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Composition of juvenile corals on different morphotypes of substrata at Karimunjawa Island (Java Sea), Indonesia

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ABSTRACT

Patterns of coral recruitment are partially explained by fitness consequences of substrate selection, and may be affected by substrate morphology. This study examined juvenile coral assemblages on morphologically different dead coral substrata in shallow water reefs (4-5 m) at Karimunjawa Island, Java Sea (Indonesia). Surveys on juvenile corals were performed using 50x50 cm transects on two different morphotypes of substrata; dead massive corals and dead branching corals. Results showed that the morphological characteristics of dead coral substrata had a significant influence on the generic composition of juvenile corals. Juvenile corals of the genus *Acropora* were dominant on (exposed microhabitats of) dead massive coral substrata, while those of the genus *Fungia* and *Montipora* were dominant on (cryptic microhabitats of) dead branching coral substrata. These results suggest that Acroporid juveniles can be settled to the various morphotype of the substrata, thus the distribution pattern of juvenile corals in shallow reef Karimunjawa correlated with the distribution pattern of adult corals.

Keywords: juvenile, microhabitat, dead coral, Karimunjawa Island.

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Introduction

Coral recruitment is the basic information to determine the pattern of distribution of hard coral at a site. Recruitment of coral can be interpreted as a hard coral larval settlement success to happen deposition process to form the skeleton on the substrate surface and last up to a certain period (Wallace, 1985). Recruitment of hard corals (Scleractinia) varies between locations (spatial), the type of substrate and occurs seasonally or temporally (Dunstan and Johnson, 1998). Coral larval settlement which succeeds is also determined by its behavior in the planktonic stage and mortality after settlement (Babcock and Mundy, 1996). Hard coral larvae are generally settled to the bottom of the plate is shielded substrate attachment (Harriott and Fisk, 1987) called the "sub-cryptic settlement microhabitat" (Arnold *et al.*, 2010). Juvenile which settled in the under surface substrate aim to avoid the possibility of threat from sedimentation and predation of fish and invertebrates (Harriott, 1983; Babcock and Mundy, 1996). The study shows that the ability of microhabitat selection by hard coral larvae when attachment is also influenced by the species and life form of corals (Babcock and Mundy, 1996).

Recruitment of hard corals (Scleractinia) occur in a variety of hard substrate that available in the coral reef environment. Hard substrate surface can be derived from coral colonies that have died either dead massive and branching coral substrata. Both kinds of the substrate surface must have a microhabitat with hidden and open. Dead massive coral substrata has an open and stable surface while the dead branching coral substrata which microhabitat have more hidden but unstable. Microhabitat differences and the stability of the state of both the hard substrate are expected to affect the density of juveniles, juvenile species composition, and life form of juvenile hard corals. For the study of juvenile hard coral communities at different substrate attachment are needed to the underlying knowledge of the resilience of reefs, coral reef rehabilitation techniques and population dynamics of hard corals (Scleractinia) in Indonesia. This paper will answer whether differences in substrate microhabitat of dead massive and branching coral substrata in influencing the composition of coral species and discuss the life form of hard corals.

Materials and Methods

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The study of coral recruitment on different morphotypes of **substrata** was performed in 3 (three) stations s which are 2 (two) stations in the rubble **substrata** of Sambangan Reefs which composed by dead branching coral **substrata**, and the other on the dead massive coral **substrata** at Genting Island, Karimunjawa (Figure 1). In order to determine the observation station, has been examined in the reef flat with SwimTime method. Juvenile coral community survey transects were performed by the square transect of 50X50 cm on the plains of the reef at a depth of 4-5 m. A total of 49 transects have been observed on dead massive coral **substrata** of Genting Reef, while for observations on dead branching coral **substrata** of Sambangan Reef using 6 and 8 transects respectively. Juveniles of hard coral measuring ≤ 5 cm (using a scale/ruler) found in the squared transects photographed using Underwater Digital Camera Canon G-10. Identification of juvenile hard coral genus (Scleractinia) made from digital images taken during the survey with the help of computer software. Determination types of juvenile hard coral genus follow to Veron (2000).

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Data analyses?

Results & Discussion

Composition juvenile corals on dead massive coral **substrata**

Observations on 233 juvenile hard corals (Scleractinia) attached to dead massive coral **substrata** with the substrate surface open (stable) has the highest density of 24 colonies/transect (50X50 cm) with an average density of 4.76 juvenile/transect. A total of 7 (seven) family and 12 (twelve) genera were found in dead massive coral **substrata** which includes family adult corals which are common in the waters of Genting Island. Family of juvenile corals that were found at Genting Island as follows Acroporidae, Pocilloporidae, Poritidae, Faviidae, Oculinidae, Agariciidae, and Mussidae (Table 1). Twelve genera of juvenile corals are Acropora, Montipora, Astreopora, Pocillopora, Porites, Favia, Favites, Goniastrea, Cyphastrea, Galaxea, Pavona, Lobophyllia. Most of juvenile corals were found on the Family Acroporidae especially genus Acropora is about 47.6% (Figure 2). Other genera of juvenile corals found are Porites (20.2 %), Favites (10.2%), Pocillopora (7.2%), Montipora (6.9%) and Galaxea (3.4%).

Juvenile corals are attached to the surface of dead massive coral [substrata](#) commonly found attached to the microhabitat initially hidden (cryptic) in the form of small holes on the surface of the rock substrate which tends to open. Then juvenile coral colonies are encrusting growth form to the open surface of the substrate. This can be seen in juvenile *Acropora*, *Porites* and *Montipora* that dominate juvenile hard coral communities are generally found in small holes or hollows hard substrate (Figure 3).

