The association of *Cassidula nucleus* (Gmelin 1791) and *Cassidula angulifera* (Petit 1841) with mangrove in Banggi Coast, Central Java, Indonesia

[1]Dafit Ariyanto, [2]Dietriech G. Bengen, [2]Tri Prartono, [3]Yusli Wardiatno

[1] Department of Aquaculture, Faculty of Agriculture, Asahan University, Kisaran, North Sumatera, Indonesia; [2] Department of Marine Science of Technology, Bogor Agricultural - University, Dramaga, West Java, Indonesia; [3] Department of Aquatic Resources Management, Bogor Agricultural University, Dramaga, West Java, Indonesia. Corresponding authors: D. Ariyanto, dafitariyanto676@gmail.com, and D. G. Bengen, dieter@indo.net.id

Abstract. *Cassidula nucleus* and *Cassidula angulifera* utilize mangrove as habitat for living, for food procurement, for protection, and for breeding. This research was conducted from September 2016 to July 2017. The objective was to determine the relationship of gastropod distribution (*C. nucleus* and *C. angulifera*) as an indicator of mangrove and environment stability. The linkages between gastropod and characteristic of the environment were analyzed by using Principal Component Analysis (PCA) and the relationship between gastropod and mangrove using Correspondence Analysis (CA). The result showed that the total of gastropod was 4,452 ind/m^2 consisted of *C. nucleus* 2,856 ind/m^2, and *C. angulifera* 1,596 ind/m^2. The highest amount of *C. nucleus* was found on *Rhizophora apiculata* mangrove. Meanwhile *C. angulifera* was found on *R. stylosa* mangrove. The gastropod *C. nucleus* and *C. angulifera* are closely associated to the type of mangrove.

Key Words: relationship, distribution, Mollusca, sediment, diameter at breast height, DBH.

Introduction. Banggi Coast is located on North Beach of Java, Rembang Regency, Central Java, Indonesia where mangrove grows and develop such as *Rhizophora mucronata, Rhizophora stylosa, Rhizophora apiculata,* and *Sonneratia alba*. The presence of anthropogenic disturbance such as aquaculture development (Fondo & Martens 1998; Beasly et al 2005) and settlement expanding caused change in mangrove ecosystem in that area (Giesen et al 2007). Skilleter & Warren (2000) reported that the change could alter the stability of mangrove structure, individual pressure about organism distribution and abundance, and food chain.

Gastropod of Ellobiidae family *Cassidula nucleus* (Gmelin 1791) and *C. angulifera* (Petit 1841) are primitive groups dominating in tropical area. Ecologically and physiologically, this organism could perform area transition between sea and land. Ellobiidae family lives in the environment characterized by mangrove forest habitat, muddy beach, and rocky beach area (Martins 2001). Gastropods interact with physical or biological factors. Physical factors consisted of temperature, sediment type, topography of the area, and water dynamics condition (Martins 1996). Meanwhile, the biological factors with an important role consisted of larva distribution, competition, predation, and trophic level.

Mangrove ecosystem in Banggi Coast is the result of restoration conducted by the government and the society. The environment change with no mangrove, previously has created new ecosystem affecting organism distribution, both spatially and temporally. Sea organism will emerge into the new mangrove ecosystem such as gastropod with its ability to adapt. Gastropods *C. nucleus* and *C. angulifera* are the type of gastropod which can survive towards environment change (Bremner et al 2006; Bremner et al 2008).

Gastropods distribution and abundance can be used as an ecological indicator toward environment changes in mangrove ecosystems. Information about the relationship of *C. nucleus* and *C. angulifera* based on environment and mangrove characteristics is still lacking. This research was aimed to determine the distribution of gastropods *C. nucleus* and *C. angulifera* as an indicator of the environment and mangrove ecosystem stability in Banggi Coast, Rembang, Central Java, Indonesia.

Material and Method

Description of the study sites. This research was conducted from September 2016 to July 2017 in Banggi Coast, Rembang, Central Java, Indonesia (Figure 1). The location was divided into four stations based on which mangrove dominating the area: Station 1 *R. mucronata*, Station 2 *R. apiculata*, Station 3 *S. alba*, and Station 4 *Rhizopora stylosa*. Each station owns observing zones as: seaward zone, middle zone, and landward zone.

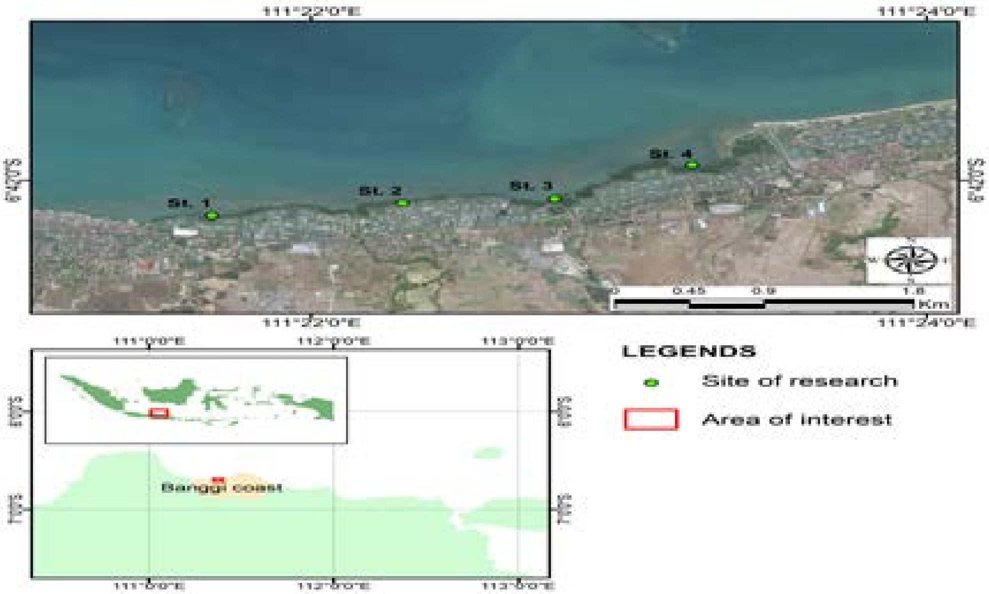


Figure 1. The location of research in Banggi Coast, Central Java, Indonesia.

