in Karimunjawa was less diverse than Bali. The difference level of diversity in those two locations can be caused by geographic topography, coral traits (including coral diversity, percentage cover of live coral, and topographic complexity created by coral skeleton) and the diversity of other marine organisms (Idjadi and Edmunds, 2006; Stella *et al.*, 2010).

ACE and Chao1 value on rarefaction curves start to plateau after fourteen dead heads, which indicated that sample addition would not alter the estimate diversity found in this location. This Chao1 (Chao, 1984) and ACE (Chao and Lee, 1992) diversity estimates are designed to provide estimates of diversity when many species remain to be sampled (Collwell and Coddington, 1994). This result was also supported by other estimation analysis such as singleton and doubleton value that indicated a very low number (Figure 4,). Based on these analyses, it was estimated that there were only 11 families of decapods will be found among all of the reefs around Menjangan Besar island. Although this data only indicated the diversity of decapod fauna in family level, the richness and abundance data of morphospecies also did not showed any significant diversity. However, the diversity of organisms in dead coral head will tend to be higher than organisms found in living coral, due to the fact that some organisms may act as an obligatory symbiont to specific types of corals (Plaisance *et al.*, 2009; 2011), which may affect the different estimation diversity between dead and living coral.

In our study, MenjanganBesar Island was chose as a pilot sampling location and used as a representation of Karimunjawa Islands reefs condition, because of its characteristic both as tourism and conservation zone. Human activities as in tourism and fisheries can make a negative impact on the sustainability of reefs ecosystems due to the lack of awareness on marine life. To prevent the damaging impact of those human activities, revealing the conditions of the marine ecosystem was one of the approaches that can be applied. Healthy communities of coral reefs with its diverse organism will increase the abundance of fish presence and thus affect the income and economic strength within the region.

By protecting the diversity of corals reefs, it will also help to sustain the fisheries management (Hoegh-Guldberg *et al.*, 2009). Disregarding the activities issue, suitable dead coral heads was hardly found on our sampling locations that matched the sampling standard. Some of the dead heads collected were still covered with ~25% of living coral, which indicated a good percentage cover of live coral



(a) (b)

Figure 2. (a) Abundance of all families. (b) Richness and abundance from each dead head.Abundance showed as the proportion of each family on each dead head (DH).

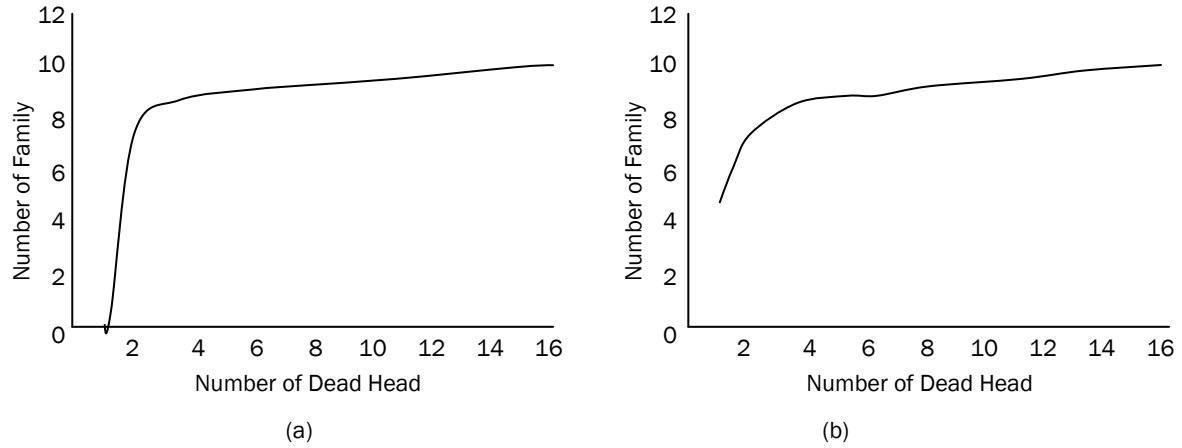


Figure 3. Rarefaction curve (line) and the value of diversity estimators ACE (a) and Chao 1(b) as a function of the number of heads entered into analysis.