Composition juvenile corals on dead branching coral [substrata](#)

Observations on the 59 colonies and 28 colonies of juvenile hard corals (*Scleractinia*) attached to the dead branching [substrata](#) (rubble substrate and unstable) in their respective Stations 2 and 3 of Sambangan Island showed that the highest density of juvenile corals at 17 colonies/transect (50X50 cm). Coral juvenile density by an average of 9.8 colonies/transect at Station 2 and 3.5 colonies/transect at Station 3. Composition of family and genera in Sambangan Island between stations 2 and 3 have the same but the number of genera in the family and station 2 is higher than at station 3. Many as 4 family and 6 genera of hard corals are found at Station 2, while in the second there are stations 3 and 4 genera family. Family of hard coral reef which compose in station 2 is *Acroporidae*, *Faviidae*, *Fungiidae*, and *Oculinidae*, while at station 3 is *Acroporidae*, *Fungiidae*, and *Oculinidae* (Table 3). The genera of coral juvenile were found at Station 2 is *Acropora*, *Montipora*, *Favites*, *Pachyseris*, *Fungia* and *Galaxea* while at station 3 is *Acropora*, *Montipora*, *Fungia* and *Galaxea*.

The composition of juvenile coral on the dead branching [substrata](#) is different than the juvenile composition on dead massive coral [substrata](#). Although juvenile coral genus *Acropora* are also found in the dead branching [substrata](#) but juvenile coral on the [substrata](#) is dominated by *Fungia* and *Montipora*. Occurrences of juvenile coral *Fungia* reached 56% at Station 2, while the emergence of juvenile coral *Montipora* obtained by 57% at Station 3 (Figure 4). Differences in the composition of juvenile coral genera probably related to the origin and source of larval settlement process. Originally resources include the distribution of coral larvae mature, reproductive season, and while the reproduction model of the settlement process associated with the selection of substrate and microhabitat.

Juvenile of *Scleractinian* corals are recruited to the dead branching [substrata](#) is generally on microhabitat which also found in the form of small holes on the surface of

the [substrata](#). This can be seen in juvenile of *Fungia* and *Montipora* were dominated at Station 2 and 3 of Sambangan Island, Karimunjawa (Figure 5).

(intergrasikan antasa hasil dan pembahasan) Coral recruitment varies between locations (spatial) and occurs seasonally (Dunstan [and](#) Johnson, 1998). Coral larval settlement is determined by its behavior during the planktonic stage and mortality after settlement (Babcock [and](#) Mundy, 1996). Juvenile corals generally found under surfaces of plates (Harriott [and](#) Fisk, 1987) called the "subcryptic settlement microhabitat" (Arnold *et al.*, 2010). Selection of coral juvenile on the under surface of [substrata](#) in order to avoid the possibility of sedimentation and predation of fish and invertebrates (Harriott, 1983; Babcock [and](#) Mundy, 1996). Selection of microhabitat by hard coral larvae when settlement takes place is also affected by the life form of corals (Babcock [and](#) Mundy, 1996). The results of this study showed that the morphotypes of [substrata](#) affects the composition of the juvenile corals.

Juvenile of coral may select microhabitat based on the different morphotypes of [substrata](#). On the dead massive coral [substrata](#) with an open surface microhabitat are found juvenile *Acropora* branching and massive corals of *Porites* and partly *Favites*. In contrast, on the dead branching coral [substrata](#) which may unstable [substrata](#) which composed juvenile of *Fungia* (free-living coral) and foliose coral *Montipora*. The results support the previous study of Babcock [and](#) Mundy (1996) that the massive corals generally prefer microhabitat on the upper surface which is more open than other lifeform. The results of this study indicate that the solitary coral (free-living) *Fungia* has settlement preferences on to microhabitat under surface and cryptic of [substrata](#) while branching coral *Acropora* prefer microhabitat on the upper surface of the [substrata](#). These results suggest that *Acroporid* juveniles can be settled to the various morphotype of the [substrata](#), thus the distribution pattern of juvenile corals in shallow reef Karimunjawa correlated with the distribution pattern of adult corals.

Conclusion ??

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References (tambahkan Pustaka minimal 20 pustaka 80 dari jurnal) terbitan 5 tahun terakhir

Arnold, SN and RS Steneck. 2011. Settling into an Increasingly Hostile World: The Rapidly Closing "Recruitment Window" for Corals. *PLoS ONE* 6(12): e28681.

Babcock, R. and C. Mundy. 1996. Coral recruitment: Consequences of settlement choice for early growth and survivorship in two scleractinians. *J. Exp. Mar. Biol. Ecol.*, 206:179-201.

Bak, R.P.M. and E.H. Meesters. 1998. Coral population structure: the hidden information of colony size-frequency distributions, note. *Mar. Ecol. Prog. Ser.*, 162:301-306.

Dunstan, P. K. and C.R. Johnson. 1998. Spatio-temporal variation in coral recruitment at different scales on Heron Reef, southern Great Barrier Reef. *Coral Reefs*, 17:71-81.

Harriott, V.J. 1983. Reproductive seasonality, settlement, and post-settlement mortality of *Pocillopora damicornis* (Linnaeus), at Lizard Island, Great Barrier Reef. *Coral Reefs*, 2:151-157.

Harriott, V.J. and D.A. Fisk. 1987. A comparison of settlement plate type for experiments on the recruitment of Scleractinian corals. *Mar. Ecol. Prog. Ser.*, 37: 201-208.

Harrison, P.L. and C.C. Wallace. 1990. Reproduction, dispersal and recruitment of scleractinian coral. In Z. Dubinsky (ed): *Ecosystem of the world Vol. 25, Coral reefs*, pp. 133-207. Elsevier, Amsterdam.

