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Distribution and abundance of *Cerithideopsilla djadjariensis* (Martin 1899) (Potamididae) on *Avicennia marina* in Rembang, Central Java, Indonesia

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

1-Department of Aquaculture, Agricultural Faculty, Asahan University, Kisaran, Sumatera Utara, 21224, Indonesia
2- Department of Marine Science and Technology, Faculty of Fisheries and Marine Science, IPB University, West Java, 16680, Indonesia
3-Department of Aquatic Resources Management, Faculty of Fisheries and Marine Science, IPB University, West Java,16680, Indonesia

*** Corresponding author: dafitariyanto676@gmail.com**

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ABSTRACT

Mangrove forests are known to provide important ecosystem goods and services such as nursery areas for several important aquatic species, and a variety of food for several animal groups, including gastropods. This research was conducted from September 2016 - August 2017. The aim of the research was to determine the spatial and temporal pattern distribution of *C. djadjariensis* based on mangrove zone, environmental characteristics, and organic materials. The gastropod samples were taken by using a square transect sized 25 cm x 25 cm. The spatial analyses were done by using transect 10 m x 10 m. The gastropod and environmental characteristics were analyzed using Principal Component Analysis (PCA). The total of gastropod *C. djadjariensis* was 528 ind./m^2. The result of high significant was organic matter (0.92), total phosphorus (0.92), dust (0.86), clay (0.86), temperature (0.69). The distribution and abundance are affected by the availability of food, water condition, and zone in the mangrove.

INTRODUCTION

Banggi coast is located on the North Coast of Java, Central Java, Indonesia which is bounded by various species of mangrove such as *Rhizophora mucronata* Lam., *Rhizophora apiculata* Blume, *Rhizophora stylosa* Griff., *Avicennia marina* (Forssk.) Vierh., and *Sonneratia alba* Sm **(Ariyanto *et al.*, 2018a; 2019a)**. Mangrove systems represent complex and highly dynamic environments in which faunal assemblages typically occupy distinct horizontal or vertical zones, and manifest complex temporal patterns in their activities **(Hogarth, 2007)**. *Avicennia marina* occupies coastal areas across a broad range of environmental conditions. Mangrove zonation is contained by the response of the mangrove ecosystem to external factors by the plant itself. **Mazda**

***et al*. (2005)** showed that these plants are highly specialized, flourishing under inhospitable environment conditions of extreme tides, high salinity, high temperature, strong winds and anaerobic soil.

Mangrove forests are known to provide important ecosystem goods and services such as nursery areas for several important aquatic species, and a variety of food, timber and chemicals for local communities **(Nagelkerken *et al.*, 2008; Ariyanto *et al.*, 2018b; Ariyanto *et al.*, 2019b, 2019c; Ningsih *et al.*, 2020)**. Gastropod and mangrove have an association in mangrove ecosystem **(Ariyanto *et al.*, 2018c; Ariyanto, 2019)**. Benthic invertebrates play an important role in the mangroves by helping to cycle and conserve nutrients in the system including the consumption of microphytobenthic individuals, plant debris and detritus deposited in the sediment, thus incorporating organic matter in their biomass **(Koch & Wolff, 2002)**. *Cerithideopsilla* is a genus of potamidid snails found in high abundance on sedimentary intertidal flats and beneath mangrove trees on continental shores in the tropical and subtropical Indo-West Pacific region **(Ozawa *et al.*, 2015)**. The mangrove fauna often show horizontal and vertical zonation. The pattern of vertical distribution of infauna is an important aspect of the structure, species interactions and organism activity in the soft bottom sediments **(Safahieh *et al.*, 2012)**. The main objective of this study was to determine spatial and temporal pattern of gastropods *C. djadjariensis* based on the environmental characteristics (C Organic Matter, Total Phosphorus, Total Nitrogen, water quality) on *A. marina* zone in Rembang, Central Java, Indonesia.

MATERIALS AND METHODS

Research Location

The research was conducted on September 2016 - July 2017 at Banggi Coast, in Rembang, Central Java, Indonesia (6’42’5 S and 111’23’16 E). The research location was divided into 3 zones of observations such as : seaward zone (A), middle zone (B), and landward zone (C).

