Post west monsoon planulae recruitment in damaged coastal corals of Panjang Island, Jepara, Central Java, Indonesia

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Abstract. Successfulness of planulae metamorphosis to become juveniles introduced succession toward the formation of a new coral community following a stress. This study is therefore, aimed to evaluate the recovery of coastal coral community in Panjang Island after west monsoon based upon several variables of water quality, recruitment through the succession stages, survivorship and the overall growth of the coral. During the first week of June 2013 until the end of October 2013, six collector devices were immersed between the slope and plain of continental shelf at the north, south and eastward of Panjang Island at 1.5 m depths. Data collected comprised of bacteria, floristic and faunistic macro- and micro-periphyton including planulae and coral juveniles, along with salinity, temperature, depth, turbidity, dissolved oxygen, orthophosphate and nitrate of the water, as well as inorganic and organic content of the sediment. Recorded genera in the collection were *Porites, Acropora, Pocillopora* and *Platygyra.* Results suggested that coastal coral in Panjang Island inclined to extinct, in particular due to the severe sedimentation load. Planulae recruit considered low with metamorphosis ability to become juveniles only at 5 colonies.m^{-2}.$month^{-1}$ at the southward and 1.3 colonies.m^{-2}.$month^{-1}$ at the northward of the island. On the other hand, dissolved organic materials in the sediment which may support the diversity of bacteria, floral- and faunal periphyton, may also prompt the increase of nitrate to cause macroalgal bloom, which in turn may cover the whole coral surface and induced the spread of pathogenic bacteria, i.e., *Pseudomonas* sp and *Phormidium coralyticum* amongst the recruited planulae.

Key Words: Damaged coral, periphyton, pathogenic bacteria, planulae recruitment

Introduction. Coastal coral community prone to environmental stresses; in one hand the stressors served as a forcing function to survive and form the community accordingly as it may alter community structure of the reef. On the other hand, although stress composed of factors that formed and upgraded coral resilience, chronic stress obviously intensified acute defect, which may be detrimental, leaving the diversity of remained species to restructure the system. Planulae recruit is therefore the main concern to recover reef damages.

Bachtiar (2011) reported that survived biological structure of a reef could become the most important seed in recovering the ecosystem since the remaining component, e.g., coral species, fish and other biotic species will be the direct succession of the new coral community. The better the remnant, the more similar the recovered community will be. Remnant may provide attachment preference for benthic organisms including planulae and indeed served as nursery ground, even a habitat, for various species. Jepara in Central Java has some remnants of coastal reefs; the one in Panjang Island is in a state of disrepair.

Recruitment is obviously not a mere process against the dynamic of physical, chemical and biological factors. Larval dispersion over dead coral and on other natural collectors marked the commencement of young juveniles. This is thus important for both local decolonization (Pearson 1981) as well as the study of community interconnectivity. Involved within these seral stages are successive courses of microorganisms to survive and thrive, including the meroplanktonic planulae. The whole process provides information regarding response of a particular coral community against physical, chemical, as well as biological stresses, such as sedimentation, hurricane, overgrazing, predation or coral bleaching phenomenon (Hughes 1994). For which, this study aimed to evaluate the decolonization development in a damage coastal coral community in Panjang Island Jepara following post west monsoon, based on some physical and chemical variables along with observation on the seral stages, including survivorship and growth of planulae along a time gradient.

Material and Method

Assessment of coral reef condition. Three stations were established in the southward (06°34’44.21”S 110°37’44.25”E), northward (06°34’21.38”S 110°37’36.71”E) and eastward of Panjang Island (06°34’30.33”S 110°37’53.77”E) from the first week of June to the end of October 2013 (Figure 1). Evaluation of reef condition after previous season was conducted at the beginning of the study (June 2013), by referring its coral coverage to the work of Gomez & Yap (1988). Coral identification was observed by means of Line Intercept Transect (LIT) method (English et al 1994; Veron 1995) on three transect lines of 30 m each held parallel to the coastline in each station.