Tomascik, T. 1991. Settlement pattern of Caribbean scleractinian coral on artificial substrate along eutrophication gradient, Barbados, West Indies. *Mar. Ecol. Prog. Ser.*, 77:261-269.

Veron, J.E.N. 2000. *Corals of the World*. Vol. III. Australian Institute of Marine Science and CRR Qld Pty Ltd., Queensland. 490pp.

Wallace, C.C. 1985. Seasonal peaks and annual fluctuations in recruitment of juvenile scleractinian corals. *Mar. Ecol. Prog. Ser.*, 21: 289-298.

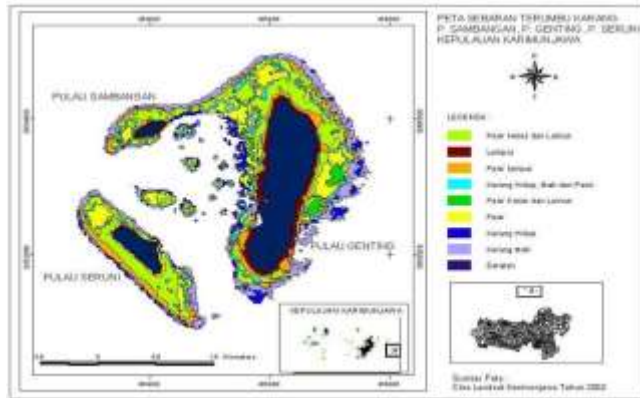


Figure 1. Study site at Genting Island and Sambangan Island, Karimunjawa, Indonesia

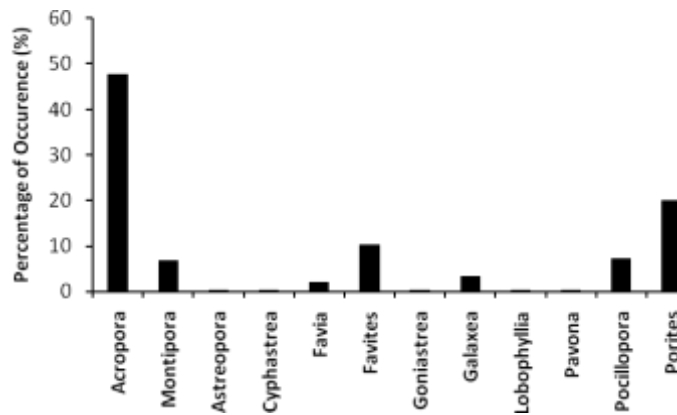


Figure 2. Percentage occurrence of coral juvenile on the surface of stable **substrata** at Genting Island, Karimunjawa.

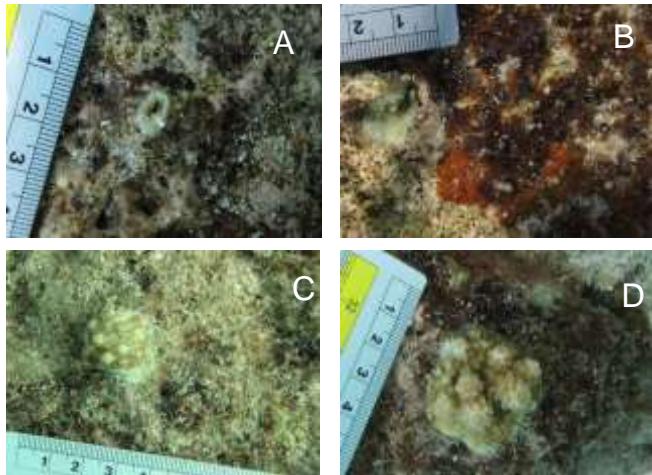


Figure 3. Juvenile *Acropora* settled on the dead massive corals [substrata](#) on the small hole (2A) and small refuge (2B), after survived and then growing to make some small branches (2C, 2D).

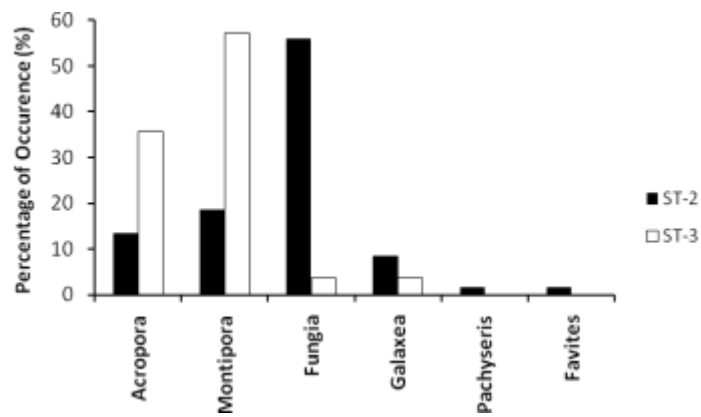


Figure 4. Percentage occurrence of coral juvenile on the surface of dead branching corals [substrata](#) at Sambangan Island, Karimunjawa.