Data retrieval procedure

Mangrove vegetation. This study employed 10 x 10 m square mangrove transects. Line transects were placed in each station based on type of mangrove vegetation. Each station had three sub-transects perpendicular with beach, placed 50 m in distance for each transect. The parameter related to the tree diameter was determined by using standard method for plant analyzing of Kauffman & Donato (2012). The measurement of the tree was conducted based on diameter at breast height (DBH) size >4 cm and height of 1.3 m (Ong 1982; Clough et al 1997; Kathiresan & Bingham 2001; Ong et al 2004). Vegetation measurement comprised of the type of mangrove, density and diameter size of the tree (dbh). Size of dbh was then divided into classes as following: small (<5cm), medium (5-15 cm), and big (>15 cm) (Day et al 1987; Comley & McGuinness 2005; Walters 2005).

Gastropods. Gastropod sampling was conducted by using six times square transect sized 25 x 25 cm, placed inside a transect sized 10x10 m. The sampling was conducted in September 2016, November 2016, March 2017, May 2017, and July 2017. The gastropod was located over sediment and taken when the sea was at the lowest reflux.

Environmental parameters. The environment parameter considered in this research consisted of water quality and sediment. The parameter of water quality comprised temperature, salinity, pH, and DO which was recorded by using water quality meter tool. The measurement was recorded once for each transect with one measurement. The measurements were performed in September 2016, November 2016, January 2017, March 2017, May 2017, and July 2017. Water quality measurement was conducted directly in the field. Sediment sample was taken from 10 cm depth by using a pipe. Samples were taken from each transect, in September 2016, January 2017, and July 2017.

Data analysis. The gastropod samples found in this research was identified as *C. nucleus* and *C. angulifera* according to Dharma (1988). The samples were morphometrically measured concerning length, using digital caliper with 0.1mm accuracy. The gastropods samples' species abundance was measured according to Brower et al (1990) and classified by length on each transect and harvest time. Length frequency distribution could determine the size group of gastropods *C. nucleus* and *C. angulifera* by looking at its frequency modus of shell length.

Mangrove vegetation. Mangrove vegetation measurements comprised the amount of species and density, counted with Bengen (2004) formula.

The environment parameters. Sediment sample analysis was conducted in Productivity Laboratory and Water Environment, Bogor Agricultural University, comprised organic materials and sediment texture. The organic compound measurement was conducted by using the Walkey-Black method. Meanwhile, soil texture measurement used pipet as tool.

Statistical analysis

Gastropods distribution based on environmental characteristics. The distribution of gastropods was measured via Principal Component Analysis (PCA) using Xlstat 2016 software. The analysis was used to determine the relationship of gastropods distribution as an indicator of the environment at various stations and times. The main component analysis showed graphical data, the information contained matrix data, consisted of the research stations as the individual (row) and environment variables and amount of gastropods *C. nucleus* and *C. angulifera* (small, medium, high) (column).

Mangrove and gastropods association. The association of gastropods *C. nucleus* and *C. angulifera* with mangrove used the Correspondence Analysis (CA). Analysis on row data matrix (gastropods category; small, medium, big) and column (mangrove type and density) purposed to discover the association between gastropods *C. nucleus* and *C. angulifera* with mangrove stability condition. This analysis was conducted using Xlstat 2016 software.

Results and Discussion

The density and DBH of mangroves. The density and DBH of mangrove on this research were the result of the re-cultivation from 1976. It is showed that each area/station has one type of dominating-mangrove (Table 1). Generally, three sampling locations showed a pretty-high density, especially at stations 1, 2, and 4. Contrary, the lowest density was recorded at station 3. The decreasing of mangrove density was caused by woodcutting activity towards usable mangrove to be materials for building, firewood, and fishponds. The mangrove density at stations of 1, 2, and 4, were around 33-43 tree/100 m^2 (3,300-4,300/ha) and categorized as good well at density of tree/ha >1,500. The diameter of the tree (DBH) showed that the trees were of the medium size. The medium size DBH was mostly recorded in stations 2 and 4. Meanwhile, the station 3 was dominated the big size DBH (Table 1).