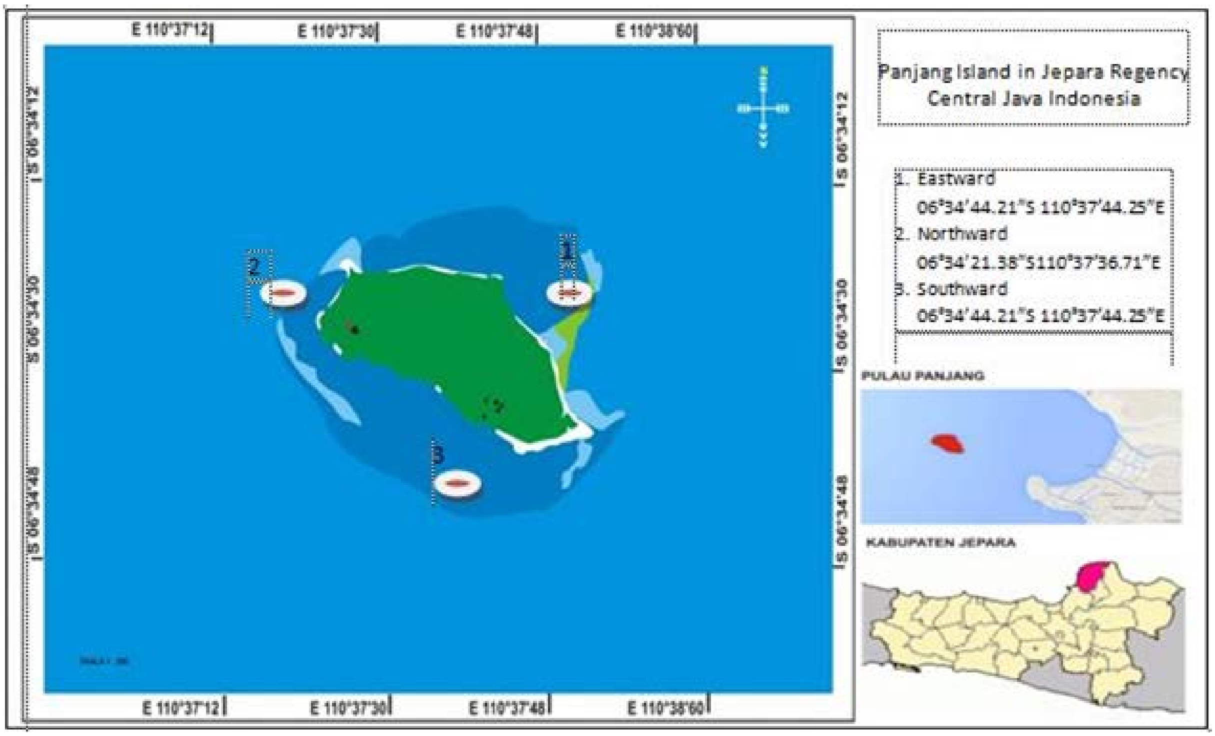

Figure 1. Panjang Island in Jepara Regency, Central Java, Indonesia.

Bacteria and periphyton sampling. Throughout the course of the study, set of 6 material collectors made of natural slate (15 x 15 cm; Figure 2) was set up in the slope of each station. The first sampling was conducted after 3 weeks submersion in the water. Therefore, thoroughly, week counted started at week III and collectors were sampled twice a week for three weeks thereafter.

Samples of planulae were taken by scraping an area of 5 x 5 cm from the slate into a wide-mouth bottle. Under aseptic condition, samples were then separated for periphyton analyses, i.e., fixed with Lugol, whilst for bacteria analyses samples were put into polyethylene plastic bag (Whirpak Nasco, USA) and kept in the cool box for further processes as soon as possible.

Pure bacteria cultures obtained from streak method were used to identify bacteria strain by observing morphological features of the colony followed by biochemical tests (oxidative test, catalase, Hugh-Leison test, H_2S, indol, methyl red, Vogen-Proskauer test, nitrate reduction, citrate, sugar, decarboxylase and carbohydrate hydrolysis) according to Holt et al (1994).