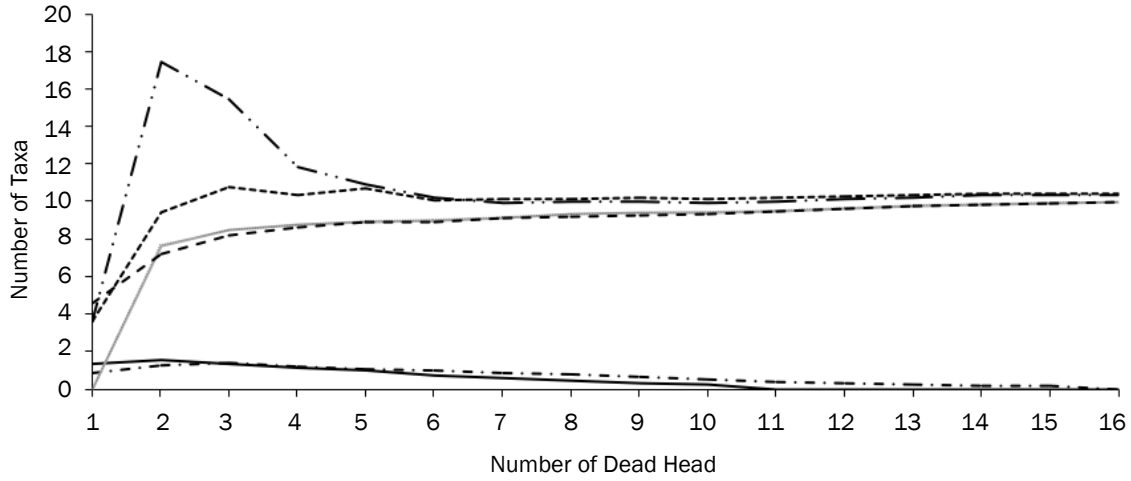


Figure 4. Rarefaction curve using other estimations analysis
Note. ___ : singletons, _ . _ : doubletons, ___ : ACE, _ _ _ : Chao 1, **....** : Chao 2, ... : ACE, dan _ . . : ICE

in the area of study. However, despite the good cover of live coral observed, the richness and abundance data on our result did not signal high diversity of decapods organism.

Using only one location and one group of organism, the result of this study may still underestimate the diversity of coral heads sampled and may only indicated a small fraction of a whole coral reefs habitat. This was also stated in Plaisance *et al.* (2011), which confirm that the estimation of regional and global diversity based on extrapolations of small samples has huge uncertainties as the samples collected using this method only focused on specific types of organism. However, the use of this method perceived the basic understanding of hidden diversity lies on Karimunjawa's coral reefs, which never been examined using conventional survey methods. In addition to this, because of our samples were taken only from one island, we cannot concluded that all of the islands in this area will also have the same diversity, which may differ according to natural conditions and disturbance perceived by each reef on each islands.

This data may use as a preliminary data of hidden diversity in Karimunjawa and could completed with further studies conducted on the other islands, especially the island with different zone's function as in primary zone, conservation zone and beneficial zone. The use of morphospecies and molecular techniques had been improved the identification and finding of cryptic samples (Knowlton *et al.*, 2010), which were lack in our sampling methods and need to be done in order to compare the diversity between different taxon level and need to be added for complete biodiversity study of cryptic organisms.

Conclusion

In conclusion, estimation of biodiversity of coral reefs in Menjangan Besar Island, Karimunjawa using decapods as a proxy indicated a low diversity. Low value of diversity was also supported by richness and abundance data, with only 11 families of decapods were found among all of sampling sites. This data provide a basic understanding of the overall biodiversity of a reef area and a basic knowledge in monitoring coral reefs ecosystems for protection and conservation in Karimunjawa.

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