Table 1

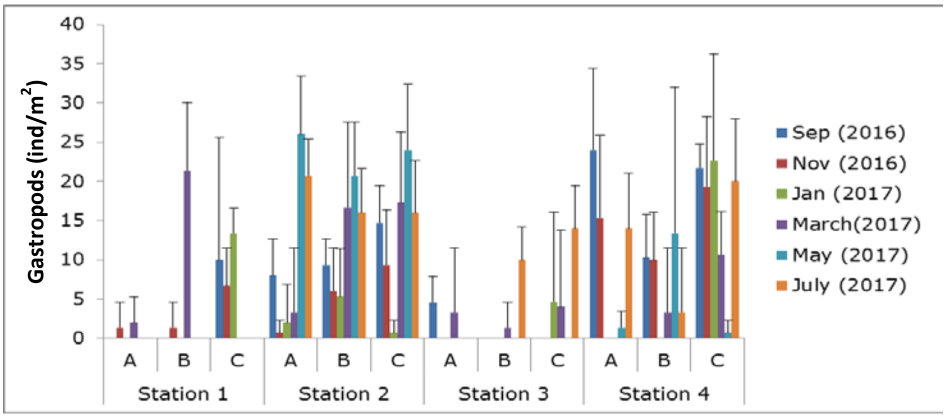
Density (trees/100 m^2) and DBH of mangroves (cm)

Station	Mangrove	Density (Individuals)	DBH (cm)		
			Small (4-4.9)	Medium (5-14.9)	Large (>15)
1	*R. mucronata*	33±6	9±15	23±12	1±1
2	*R. apiculata*	44±15	6±8	38±8	0
3	*S. alba*	4±2	1±1	1±1	3±3
4	*R. stylosa*	43±8	2±2	37±7	4±1

DBH - diameter at breast height.

The abundance of gastropods C. nucleus and C. angulifera. The abundance of gastropods *C. nucleus* and *C. angulifera* showed different abundance at each stations, according to flux-and-reflux zone type, and according to the time ofprevalence (Figure 2a and 2b). This research found 4,452 ind/m^2 gastropods in total, consisted of 2,856 ind/m^2 *C. nucleus* and 1,596 ind/m^2 *C. angulifera*. The abundance of gastropods *C. nucleus* and *C. angulifera* had the different amount at each station (Figure 2a and 2b). The highest abundance of *C. nucleus* was located at station 2. Meanwhile, *C. angulifera* showed the highest abundance at station 4. Based on flux-and-reflux zone type, the highest to the lowest abundance of *C. nucleus* and *C. angulifera* in the sequence was zona C (landward) > zona B (middle) > zona A (seaward).

(2a)



(2b)

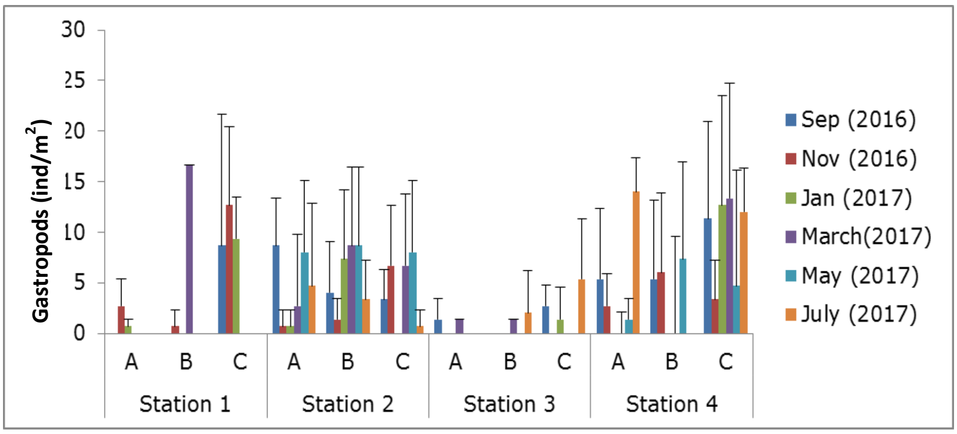


Figure 2. Gastropods abundance of *Cassidula nucleus* and *C. angulifera* based on station, zone and time at Banggi Coast Rembang, Central Java, Indonesia (A - seaward zone, B - middle zone, C - landward zone).

The distribution of C. nucleus and C. angulifera length. The distribution of gastropods *C. nucleus* and *C. angulifera* size has spatial and temporal distribution (Figure 3a and 3b). The highest distribution of *C. nucleus* was found at station 2 and of *C.*

angulifera was found at station 4. The largest *C. nucleus* gastropods was found at station 2 (sized >25.62 mm) meanwhile the dominating size was 17.4 to 19.0 mm (160 ind/m^2). The largest *C. angulifera* were found at station 4 (>26.31 mm) meanwhile the dominating size was 16.82 to 19.82 mm (76 ind/m^2).