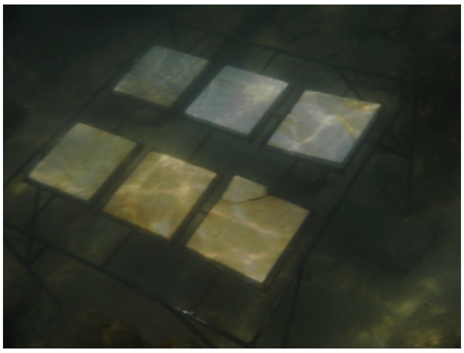

Figure 2. Slate collector used in the present study.

Sedimentation rate was measured by placing sediment traps sampled every 3 weeks. Meanwhile, water temperature, salinity, pH, current speed and direction, depth, dissolved oxygen, nitrate and orthophosphate were collected fortnightly in situ by means of diving gear. Dissolved organic matter was measured in the laboratory according to Walkley & Black (1934) and Gelman et al (2011).

Data analyses. Chi square test with contingency table, coupled by correlation and regression analyses (Gomez & Gomez 1995) were used to access the relationship between studied biota against the changeable physical and chemical factors in the area.

Results

Table 1 shows that, according to Gomez & Yap (1988) coral reef in Panjang Island is indeed not in a good , explained by its low coral coverage (<25%).

Table 1

Coral cover percentages in Panjang Island, Jepara

Specification	*Southward*		*Northward*		*Eastward*	
	Plain	*Slope*	*Plain*	*Slope*	*Plain*	*Slope*
Live coral	10.2%	19.9%	2.4%	6.2%	0%	1.2%
Dead coral	53.2%	53.8%	74.3%	46.5%	4.9%	13%
Biotic non-coral (Crustose algae)	5.8%	6.1%	6.0%	18.7%	26.2%	23.2%
Abiotic (sand. rubble)	30.8%	20.2%	17.3%	28.6%	68.9%	62.6%
Total	100%	100%	100%	100%	100%	100%

In southward plain of Panjang Island, *Acropora* and *Porites* dominated a community comprise of *Platygyra* and *Pocillopora*. This community has a low diversity index, i.e., 1.12 and is considered low in stability (Table 2). In southward slope however, among the genera found were *Porites, Platygyra, Pocillopora, Favites, Pavona, Goniastrea* and *Acropora*, which again is dominated by *Porites*, has a slightly higher diversity index, i.e., 1.52, yet still indicates a low stability (Table 2). These findings were 10 to 15 % lower than those of Hafiz (2012) and Wismaya (2012) in the previous year; means that one year has elapsed without meaningful recovery.

Microbial samples have been collected from week III until week XVIII, results of total colonies are presented in Table 3, showing the ups and downs of four microbial species growth with an inclination to totally decline both in south- and northward of the island, yet remained high eastwardly.

Table 2
Number of colonies and diversity index (H') of coral genera in Panjang Island, Jepara

No.	*Genera*	*Plain*		*Slope*	
		n	*H'*	*n*	*H'*
1.	*Porites*	210		490	
2.	*Platygyra*	30		120	
3.	*Pocillopora*	50		50	
4.	*Favites*	-	1.12	50	1.52
5.	*Pavona*	-		70	
6.	*Goniastrea*	-		45	
7.	*Acropora*	220		130	
	Total	550		955	

It was also recorded the presence of pathogenic bacteria, i.e., *Pseudomonas* sp and *Phormidium corralyticum.* The first is a fish pathogen (Hatmanti et al 2009), whereas the latter is a pathogen causing Black Band Disease (BBD*)* in corals (Richardson 1996; Frias-Lopez et al 2003; Sabdono 2009; Sabdono et al 2015). Table 3 shown that two *Pseudomonas* sp were found in all three stations, whilst *P. corallyticum* was only found north-south of the island. Moreover, growth in *P. corallyticum* showing a similar pattern north to south, for which during the first few weeks (week III to week IX) total number of cells in the south was not significantly different to that in the north. However, when in the south cell growth started to decline, i.e., from 7.4 x 10^3 to 3.9 x 10^3 cfu/mL/cm^2 (week IX to week XII) down to zero (week XV - XVIII); the one in the north soaring to its highest number 74 x 10^3 (week XII) prior to be also decreasing in week XV (11.2 x 10^3 cfu/mL/cm^2) but not went down to zero (1.2 x 10^3 cfu/mL/cm^2, week XVIII, Table 3).