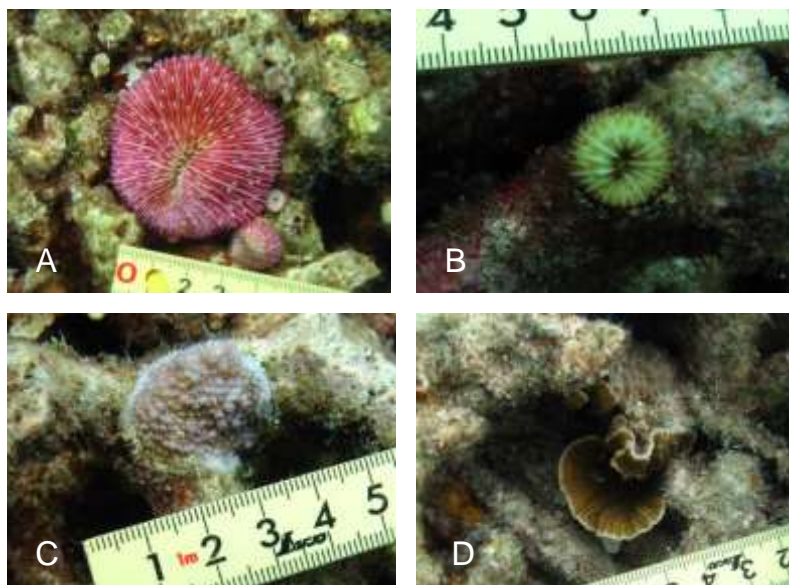


Figure 5. Coral juvenile settled on small refuge of the unstable [substrata](#) at Sambangan Island, Karimunjawa (A. Juvenile Fungia in various stages; B. Juvenile Fungia; C. Acropora; D. Montipora)

Table 1. Generic composition of coral juvenile (Scleractinia) on the dead massive coral [substrata](#) in the reef flat of Genting Island, Karimunjawa. The number of juvenile corals and its proportion (%) in each genus are shown.

No	Family	Genera	Number (% Occurrences)
1	Acroporidae	Acropora	111 (47.6)
2	Acroporidae	Montipora	16 (6.86)
3	Acroporidae	Astreopora	1 (0.43)
4	Pocilloporidae	Pocillopora	17 (7.3)
5	Poritidae	Porites	47 (20.2)
6	Faviidae	Favites	24 (10.3)
7	Faviidae	Favia	5 (2.14)
8	Faviidae	Goniastrea	1 (0.43)
9	Faviidae	Cyphastrea	1 (0.43)
10	Oculinidae	Galaxea	8 (3.4)
11	Agariciidae	Pavona	1 (0.43)
12	Mussidae	Labophyllia	1 (0.43)
			233

Table 2. Generic composition of coral juvenile (Scleractinia) on dead branching coral [substrata](#) in the reef flat of Sambangan Island, Karimunjawa. The number of juvenile corals and its proportion (%) in each genus are shown.

No	Family	Genera	Number (% Occurrences)	
			ST-2	ST-3
1	Acroporidae	Acropora	8 (13.5)	10 (35.7)
2	Acroporidae	Montipora	11 (18.6)	16 (57.1)
3	Faviidae	Favites	1 (1.7)	-
4	Faviidae	Pachyseris	1 (1.7)	-
5	Fungidae	Fungia	33 (55.9)	1 (3.6)
6	Oculinidae	Galaxea	5 (8.5)	1 (3.6)
			59	28

Composition of juvenile corals on different morphotypes of substrate at Karimunjawa Archipelago (Java Sea), Indonesia

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ABSTRACT

Patterns of coral recruitment are partially explained by fitness consequences of substrate selection, and may be affected by substrate morphology. This study examined juvenile coral assemblages on morphologically different dead coral substrate in shallow water reefs (4-5 m) at Karimunjawa Island, Java Sea (Indonesia). Surveys on juvenile corals were performed using 0.5×0.5 m transects on two different morphotypes of natural substrate; tabular dead corals (stable) and branching dead corals (unstable). Results showed that the morphological characteristics of dead coral substrate had a significant influence on the generic composition of juvenile corals. Coral recruits on tabular dead coral substrate (stable) which composed micro-cervices was more diverse than on branching dead coral substrate (unstable). Juvenile corals of the genus *Acropora* were dominant on (exposed microhabitats of) tabular dead coral substrate, while those of the genus *Fungia* and *Montipora* were dominant on (cryptic microhabitats of) branching dead coral substrate. These results suggest that Acroporid juveniles can be settled to the various morphotype of the substrate, thus the distribution pattern of juvenile corals in shallow reef Karimunjawa may correlated with the distribution pattern of natural substrates.

Keywords: juvenile, microhabitat, dead coral, [substrate](#) Karimunjawa Archipelago

Introduction

Coral Recruitment is the basic information to determine the pattern of distribution of hard coral in coral reef area. Recruitment of coral can be interpreted as a hard coral larval settlement success to happen deposition process to form the skeleton on the substrate surface and last up to a certain period (Wallace, 1985; Harrison & Wallace, 1990). Recruitment of hard corals (Scleractinia) varies between locations (spatial), the type of substrate and occurs seasonally or temporally (Dunstan & Johnson, 1998). Larval recruitment is essential processes for coral population maintenance and reef recovery. Coral larval settlement which succeeds is determined by its behavior in the planktonic stage and surface structure of the substrate (Babcock & Mundy, 1996; Nozawa, 2010). Coral larvae are generally settled to the bottom of the substrate (Harriott & Fisk, 1987), and settled on micro-crevices (Nozawa, 2008, 2012) and also on the sub-cryptic settlement microhabitat (Arnold et al., 2010). A microhabitat considerably as protective refuges for coral recruits by fish and invertebrate predation (Harriott, 1983; Babcock & Mundy, 1996; Edmunds et al., 2014; Doropoulos et al., 2016). Micro-crevices considerably influence coral settlement and early post settlement survival (Nozawa, 2008, 2010; Nozawa et al., 2010; Edmunds et al., 2014) and the ability of microhabitat selection by coral larvae is also influenced by the species and life form of corals (Babcock & Mundy, 1996).