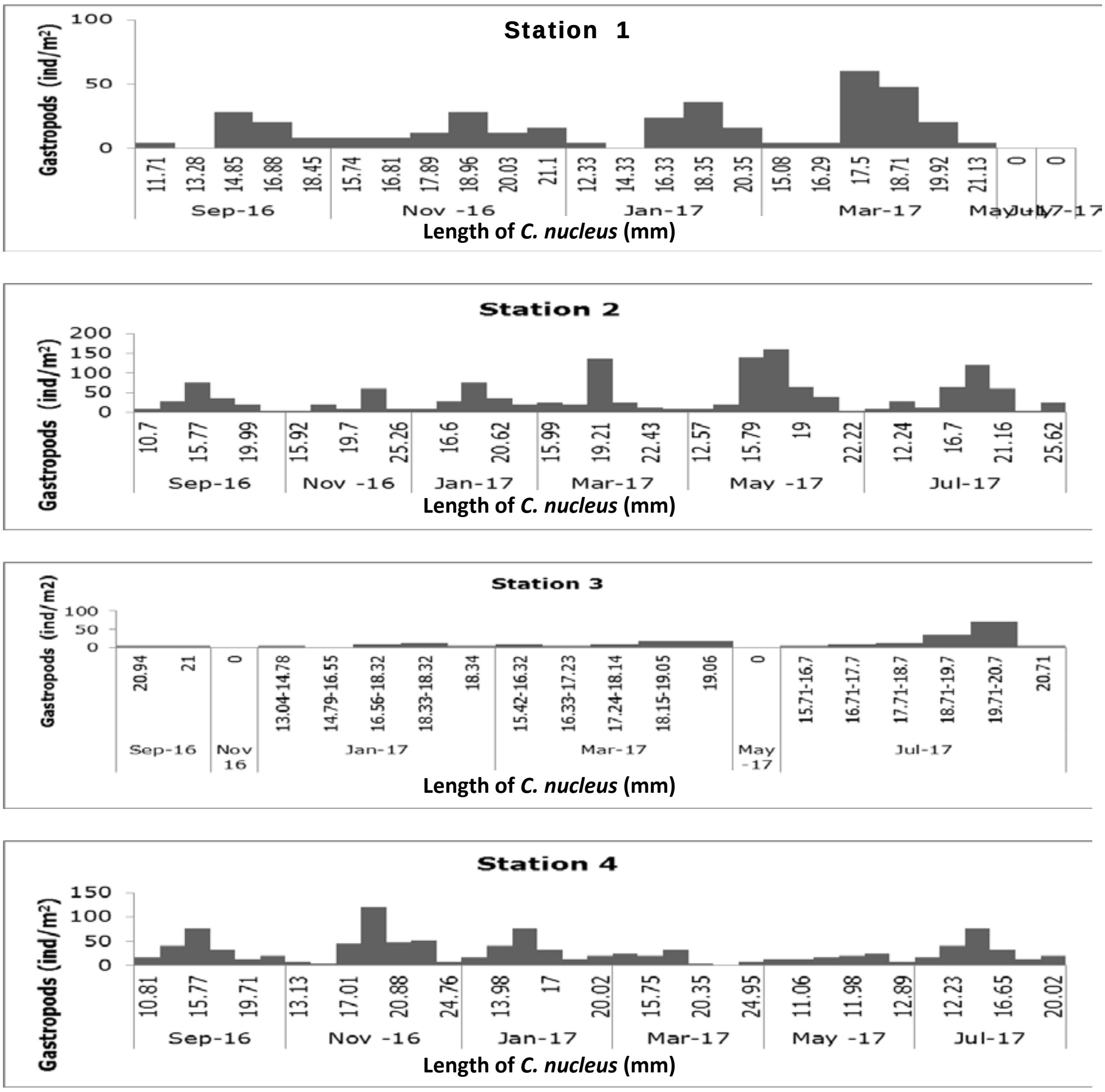


Figure 3a. Length distribution of *Cassidula nucleus* at Banggi Coast, Rembang, Central Java, Indonesia.