Meanwhile, *Pseudomonas bromoutilis* started growing in a much higher cell density in the south (15 - 74 x 10^3 cfu/mL/cm^2, week III to IX) than in the north (4.1 - 8.7 x 10^3 cfu/mL/cm^2, week III to IX). Indeed, *P. bromoutilis* in the north then also soaring to 87 x 10^3cfu/mL/cm^2 in week XII prior to decline following after the growth pattern of the south (week XV to XVIII; Table 3). This density pattern is not the case for *P. bromoutilis* eastward of the island, which grew steadily toward its peak in week XVIII albeit less dense compared to both the north and the south; a pattern similar to its congeneric *Pseudomonas fluorescens*, which was only found eastward of Panjang Island (Table 3).

Floristic periphyton observed mostly is microorganisms, whereas the faunistic comprised of both micro- and macro-organisms. Community structure indices upon floristic and faunistic periphyton are shown in Table 4.

In general, the average figures for microalgal diversity and evenness indices were high (>2.8), indicating a relatively stable environment in balancing interspecific competition amongst various components. Indeed, albeit insignificant, eastward diversity index were slightly higher than both, the north- and southward of the island. Data observation starting from week XV revealed that in the south, some microalgae species disappeared in week XVIII, they were *Chaetophora tuberculosa*, *Amphipleura micans, Cylindrotheca closterium, Diplopsalis lenticulata, Navicula membranaceae, Peridinium sphaericum* and *Zygnema insigne*. Planulae found in these stations survived from week IX to week XVIII (data available on request). Toward the end of the course in week XVIII eastward community member of microalgae periphyton stayed relatively the same; whereas succession in southward was mingled by both filamentous and crustose macroalgae.

In northward stations, only 5 out of 11 species or 45% faunistic macro-periphyton survived toward week XVIII, i.e., *Balanus improvisus, Cerithium rostratum, Macropipus arcuatus, Obelia dichotoma, Persicula minuta* and *Plumaria undulata.* Some coral planulae were found in the substrate collector, albeit only stayed for 3 weeks (week VI to week IX); at week XII they were disappeared.

Table 3

Total bacterial growth along time gradient in collector in Panjang Island Jepara

No.	Species	Total bacteria ($cfu/mL/cm^2$) in week:					
		III	*VI*	*IX*	*XII*	*XV*	*XVIII*
	Southward of Panjang Island						
1	*Bacillus firmus*	$5.6x10^3$	$6.3x10^3$	$50x10^3$	$25x10^3$	$1.2x10^3$	0
2	*Bacillus licheniformis*	$4.3x10^3$	$7.5x10^3$	$62x10^3$	$74x10^3$	$7.4x10^3$	$2.5x10^3$
3	*Micrococcus luteus*	$3.8x10^3$	$6.7x10^3$	$87x10^3$	$50x10^3$	$1.2x10^3$	0
4	*Phormidium corallyticum*	$3.7x10^3$	$5.7x10^3$	$7.4x10^3$	$3.9x10^3$	0	0
5	*Pseudomonas bromoutilis*	$15x10^3$	$37x10^3$	$74x10^3$	$74x10^3$	$11.2x10^3$	$1.2x10^3$
	Northward of Panjang Island						
1	*Bacillus firmus*	$2.5x10^3$	$8.2x10^3$	$5.0x10^3$	$74x10^3$	$2.5x10^3$	0
2	*Bacillus licheniformis*	$3.2x10^3$	$6.2x10^3$	$7.4x10^3$	$74x10^3$	$3.7x10^3$	0
3	*Micrococcus luteus*	$4.6x10^3$	$5.9x10^3$	$8.7x10^3$	$99x10^3$	$2.5x10^3$	$2.2x10^3$
4	*Phormidium corallyticum*	$2.2x10^3$	$7.7x10^3$	$7.4x10^3$	$74x10^3$	$11.2x10^3$	$2.5x10^3$
5	*Pseudomonas bromoutilis*	$4.1x10^3$	$7.4x10^3$	$8.7x10^3$	$87x10^3$	$9.9x10^3$	$2.7x10^3$
	Eastward of Panjang Island						
1	*Bacillus firmus*	$4.2x10^3$	$8.7x10^3$	$37x10^3$	$74x10^3$	$72x10^3$	$8.7x10^3$
2	*Bacillus licheniformis*	$3.7x10^3$	$6.2x10^3$	$8.7x10^3$	$9.4x10^3$	$87x10^3$	$9.9x10^3$
3	*Desulfomonas pigra*	$5.2x10^3$	$7.5x10^3$	$62x10^3$	$86x10^3$	$87x10^3$	$9.9x10^3$
4	*Nocardia* sp	0	$3.2x10^3$	$5.8x10^3$	$7.2x10^3$	$34x10^3$	$62x10^3$
5	*Pseudomonas fluorescens*	$2.5x10^3$	$6.2x10^3$	$12x10^3$	$51x10^3$	$56x10^3$	$62x10^3$
6	*Pseudomonas bromoutilis*	0	0	$2.2x10^3$	$7.4x10^3$	$8.4x10^3$	$47x10^3$