In the present study, we examined composition of coral recruits on different morphotypes of substrate at the reefs of Karimunjawa Archipelago, Java Sea. Natural substrates of Karimunjawa reef flat are mostly composed by two different dead coral structures due to physical disturbance during west monsoonal storm (Nababan et al., 2010; Tomascik et al., 1997) i.e. branching dead corals and tabular dead corals. Branching dead corals as unstable substrates which are found in west Sambangan Island reef while tabular dead corals are stable substrates and available in east Genting Island reef. Branching dead corals are generally assorted form made of broken dead coral, rubble and cemented together by CCA (Crustose Coralline Algae) and their surface structure is characterized as plain surfaces (cryptic microhabitats) while their surface of tabular dead corals generally composed by micro-crevices (exposed microhabitats). Previous study indicated that varied in mechanical stability (stable vs. unstable) substrates influence settlement structure (Yadav et al., 2016). The results are

needed to the underlying knowledge of the vulnerability to physical disturbance in structuring coral communities of Karimunjawa (Java Sea).

Materials and Methods

The survey of coral recruitment on different morphotypes of substrate were performed in 3 (three) station which is 2 (two) stations in natural branching dead corals substrates (unstable substrate) of west Sambangan Island, and one station as natural tabular dead corals (stable substrate) in the east side of Genting Island, Karimunjawa Archipelago (Figure 1). In order to determine these natural substrates, has been examined in the reef flat by Swim Time method. Subsequently, square transect of 0.5 X 0.5 m were applied at a depth of 4-5 m to observed juvenile corals. A total of 49 square transects have been observed in stable substrate of Genting Island (ST-1; 5° 50' S, 110° 37' E), while for observations on unstable substrates of Sambangan Island in Station 2 (ST-2; 5° 50' S, 110° 34' E) totally 6 square transects and totally 8 square transects in station 3 (ST-3; 5° 50' S, 110° 35' E). Juveniles of hard coral measuring ≤ 5 cm (using a scale/ruler) contained in the squared transects photographed using Underwater Digital Camera Canon G-10. Identification of juvenile hard coral genus (Scleractinia) made from digital images taken at the time -scale survey with the help of computer software. Determination types of juvenile hard coral genus undertaken to follow Veron (2000). Coral juvenile density data that found in the transects are then calculated by using the formula of Odum (1971) that the number of juvenile corals per unit area.

Result and Discussion

Composition of juvenile corals on tabular dead coral substrate

A total 233 juvenile corals (Scleractinia) were observed on natural tabular dead corals (stable substrate) in the east Genting Island. The highest density of coral recruits was 24 colonies/transect (0.5 X 0.5 m) with an average density of 4.76 juvenile/transect. Seven family and twelve genera were found in the stable substrates, including Acroporidae, Pocilloporidae, Poritiidae, Faviidae, Oculinidae, Agariciidae, and Mussidae (Table 1). While genera of juvenile corals were found in stable substrate as follows Acropora, Montipora, Astreopora, Pocillopora, Porites, Favia, Favites, Goniastrea, Cyphastrea, Galaxea, Pavona, Lobophyllia. Most of juvenile corals were

found on the stable substrate Family Acroporidae especially genus Acropora is about 47.6% (Figure 2). Subsequently, Porites (20.2 %), Favites (10.2%), Pocillopora (7.2%), Montipora (6.9%) and Galaxea (3.4%) are found in the stable substrates.

Corals recruits were settled on the surface of natural tabular dead corals which composed more micro-cervices. Acropora juveniles generally showed planar growth and grew initially by budding daughter polyps in a small hole (cryptic) and microhabitat, and then the encrusting Acropora grew to branching form in open surfaces of substrate. The results indicated that dead table corals substrate is highly preferred by coral recruits because their composition of more micro-crevices (Nozawa et al., 2010). This study also showed that the natural tabular dead corals substrate is composed many genera of coral recruits (Figure 3).

Composition of juvenile corals on branching dead coral substrate

A total of 59 colonies and 28 colonies of juvenile hard corals (Scleractinia) respectively observed on natural branching dead corals substrates (unstable substrate) of west Sambangan Island in Station 2 and Station 3 Sambangan Island. The highest density of corals recruit was 17 colonies/transect (0.5 X 0.5 m), while the average density of corals recruit in Station 2 (9.8 colonies/transect) was higher than in Station 3 (3.5 colonies/transect). Six family were found in Station 2, while four family were recorded in Station 3. Family of juvenile corals which found in Station 2 is Acroporidae, Faviidae, Fungiidae, and Oculinidae, while in Station 3 is Acroporidae, Fungiidae, and Oculinidae (Table 2). Generic composition of coral juvenile in both station of Sambangan Island showed a similar which is Acropora, Montipora, Fungia and Galaxea (Figure 4).

Branching dead corals substrates in west Sambangan Island are generally assorted form made of broken dead coral, rubble and cemented together by CCA and their surface structure is characterized as plain surfaces and frequently covered by turf algae and dominated by specific generic. Consequently, density of juvenile corals which settled on branching dead coral substrate (unstable) is lower than density of coral recruits on stable substrate and the coral recruits were dominated by coral mushroom Fungia and coral foliose Montipora (Figure 5). The results confirmed to Yadav et al. (2016) that structure on reef varied in mechanical stability and substrat composition.

Coral larvae may select microhabitat based on the surface structure and substrate composition (Nozawa, 2008; Yadav et al., 2016). Surface structure of branching dead corals substrates generally plain and covered by turf algae rather than tabular dead coral composed by micro-crevices. The surface structure of tabular dead coral enhanced both settlement rate and survival rate of juvenile coral (Nozawa, 2008). Coral larvae behavior were similar among species while larval size is varied among taxa (Whalan et al., 2016), suggesting surface structure had influence taxa composition in coral settlement. Solitary coral *Fungia* is generally gonochoric brooder (Loya et al., 2012), produce larvae had high tolerance to elevated temperature stress (Baria et al., 2015) and can recruit locally. The results of this study indicate that the solitary coral (free-living) *Fungia* has settlement preferences on to microhabitat under surface and cryptic of branching dead corals substrates while branching coral *Acropora* prefer microhabitat on the upper surface of the tabular dead coral substrates.