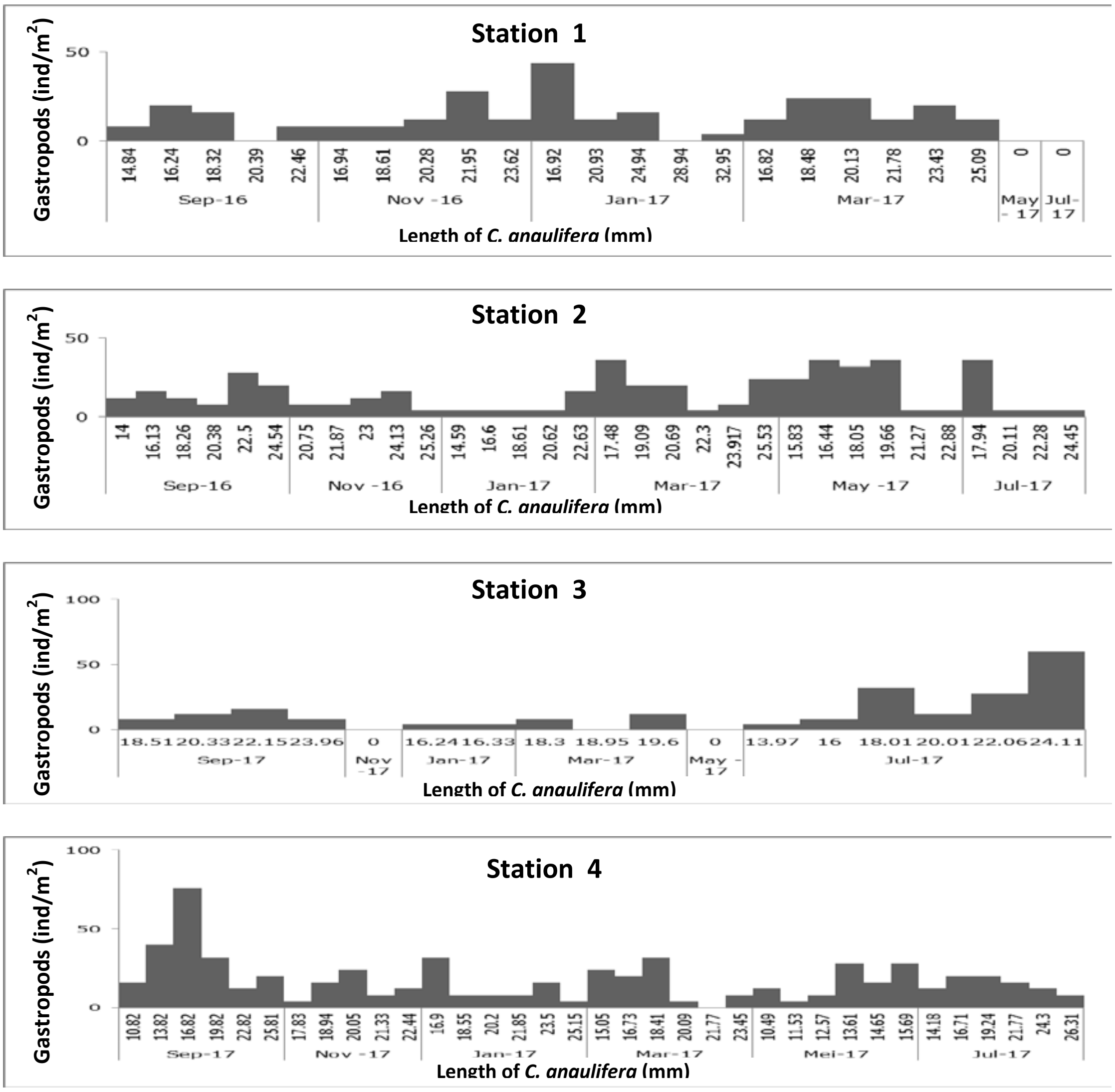


Figure 3b. Length Distribution of *Cassidula angulifera* at Banggi Coast, Rembang, Central Java, Indonesia.

Environmental parameters. The organic compounds and sediment texture (sand, dust, clay) varying according to zone, station and time (Table 2). According to the observation at flux zone, the result showed that the whole level of the organic compound was increasing from sea zone to the sea in sequence: zone A (seaward) > zone B (middle zone) > zone C (landward). Based on observation towards the season, it showed that the organic compound was increasing from the beginning until the end: July 2017 > January 2017 > 2016. As a whole, each station did not show any variation on organic compounds level. It indicated that generally, each station, flux-and-reflux zones, and seasons, all of them had the same organic compounds level. The substrate texture distribution at all areas of the research showed that dust substrate was more dominating than sand and clay (Table 2).

According to flux zone observation, it showed that the dust substrate was fluctuating, however as a whole, the zone C still showed higher dust substrate. According to seasonal observation, the dust substrate was increasing along with season change, but station 2 and 4 seemed to be decreasing. It indicated that the research locations generally (stations, flux-and-reflux zone, and season) have similar substrate condition, nevertheless the fluctuation (Table 2).

Parameter of water quality showed various conditions at various stations and time (Table 3). DO and salinity has various striking-value rather than the other parameters at each stations and time.

Table 2

The organic compounds and the substrate texture distribution at Baggi Coast, Rembang, Central Java, Indonesia

St	Organic matter (%)			Sand (%)			Dust (%)			Clay (%)		
	Sept	Jan	July	Sept	Jan	July	Sept	Jan	July	Sept	Jan	July
1 A	1.24	2.22	4.13	5.79	0.03	0.23	89.12	94.26	94.75	5.09	5.71	5.02
B	2.13	3.38	4.17	3.61	0.02	0.31	92.74	96.05	93.43	3.65	3.93	6.26
C	2.63	3.43	4.68	6.1	0.04	0.21	91.77	93.35	91.01	2.13	6.61	8.78
2A	1.23	3.42	4.79	0.67	0.02	0.30	94.96	96.11	93.01	4.37	3.87	6.69
B	1.8	3.65	4.47	0.55	0.03	0.16	96.23	94	93.72	3.22	5.97	6.12
C	1.68	3.81	2.64	4.57	0.03	0.15	91.21	94.49	93.92	4.22	5.48	5.93
3A	2.13	3.58	4.16	0.85	0,02	0.39	94.71	96.72	91.21	4.44	3.26	8.40
B	2.77	3.4	3.19	3.05	0.02	0.43	93.34	97.03	93.46	3.61	2.95	6.11
C	2.28	3.65	5.29	1.45	0.04	1.31	97.23	92.66	85.47	1.32	7.3	13.22
4A	2.36	3.33	4.77	1.72	0.02	0.46	95.56	95.58	91.72	2.72	4.4	7.82
B	1.74	3.36	5.21	0.55	0.03	0.43	96.05	95.64	90.50	3.4	4.33	9.07
C	3.26	3.64	5.46	12.63	0.03	0.28	85.36	93.79	91.03	2.02	6.18	8.69

St – station.

Table 3

Environmental parameters in Banggi Coast, Rembang, Central Java, Indonesia

St	Parameter	September 2016	November 2016	January 2017	March 2017	May 2017	July 2017
1	DO (mg/L)	5.98±1.51	4.36±0.11	5.41±0.87	8.000±0.00	7.30±1.90	4.13±0.12
	Salinity (psu)	29.33±1.15	26.0±3.00	16.67±2.87	32.83±2.03	32.90±0.34	33.87±0.05
	pH	7.43±0.10	8.02±0.24	7.96±0.03	5.51±2.86	8.37±0.38	6.33±2.94
	Temp (°C)	28.66±0.25	29.50±0.36	29.43±0.32	27.63±2.56	27.73±1.1	26.87±0.06
2	DO (mg/L)	5.23±0.35	4.09±0.52	7.91±0.51	5.29±2.36	5.71±0.45	4.54±0.36
	Salinity (psu)	28.5±1.5	29.33±1.15	31.33±1.15	30.53±4.64	31.1±0.17	30.87±1.64
	pH	7.17±0.47	7.68±0.20	7.76±0.38	5.26±2.71	8.09±0.07	7.92±0.02
	Temp (°C)	28.05±0.7	27.53±0.55	30.1±4.20	28.33±0.89	27.17±0.12	26.17±0.4
3	DO (mg/L)	6.03±0.7	4.53±0.25	5.85±0.28	8.02±0.01	7.41±0.52	4.16±0.26
	Salinity (psu)	31.33±1.15	29.00±0.00	26.67±2.89	24.60±4.40	32.9±0.55	34.07±0.05
	pH	7.43±0.16	7.68±0.03	7.68±0.03	7.72±0.28	8.08±0.11	7.96±0.13
	Temp (°C)	24.73±2.51	29.73±1.00	29.73±1.00	28.93±0.25	27.30±0.17	27.04±0.71
4	DO (mg/L)	7.96±0.7	4.89±0.73	7.22±0.07	8.02±0.02	6.18±1.32	4.37±0.81
	Salinity (psu)	26.33±1.52	29.33±2.31	28.33±2.28	33.26±0.65	32.93±0.25	34.46±0.78
	pH	7.38±0.08	7.51±0.25	7.52±0.04	6.30±2.98	8.01±0.31	7.69±0.36
	Temp (°C)	27.63±1.58	27.83±0.55	29.27±0.45	29.30±0.26	26.87±0.41	25.9±1.64