Table 4

Community structure indices of floristic and faunistic macro- and micro-periphyton recorded from the collector in Panjang Island (data available on request)

Indices of community structure	*Week*					
	III	*VI*	*IX*	*XII*	*XV*	*XVIII*
Southward of Panjang Island						
Floristic periphyton						
Diversity Index	2.75	2.88	2.96	2.97	2.59	2.43
Evenness Index	0.95	0.96	0.99	0.99	0.90	0.98
Abundance (individual/cm^2)	107,586	212,670	322,758	325,260	155,124	40,032
Number of Species	18	20	20	20	18	12
Faunistic periphyton						
Diversity Index	1.74	2.36	2.43	2.33	1.79	1.36
Evenness Index	0.97	0.98	0.98	0.94	0.92	0.85
Abundance (individual/cm2)	22,518	77,562	75,060	52,542	30,024	25,020
Number of species	6	11	12	12	7	5
Northward of Panjang Island						
Floristic periphyton						
Diversity index	2.91	2.94	2.98	2.95	2.69	2.43
Evenness index	0.97	0.98	0.99	0.98	0.90	0.98
Abundance (individual/cm^2)	105,084	205,164	292,734	310,248	220,176	40,032
Number of species	20	20	20	20	20	12
Faunistic periphyton						
Diversity index	1.36	2.01	2.19	2.11	2.05	1.62
Evenness index	0.85	0.97	3.16	0.96	0.93	0.90
Abundance(individual/cm^2)	30,024	42,534	77,562	75,060	67,554	35,028
Number of species	5	8	10	9	9	6

Indices of community structure	Week					
	III	*VI*	*IX*	*XII*	*XV*	*XVIII*
Eastward of Panjang Island						
Floristic periphyton						
Diversity index	2.51	2.83	2.89	2.96	2.96	2.93
Evenness index	0.98	0.96	0.96	0.99	0.99	0.98
Abundance (individual/cm^2)	62,550	125,100	255,204	290,232	322,758	360,288
Number of species	13	19	20	20	20	20
Faunistic periphyton						
Diversity index	1.74	1.99	2.008	2.066	2.108	2.26
Evenness index	0.97	0.95	0.97	0.94	0.96	0.98
Abundance (individual/cm^2)	22,518	45,036	97,578	105,084	102,582	135,108
Number of species	6	8	8	9	9	10

Physical and chemical variables of the water and sediments were within the optimum range for planulae, juveniles and grown up coral; yet some other within the range of direct and indirect destruction, likewise nitrate and orthophosphate. Water temperature 28.5-30^{0}C were optimum (Supriharyono 2017), salinity were at 31-32.5 ‰ of the optimum range of 31-36 ‰, clarity were up to the bottom and dissolved oxygen were at 3.61-6.53 mL/L. All these results support the aerobic conditions for optimum coral growth, periphyton respiration, as well as decomposition by the obtained aerobic bacteria. However, high-pressure variables for corals arising from both potential sedimentation and sedimentation rate (Table 5), organic content of the sediment, nitrate and orthophosphate as shown in Table 6.