Conclusion

Coral recruits on tabular dead coral substrate (stable) which composed micro-crevices was more diverse than on branching dead coral substrate (unstable). Juvenile corals of the genus *Acropora* were dominant on (exposed microhabitats of) tabular dead coral substrate, while those of the genus *Fungia* and *Montipora* were dominant on (cryptic microhabitats of) branching dead coral substrate. The results suggest that Acroporid juveniles can be settled to the various morphotype of the substrate, thus the distribution pattern of juvenile corals in shallow reef Karimunjawa may correlated with the distribution pattern of natural substrates.

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References

- Arnold, SN and RS Steneck. 2011. Settling into an Increasingly Hostile World: The Rapidly Closing "Recruitment Window" for Corals. *PLoS ONE* 6(12): e28681.
- Babcock, R. and C. Mundy. 1996. Coral recruitment: Consequences of settlement choice for early growth and survivorship in two scleractinians. *J. Exp. Mar. Biol. Ecol.*,206:179-201.
- Baria MVB, Kurihara H, Harii S. 2015. Tolerance to elevated temperature and ocean acidification of the larvae of the solitary corals *Fungia fungites* (Linnaeus, 1758) and *Lithophyllon repanda* (Dana, 1846). *Zool Sci.* 32:447-454
- Doropoulos C, Roff G, Bozec YM, Zupan M, Werninghausen J, Mumby PJ. 2016. Characterizing the ecological trade-offs throughout the early ontogeny of coral recruitment. *Ecol Monogr* 86:20-44
- Edmunds PJ, Nozawa Y, Villanueva RD. 2014. Refuges modulate coral recruitment in the Caribbean and the Pacific. *J Exp Mar Bio Ecol* 454:78-84.
- Dunstan, P. K. and C.R. Johnson. 1998. Spatio-temporal variation in coral recruitment at different scales on Heron Reef, southern Great Barrier Reef. *Coral Reefs*, 17:71-81.
- Harriott, V.J. 1983. Reproductive seasonality, settlement, and post-settlement mortality of *Pocillopora damicornis* (Linnaeus), at Lizard Island, Great Barrier Reef. *Coral Reefs*, 2:151-157.
- Harriott, V.J. and D.A. Fisk. 1987. A comparison of settlement plate type for experiments on the recruitment of Scleractinian corals. *Mar. Ecol. Prog. Ser.*, 37: 201-208.
- Harrison, P.L. and C.C. Wallace. 1990. Reproduction, dispersal and recruitment of scleractinian coral. *In* Z. Dubinsky (ed): *Ecosystem of the world Vol. 25, Coral reefs*, pp. 133-207. Elsevier, Amsterdam.
- Loya Y, Munasik M, Hirose M, Sakai K. 2012. The solitary coral *Fungia fungites* is a gonochoric brooder. *Proc. 12th Int Coral Reef Symp.* 12:263
- Nababan MG, Munasik, Yulianto I, Kartawijaya T, Prasetya R, Ardiwijaya RL, Pardede ST, Rohmani S, Mulyadi, Syaifudin Y. 2010. Status ekosistem di Taman Nasional Karimunjawa. *Wildlife Conservation Society-Indonesia Program. Bogor* 78pp.
- Nozawa, Y. 2008. Micro-crevice structure enhances coral spat survivorship. *J Exp Mar Bio Ecol.* 36:127-130.
- Nozawa Y. 2010. Survivorship of fast-growing coral spats depend less and refuge structure: the case of *Acropora solitaryensis*. *Galaxea* 12(1):31-36.

- Nozawa, Y. 2012. Effective size of refugia for coral spat survival. *J Exp Mar Bio Ecol.* 413:145-149.
- Nozawa, Y. Tanaka K, Reiner DJ. 2010. Reconsideration of the surface structure of settlement plates used in coral recruitment studies. *Zool Stud* 50:53-60
- Tomascik, T. 1991. Settlement pattern of Caribbean scleractinian coral on artificial substrate along eutrophication gradient, Barbados, West Indies. *Mar. Ecol. Prog. Ser.*, 77:261-269.
- Tomascik T, Mah AJ, Nontji A, Moosa MK. 1997. The ecology of Indonesian Sea. Periplus Editions. Singapore. 637pp
- Veron, J.E.N. 2000. *Corals of the World*. Vol. III. Australian Institute of Marine Science and CRR Qld Pty Ltd., Queensland. 490pp.
- Wallace, C.C. 1985. Seasonal peaks and annual fluctuations in recruitment of juvenile scleractinian corals. *Mar. Ecol. Prog. Ser.*, 21: 289-298.
- Whlan S, Abdul Wahab MA, Sprungala S, Poole AJ, de Nys R. 2015. Larval settlement: The role of surface topography for sessile coral reef invertebrates. *PLoS ONE* 10(2): e0117675
- Yadav S, Rathod P, Alcoverro T, Arthur R. 2016. "Choice" and destiny: the substrate composition and mechanical stability of settlement structures can mediate coral recruit fate in post-bleached reefs. *Coral Reefs* 35:211-222.