St – station, DO - dissolved oxygen, pH - potential of hydrogen.

The distribution of gastropods based on environmental characteristics. The relationship of gastropods based on the characteristic of the environment could be seen in Figure 4. The PCA result showed that the total diversity of F1 and F2 was 44.02%, consisted of F1 diversity of 22.07% and F2 diversity of 21.95%. Figure 4 showed that the distribution of *C. nucleus* with medium and large size was found at clay substrate and positively correlated with DO, pH, and organic compound but negatively correlated to temperature. Meanwhile, *C. nucleus* with small size was spread on the sand substrate and positively correlated to salinity condition. It showed that the higher the salinity is, the more vulnerable the gastropod *C. nucleus* is, especially the small-sized one. Meanwhile, the gastropods *C. nucleus* with medium and large size was very dependent on organic compound availability in big amount as a source of energy. The large-sized gastropods *C. angulifera* was spread on clay substrate, with pH >7, containing organic compounds, salinity and negatively correlated with temperature. Meanwhile, the small-sized individuals were spread on the sand substrate and negatively correlated to dust substrate. It showed that the higher the temperature, the lower the distribution of big-sized gastropods is, and the dominating dust substrate will allow the lower distribution caused by habitat suitability at the life cycle of gastropods *C. angulifera*. All gastropods *C. nucleus* and *C. angulifera* with medium size were found near by the coast at dry and wet season. Meanwhile the small one was found in the area near by the coast at transition season, and the big-sized one was found at the middle area at transition season.

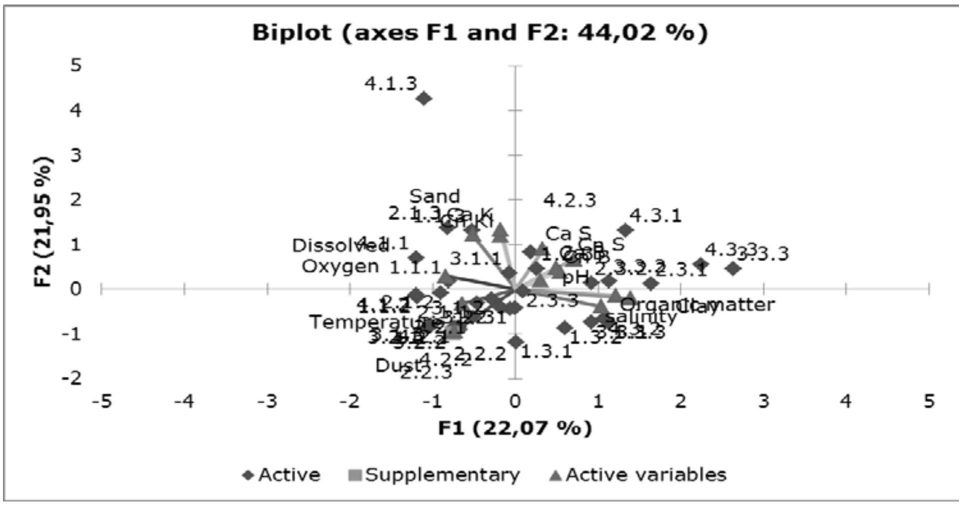


Figure 4. Principal Component Analysis (PCA) for association of gastropods *C. nucleus* and *C. angulifera* with environmental parameters at Banggi Coast, Rembang, Central Java (Ca - *C. nucleus*, Cn - *C. angulifera*, K - low, S - medium, B – high).

The association of gastropods and mangroves. The association of gastropods and mangrove is very important to support the continuance of life cycle. Figure 6 shows that the distribution of gastropods size was divided into 3 groups based on stations and density of mangrove.