Table 5

Potential sedimentation and sedimentation rate in surrounding water of Panjang Island

Week	*Panjang Island Jepara*					
	Southward		*Northward*		*Eastward*	
	Potential (mg)	*Rate (mg/cm^2/d)*	*Potential (mg)*	*Rate (mg/cm^2/d)*	*Potential (mg)*	*Rate (mg/cm^2/d)*
III	88.7	4.22	166.5	7.93	217.8	10.37
VI	79.7	3.80	176.4	8.40	264.7	12.60
IX	81.4	3.88	144.6	6.89	237.5	11.31
XII	112.9	5.38	156.4	7.45	198.7	9.46
XV	68.9	3.28	127.2	6.06	249.6	11.89
XVIII	97.8	4.66	134.8	6.42	306.6	14.60

Table 5 depicted a stable potential and relatively high rate of sedimentation in each of study sites, for which the lowest (3.28-4.66 mg/cm^2/d) was southward and the highest, was eastward (9.46-14.6 mg/cm^2/d). This excessive variable might have quite a detrimental impact to planulae recruitment (Babcock & Mundy 1996).

Table 6 further indicating significant correlation between the sediment organic content and nitrate, i.e., Y = 0.0478 + 0.0095 X (R = 0.89) southward; Y = -0.0916 + 0.0081 X (R = 0.88) northward and Y = 0.1423 + 0.0041 X (R = 0.98) at the eastward of Panjang Island. These simple linear regressions suggesting the continue supply of nitrate resulting from decomposition of dissolved organic matter into the water column.

Present study reported that nitrate in the southward ranged from 0.276 to 0.414 mg.L^{-1}, in the northward 0.291-0.410 mg.L^{-1} and in eastward stations were from 0.375–0.530 mg.L^{-1} subsequently (Table 6), which according to Parson et al (1984) is considered very high. Active decom-position of organic matter that yielding in nitrate as nutritive product presumably gave rise to stable periphyton growth in three study sites as sampled from the collectors (Figure 3).

Table 6
Dissolved organic matter in the sediment, nitrate and orthophosphate in the water of Panjang Island every 3 weeks (21 days) during the study

Week	*Panjang Island*								
	Southward			*Northward*			*Eastward*		
	DOM (mg)	*NO_3-N (mg/L)*	*PO_4-P (mg/L)*	*DOM (mg)*	*NO_3-N (mg/L)*	*PO_4-P (mg/L)*	*DOM (mg)*	*NO_3-N (mg/L)*	*PO_4-P (mg/L)*
0-3	28.02	0.306	0.0090	51.62	0.316	0.0990	67.52	0.402	0.2462
3-6	26.30	0.276	0.0041	50.27	0.307	0.0736	95.29	0.530	0.3405
6-9	27.68	0.302	0.1821	52.78	0.328	0.1590	86.69	0.488	0.2982
9-12	34.22	0.353	0.0472	54.74	0.340	0.1620	81.47	0.489	0.3368
12-15	22.43	0.287	0.0781	44.52	0.291	0.1491	54.91	0.375	0.2721
15-18	35.20	0.414	0.1951	57.96	0.410	0.1633	85.85	0.509	0.3046

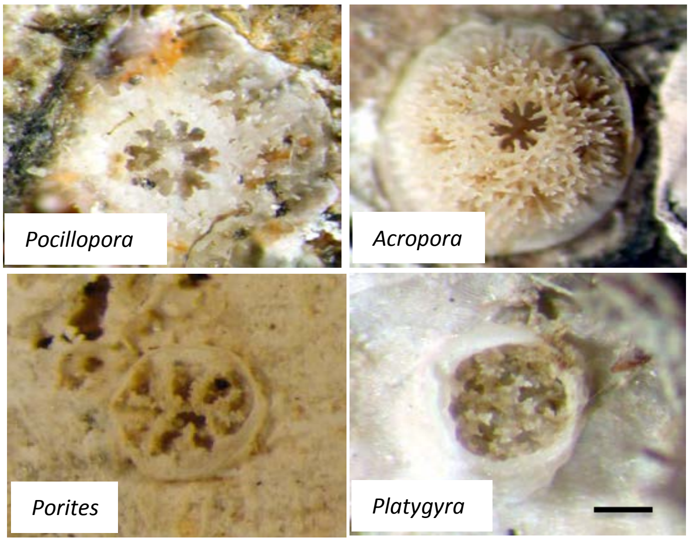

Figure 3. Juveniles of *Pocillopora*, *Acropora*, *Porites* and *Platygyra* from the collector in Panjang Island. Scale bar 1 cm.