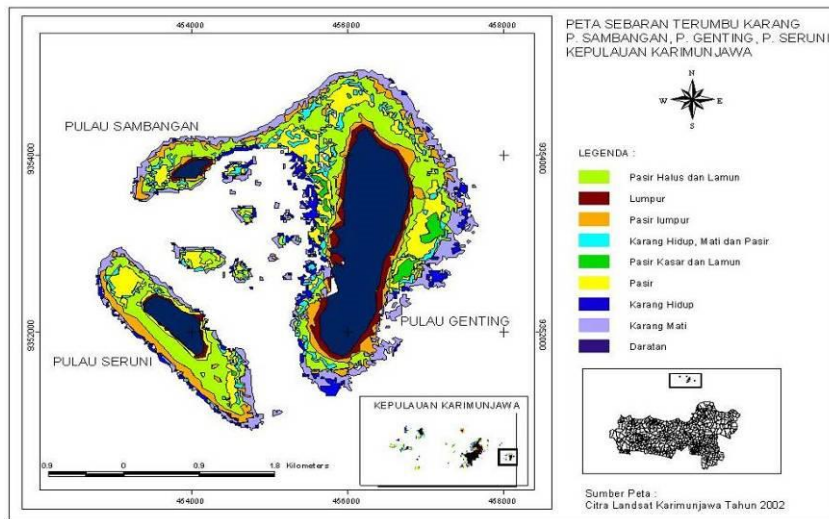


Figure 1. Study site at Genting Island and Sambangan Island, Karimunjawa Archipelago, Indonesia

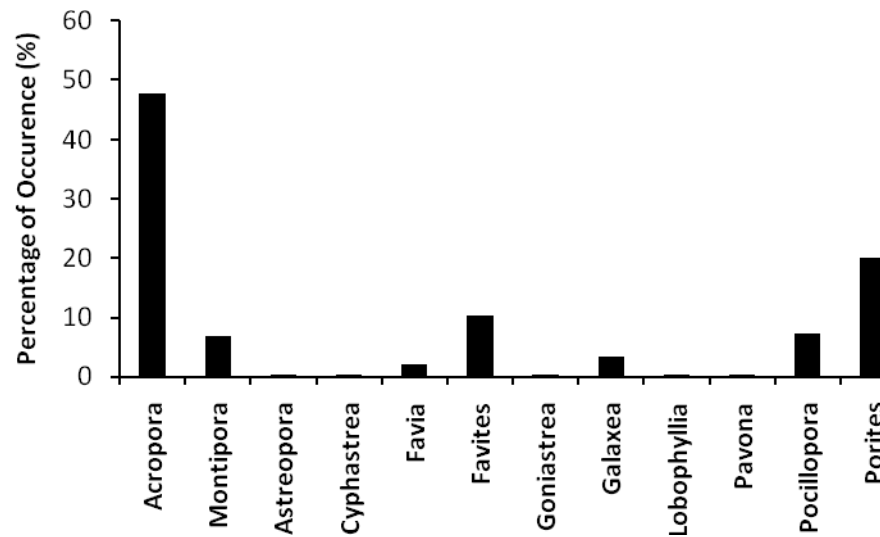


Figure 2. Percentage occurrence of coral juvenile on the surface of stable substrate at Genting Island, Karimunjawa.

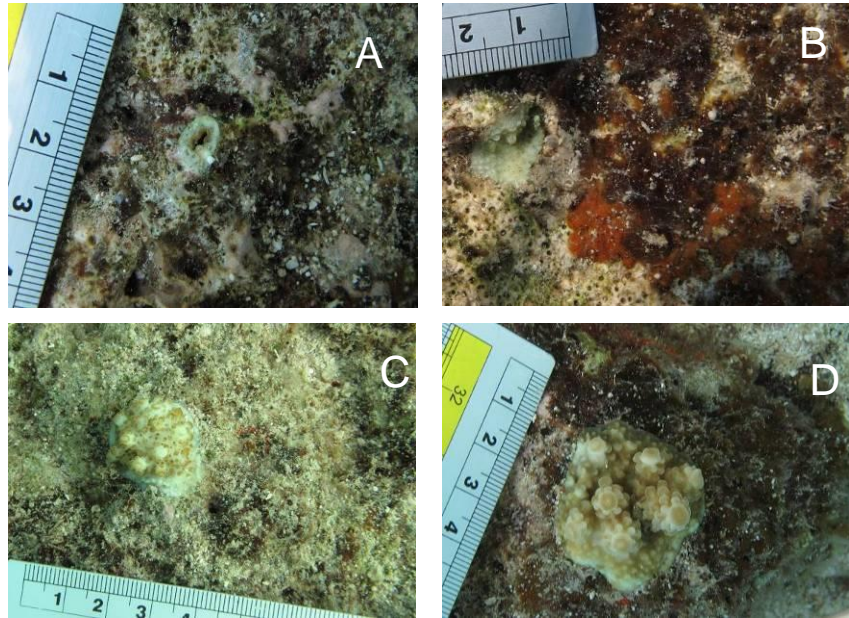


Figure 3. Juvenile *Acropora* settled on the dead massive corals substrate on the small hole (2A) and small refuge (2B), after survived and then growing to make some small branches (2C, 2D).