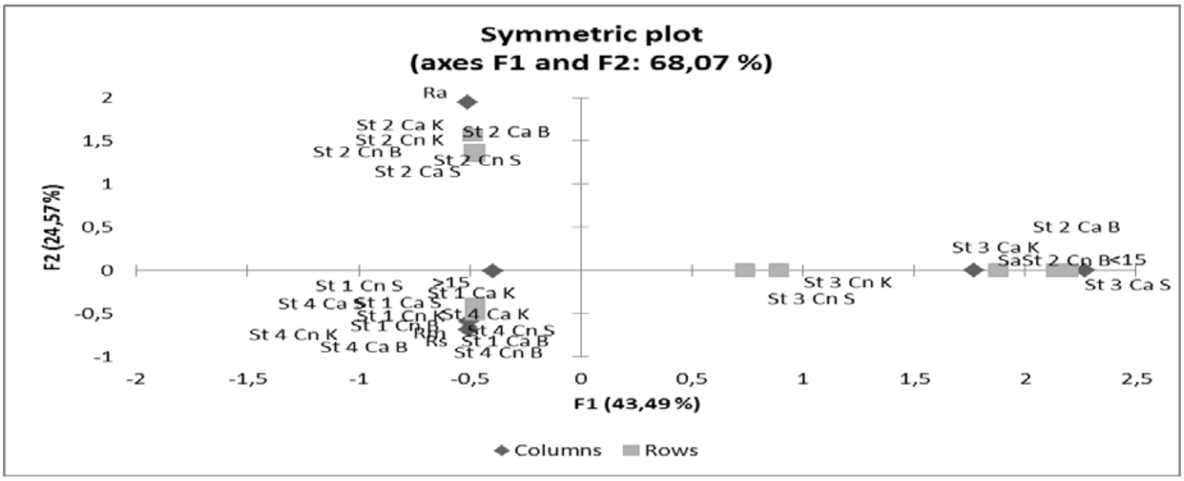


Figure 6. Correspondence Analysis (CA) for association of gastropoda *C. nucleus* and *C. angulifera* with mangrove at Banggi Coast, Rembang, Central Java (Ca - *C. nucleus*, Cn - *C. angulifera*, K - low, S - medium, B - high, Sa - *S. alba*, Rs - *R. stylosa*, Ra - *R. apiculata*, Rm - *R. mucronata*).

The small-sized *C. nucleus* gastropods was associated with *S. alba* mangrove with density of <15 trees, the medium one associated with *R. apiculata*, and the biggest one associated with *R. stylosa*. The small-sized gastropods *C. angulifera* are associated with *R. mucronata* with density of <15 trees, the medium sized individuals with *R. apiculata*, and the large sized with *R. stylosa*. According to that, it can be stated that type and density of mangrove can determine the characteristics and size of gastropods inhabiting.

Discussion. The differences of DBH size category showed age of mangrove (Table 1). The bigger the DBH, the older is the mangrove. Mangrove *S. alba* has the largest DBH size compared to other species, approaching 32 cm. Mangrove with DBH size around 18-32 cm aged around 18 to 32 years with 1.15±0.17 year/cm growth (Devoe & Cole 1998; Nazim et al 2013). *R. apiculata* had growth around 0.25 to 0.32 cm/year (Putz & Chan 1986; Devoe & Cole 1998). Mangrove *R. mucronata* had maximum DBH size of 18.04 cm, therefore it can be predicted to be aged around 36 years. The mangrove *R. mucronata* aged 12 years in Kenya has DBH size of 6.2±1.9 cm with diameter growth of 0.37 cm/year (Srivasatava et al 1988; Kairo et al 2008). This research found out that the middle-sized DBH is more dominating at the whole research area. Sulung et al (2002) reported that Rhizopora with DBH size of 11.7 cm is categorized as young mangrove and with DBH size of 21.4 is categorized as old mangrove. Hookham et al (2014) stated that the DBH size could image its condition in terms of health.

The distribution of gastropods *C. nucleus* and *C. angulifera* based on temporary observation, imaged a random pattern, however *C. nucleus* was in high-distribution in May 2017 at station 2, and meanwhile *C. angulifera* was highly distributed in September 2016. As a whole, gastropods *C. nucleus* and *C. angulifera* have different morphology characteristics at different habitat (mangrove) at each period. The gastropods *C. nucleus* and *C. angulifera* had a similar condition with *M. coffeus* with an average size of 18.55±2.42 mm in Brazil (n=71) (Maia et al 2012). Research conducted by Phillips & Campbell (1974) also reported that *D. orbita* had size of 10 mm, recorded at its 18 months age and increased after 2 to 5 years with a maximum growth rate of 2 mm length per month.

Based on temporary observation, the gastropods *C. nucleus* recorded to have the highest abundance in July 2017; meanwhile *C. angulifera* was in September 2016. The abundance of gastropods can be used as an ideal indicator as it is easy to identify, can be found in a whole year, tolerant to the environment (Amin et al 2009), and having mobility and abundance towards time; it can give representative image (Aston et al 2003). This research had high abundance during the post-rainy season and dry season. It has almost the same situation with observation conducted by Kumar (1997). The low abundance probably happened due to influence of rainfall, as observed previously by Saravanakumar et al (2007).

The development of mangrove area at Banggi Coast was very good, caused by flux-and-reflux effect and due to the soil texture. Cultivation and protection of mangroves is a protection system for maintaining the stability of sea line naturally to prevent abrasion, thus will support ecological process at coastal area. Mangrove type distribution has wide effect towards mangrove ecosystem depending on species' characteristics and interaction to the environment. Its root structure and stem density affected material exchange during flux-and-reflux (Cahoon et al 2003; Koch et al 2009). Some of mangrove types grew well on muddy soil and flux-and-reflux (McKee et al 2007). Mangrove distribution with natural or synthetic development can support the life and regeneration of mangrove (Clarke 2004; Amir 2012).

The parameter of water quality showed various conditions at various stations and time (Table 3). DO and salinity have various striking-value rather than the other parameters at each stations and time. However, the station 2 and 4 showed similar water quality. All of the research locations showed the DO value was around 4.09 to 8.02 mg/L meanwhile the salinity was 26.3 to 34.46 PSU. It can be assumed that the parameter of water supported the gastropods existence in January 2017. It happened as result of the wet season which reached a peak. Therefore salinity was slightly affected by the mixing sea water with rain water. Salinity is a limiting-factor towards living organism distribution, as the effect of dilution and evaporation most abundant on fauna and mangrove ecosystem (Manikannan et al 2011). The higher DO concentration recorded during dry the season is possibly caused by the assimilation by higher wind energy and dilution between rain water and freshwater. These results are closely similar to a study conducted by Damotharan et al (2010).