Discussion. Coral colonization occurred through several stages depend on several environmental factors. First is reproductive success to produce ample planktonic larvae. Secondly is larval capability to identify and to attach to suitable substrates. Furthermore, settlement urged certain physical and biological requirements, such as substrate type, current speed and direction, adequacy of light, sedimentation load and availability of biofilm covering surface of the assorted substrate, which normally consisted of bacteria and diatom (Sorokin 1993; Richmond 1997).

In this study, all ingredients to produce such a biofilm are available from the bacteria community (Table 3). Kioerboe et al (2003) stated that as an important biological feature, biofilm establishment in corals commenced when organic materials is adequate to support firm attachment of bacteria and other microorganisms upon immersed solid materials, which then grow and reproduce to yield in layer of extracellular polymer called biofilm. In this work, organic material from sedimentation as nutritive source for microorganisms is abundant. At the first week of collector settlement, it brings in organic 1.38 $mg.DOM^{-1}.d^{-1}$ southward, 2.48 $mg.DOM^{-1}.d^{-1}$ northward and 3.74 $mg.DOM^{-1}.d^{-1}$ eastward of the Panjang Island (Table 6). The presence of microorganisms inevitably acts to trigger active process of decomposition, as such that the blanket attracts various periphytonic microalgae to attach. In turn, periphyton produces exudate, excrete and secret which along the decomposition process is transformed into nitrate (NO_3) and orthophosphate (PO_4).

Coral community is a fragile ecosystem, it thrives in low-nutrient environment, so high-level nutrient inevitably jeopardies the coral animals, since its space competition are weaker than macroalgae. Accordingly, Muller-Parker & D'Elia (1997) demonstrated that nitrogen directly affected coral growth, under high nitrogen concentration growth of zooxanthellae population increased. Yet, in excessive amount, nitrogen may cause inverted impact, i.e., declining the coral growth due to competition with macroalgae expansion (Paonganan 2008).

Bacterial function is imperative in ripening process of this habitat. In the present study, eight heterotrophic bacteria species belong to six genera were identified, i.e., *P. fluorescens*, *P. bromoutilis, Nocardia spp.*, *Bacillus firmus, Bacillus licheniformis, Desulfomonas pigra, Micrococcus luteus* and *P. coralyticum* (Table 3). They are able of degrading dissolved organic complex and inorganic matters to yield in short and simple materials, e.g., nitrite, nitrate and ammonia, which have important role in commencing biofilm succession (Vermeij et al 2009). In turn, the biofilm triggered the attachment course of recruited planulae.

Recruitment process in Panjang Island was very poor. In average, colonization rate was 4 colony.m^{-2}.mo^{-1} southward, even lower, only 1.0 colony.m^{-2}.mo^{-1} northward and none in the eastward of the island. Among the recruited juveniles found in the south, composition of the community was comprised of *Porites* (31.25%), *Platygyra* (12.5%), *Acropora* (25 %), *Pocillopora* (31.25%). *Acropora* (2 colony.m^{-2}.mo^{-1}, 50%) and *Pocillopora* (2 colony.m^{-2}.mo^{-1}, 50%) were the only found northward of the Panjang Island. Taking into account the dominance coverage of the two species in the north, each was 50%, in comparison to Kisworo et al (2012) whose highlighting *Pocillopora* attachment in Panjang Island, this result was significantly low. According to Kisworo et al (2012), in average *Pocillopora* has 10-12 colony.m^{-2}.mo^{-1} excluding the two dominant species in their area of study, i.e., *Acropora* and *Porites*.

Rani (2003) in Barrang Lompo, Spermonde Island, Makassar reported that peak reproduction season for *A. nobilis* ranged from August through October. Similarly, Oliver et al (1988) suggested that coral breeding occurred ca. 6 months within a year. Moreover, McGuire (1998) stated that coral species occupying areas with less varied annual temperature might reproduce the whole year. Therefore, low colony recruits at the beginning of collector placement (June-August 2013) suggesting that collectors might have yet ready as habitat for settlement due to the lack of time during assignation rather than the lack number of recruits in the water, besides, the high sedimentation rate (Table 5).