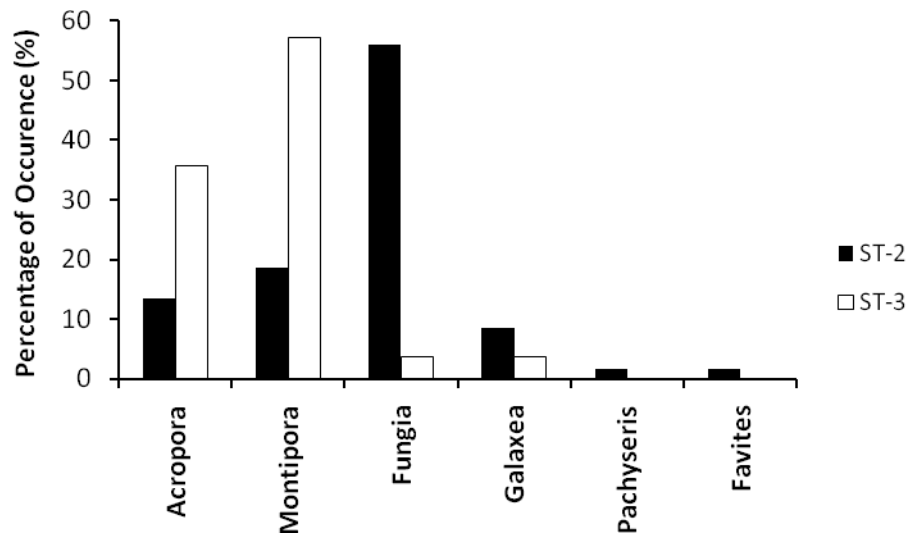


Figure 4. Percentage occurrence of coral juvenile on the surface of dead branching coral substrate at Sambangan Island, Karimunjawa.

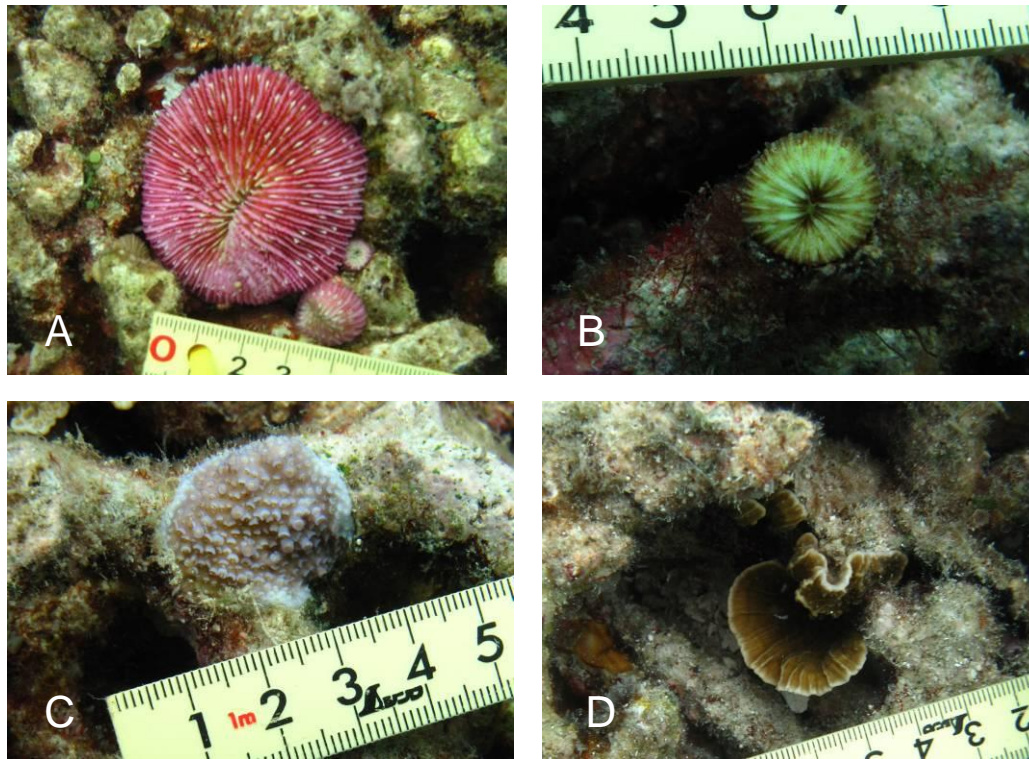


Figure 5. Coral juvenile settled on small refuge of the unstable substrate at Sambangan Island, Karimunjawa (A. Juvenile *Fungia* in various stages; B. Juvenile *Fungia*; C. *Acropora*; D. *Montipora*)

Table 1. Generic composition of coral juvenile (Scleractinia) on the dead massive coral substrate in the reef flat of Genting Island, Karimunjawa. The number of juvenile corals and its proportion (%) in each genus are shown.

No	Family	Genera	Number (% Occurrences)
1	Acroporidae	<i>Acropora</i>	111 (47.6)
2	Acroporidae	<i>Montipora</i>	16 (6.86)
3	Acroporidae	<i>Astreopora</i>	1 (0.43)
4	Pocilloporidae	<i>Pocillopora</i>	17 (7.3)
5	Poritidae	<i>Porites</i>	47 (20.2)
6	Faviidae	<i>Favites</i>	24 (10.3)
7	Faviidae	<i>Favia</i>	5 (2.14)
8	Faviidae	<i>Goniastrea</i>	1 (0.43)
9	Faviidae	<i>Cyphastrea</i>	1 (0.43)
10	Oculinidae	<i>Galaxea</i>	8 (3.4)
11	Agariciidae	<i>Pavona</i>	1 (0.43)
12	Mussidae	<i>Labophyllia</i>	1 (0.43)
			233

Table 2. Generic composition of coral juvenile (Scleractinia) on dead branching coral substrate in the reef flat of Sambangan Island, Karimunjawa. The number of juvenile corals and its proportion (%) in each genus are shown.

No	Family	Genera	Number (% Occurrences)	
			ST-2	ST-3
1	Acroporidae	Acropora	8 (13.5)	10 (35.7)
2	Acroporidae	Montipora	11 (18.6)	16 (57.1)
3	Faviidae	Favites	1 (1.7)	-
4	Faviidae	Pachyseris	1 (1.7)	-
5	Fungidae	Fungia	33 (55.9)	1 (3.6)
6	Oculinidae	Galaxea	5 (8.5)	1 (3.6)
			59	28