The gastropods *C. nucleus* and *C. angulifera* were found at zone B (midle) and C (landward) (Figure 2a, b). This showed the possible preference of gastropods to tidal fluctuation and salinity. The gastropods abstained directly from zone A (seaward). The organic compounds increased from seaward to landward. This supported the gastropods' movement to high organic compounds. Sanders et al (2010) and Kauffman et al (2011) reported that the organic compounds increased at mangrove's sediment near by the sea (seaward) to a nearby land area (landward). Boto et al (1989) reported that stability and transportation of sediment had caused the difference of granule size rich in organic compounds and soft sand. Gastropods *C. nucleus* and *C. angulifera* were abundant on mangrove type of *R. stylosa*. It was supported by the high level of organic compound sand dominant soft substrate. Davis et al 2003 stated that the softer the sediment substrate, the higher the level of organic compounds. Gastropods living at mangrove forest require specific environment conditions. The small-sized gastropod is vulnerable to salinity condition. In mangrove ecosystems the gastropods distribution is closely related to the water quality (salinity, oxygen, temperature, and nutrients) (Swami et al 2000; Jayaraj et al 2007). Gastropods have several kinds of adaptation abilities to survive at different environment conditions; many of them survive extreme temperatures and sustain the energy to convert salinity (Shumway & Marsden 1981). Salinity is the main factor determining the pattern of distribution and abundance of gastropods (Martins 2001). The large and medium-sized *C. nucleus* gastropods are very dependent on high level organic compounds availability as source of food. Wet season is considered as important factor to benthic distribution (Beasley et al 2005). The big-sized *C. angulifera* gastropods were found spread at clay substrate and organic compounds. Its distribution was negatively correlated with temperature. Meanwhile the small-sized gastropods were spread at sand substrate. Dittmann (2002) reported that gastropods would follow the character of the sediment and period of inundation which supports their metabolic processes. The substrate condition at the bottom of coastal region, such as texture and sediment composition, affected the gastropods distribution (Batomalaque et al 2010). Mangrove is able to take role as organic compounds absorber and as place to fertilize the coastal area (Dittmar et al 2006). Gastropods grow less well at sandy-mangrove forest with lack of food; meanwhile the full-grown and largeer gastropods may have grown at muddy-mangrove forest due to the rich source of food (Nishihira et al 2002). The morphology of *C. nucleus* and *C. angulifera* found were various at different habitats as response towards environment factors such as temperature, salinity, DO, pH, sediment texture, and organic compounds. Tokeshi et al *(*2000) explained that small-sized individuals probably had lower metabolism to produce organic compounds needed for shell production, than the bigger ones.

Gastropods *C. nucleus* and *C. angulifera* at Banggi Coast, Rembang can be categorized as tree-climbers, moving up and down following the flux to avoid submersion and to feed themselves around fallen-leaves over the sediment surface. Walthew (1995) showed that *Cassidula aurifelis* was limited by some mangrove vegetation. The main factor affecting the distribution and diversity of animals were structure and composition of mangrove vegetation (Zakaria & Rajpar 2015), physical pressure, predation pressure (Peng et al 2017), and better toleration ability of gastropods toward difficult condition around mangrove ecosystem (Hogarth 2015). Gastropods have high abundance and distribution at mangrove forest due to its moving ability. The abundance of gastropods was affected by mangrove type as source of food and mangrove producing leaves as substitute of food source during flux-and-reflux. Gastropods also have vertical migration habit to prevent submersion (Maia & Coutinho 2013). Dynamism and daily behavior of gastropods *C. nucleus* and *C. angulifera* formed gastropods zonation, affected by availability and quality of mangrove forest comprised of leaves production, organic matter, species varieties, and leaves-aging variety.

Conclusions. Banggi Coast, Rembang Regency, Central Java has some types of mangrove, which can be utilized to support the distribution of *C. nucleus* and *C. angulifera* gastropods. The stability of mangrove ecosystem can be seen from the abundance of gastropods. The highest abundance of *C. nucleus* was found on *R. apiculata* mangrove, meanwhile the *C. angulifera* one was found on *R. stylosa* mangrove. According to the size of gastropods, the large-sized *C. angulifera* were spread on clay substrate, with pH >7, with organic compound content, and salinity 26–34.07 psu. Meanwhile, the small and medium-sized individuals were spread on the sand substrate. The small-sized *C. nucleus* was associated with *R. stylosa*, the medium ones with *R. apiculata*, and the large ones with *R. mucronata*. Meanwhile all size of *C. angulifera* was closely associated with *R. stylosa* mangrove.

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Authors:
Dafit Ariyanto, Asahan University, Agricultural Faculty, Department of Aquaculture, Indonesia, North Sumatera, Kisaran, 21224, e-mail: dafitariyanto676@gmail.com
Dietriech Geoffrey Bengen, Bogor Agricultural University, Fisheries and Marine Science, Department of Marine Science and Technology, Faculty, Indonesia, Bogor, 16680, e-mail: dieter@indo.net.id
Tri Prartono, Bogor Agricultural University, Fisheries and Marine Science, Department of Marine Science and Technology, Faculty, Indonesia, Bogor, 16680, e-mail: triprartono@yahoo.com
Yusli Wardiatno, Bogor Agricultural University, Fisheries and Marine Science Faculty, Department of Aquatic Resources Management, Indonesia, Bogor, 16680, e-mail: wardiatno@gmail.com

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