Broadcast-spawning corals like *Acropora* expel eggs and sperm, and the fertilized eggs develop into planulae in the water column. As these sessile corals generally disperse during the planktonic larval stage, their larval characteristics (e.g., survival and settlement rates) are thought to be important for their dispersal. Some studies of coral larval dispersal have focused on the maximum time that larvae can remain viable and settle. Richmond (1997) reported that after spawning, *Acropora* has only 20 days (3-4 weeks) to live their planktonic competence, whereas Pocilloporidae, which lead a different reproductive strategy, i.e., brooding and has zooxanthellae, performed a longer planktonic stage, ca. 100 days. Nishikawa & Sakai (2005) work in Japan waters recorded that the maximum settlement competency period was lower in planulae of *A. digitifera* (54 days) than in *A. tenuis* (69 days); both are much longer than the result of Richmond (1997), despite, for some species like *Acropora,* time needed for larvae to lead their planktonic life limit their competence.

Diaz-Pulido & McCook (2002) recorded that substrate in coral reef environment might be colonized quickly by filamentous algae, yet succession from filamentous algae to CCA (Crustose Corraline Algae) could take weeks even years to accomplished. Further, they stated that new substrates take 3 months to be suitable for larval attachment. On the other hand, Glynn et al (1991) reported that as a pioneer, member of the family Pocilloporidae is capable of colonizing new substrate very quickly. Besides, it spawns all year long, ample to dominate mature coral community.

Brown & Bythell (2005) suggested that mucus on the polyps' surface is vital for various matter, such as stress resisting, avoiding predation and sediment cleaning. Lenhoff (1974) identified it as high amino acid coral secretion rich in glutathione which coming into contact with organic and inorganic materials in surroundings, decomposed certain compounds that attract planulae to attach (Wilson et al 2012; Aebu & Santavy (2006) and these bacteria enriched biofilm continued to function in the polyp metabolism until post spawning and planulae replacement (Ceh et al 2012). This phenomenon is common in *Acropora tenuis, Pocillopora damicornis* and *Tubastrea fulkneri.*

In general, this study suggested that planulae recruitment is limited by various environmental factors, which in this case were the dissolved organic matters coupled by high sedimentation rate. In the sampling sites of this study, sedimentation rate ranged from 3.28 $mg.cm^{-2}.day^{-1}$ in the south to 14.6 $mg.cm^{-2}.day^{-1}$ in the east. Following Babcock & Mundy (1996), the high rate of sedimentation in their area of study, i.e., 3.1 $mg.cm^{-2}.day^{-1}$ may halt the recruitment process, either through the decomposition as well as the biological response of the planulae. Positive sign of biofilm formation was also prevented by the presence of pathogenic bacteria, *Pseudomonas spp.* and *P. coralyticum*. Hatmanti et al (2009) revealed that *Pseudomonas* sp is pathogenic in grouper, whereas *P. coralyticum* is causing BBD (Black Band Disease*)* in corals (Richardson 1996; Sabdono 2009).

Conclusions. It is shown clearly that planulae recruitment rate in Panjang Island is low and this can be explained by the poor water quality, in particular by the high rate of sedimentation. Although may also referring to the increase of nitrate to cause macroalgal bloom and induced the spread of pathogenic bacteria; the high content of organic material in the sediment is supportive to the relatively diverse communities of bacteria, floral- and faunistic periphyton, which in turn provide a better chance to produce biofilm for recruitment. However, this possibility was hampered by the exaggerated sedimentation.

Acknowledgements. We are grateful to the Faculty of Fisheries and Marine Science Diponegoro University for funding and logistic support in this study, also our sincere grateful extends to anonymous reviewers for this manuscript improvement.

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Received: 14 December 2017. Accepted: 01 February 2018. Published online: 09 February 2018.

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How to cite this article:
Purnomo P. W., Afiati N., 2018 Post west monsoon planulae recruitment in damaged coastal corals of Panjang Island, Jepara, Central Java, Indonesia. AACL Bioflux 11(1):132-142.