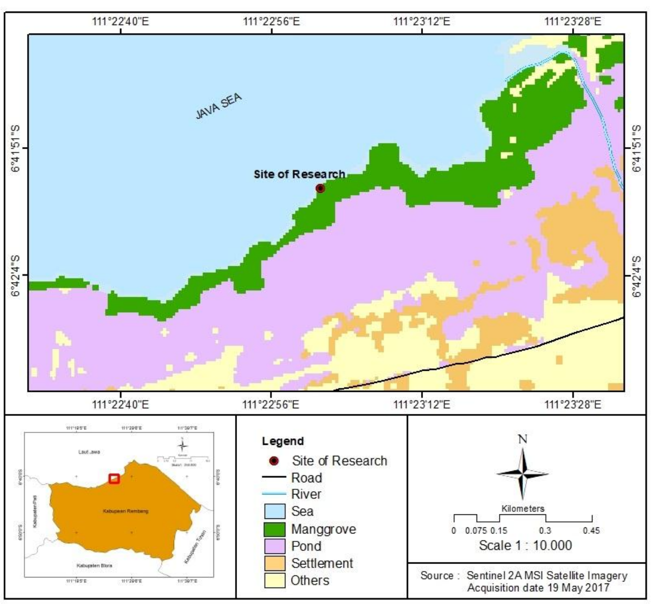

Figure 1. The location of research in Banggi Coast Rembang, Central Java, Indonesia.

Samples collection

The gastropod samples were taken by using six times square transect sized 25cm x 25cm, placed inside transect sized 10 m x 10 m. The sampling was conducted in September and November 2016, January, March, May and July 2017. The gastropod was located over sediment and taken when the sea was at the low tide. The gastropod sample found in this research was identified morphologically as *C. djadjariensis* by using **Dharma (1988)**. Length measurement was done by using digital caliper with 0.1 mm accuracy. The gastropods samples' species abundance was measured **(Brower & Zar, 1990)** and classified of length on each transect and time taken. Length frequency distribution allow to determine the size group of gastropods *C. djadjariensis* by looking at it's frequency modus of shell length.

Physico-chemical Parameters

The water quality measurements in each zone were : temperature, salinity, pH, DO, redox potential and conductivity by using water quality meter. Each zone was measured six times included September, November 2016, January, March, May and July 2017. Analysis of sediment samples was conducted at the Aquatic Productivity and Environment Laboratory, Bogor Agricultural University, which included organic materials, soil texture, total nitrogen and total phosphorus. Measurement of organic matter content was done by Walkey-Black method, while soil texture measurement was done by pipette method, and total nitrogen and total phosphorous used a spectrophotometry **(Pansu & Gautheyrou, 2006)**.

RESULTS

Abundance

The abundance of gastropods C. djadjariensis in mangrove A. marina was functions differently in each zone (Fig 2). All three zones decreased close to Nov 2016 and increased in zones A and B. Zones A and B declined until May 2017 and saw another rise in June 2017. Zone C (Landward) January 2012 May was required for incoming airflow in the *A. marina* mangrove area.

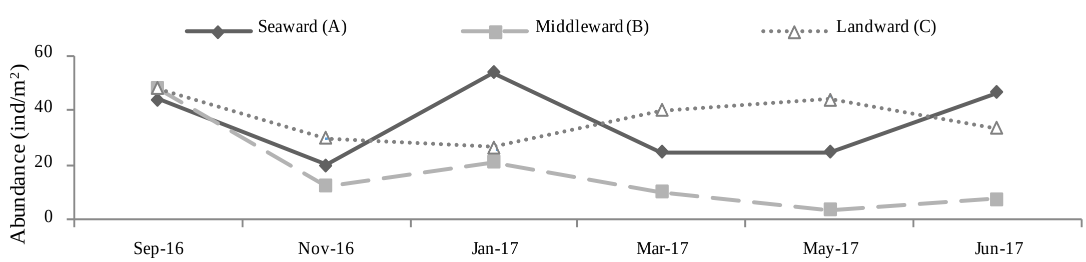

Figure 2 .The abundance of *C. djadjariensis* on *A. marina* in Banggi Coast Rembang Central Java Indonesia

Distribution of Lenght

This study shows the size variation in various zones (Figure 2). Zone A (seaward) has a variety of sizes with most sizes found 19.41-21.56 mm as much as 88 ind. The largest size in zone A was also found in January (30.2-32.45 mm). The size of zone B (middle zone) has the largest size (31.38-34.82 mm). The highest size in zone B with size 21.03-24.47 mm as much as 96 ind. Zone C (landward zone) has a size of 23,29-24,96 mm as many as 96 ind. Zone C (Landward) also found the largest size 34.57-36.85 mm.

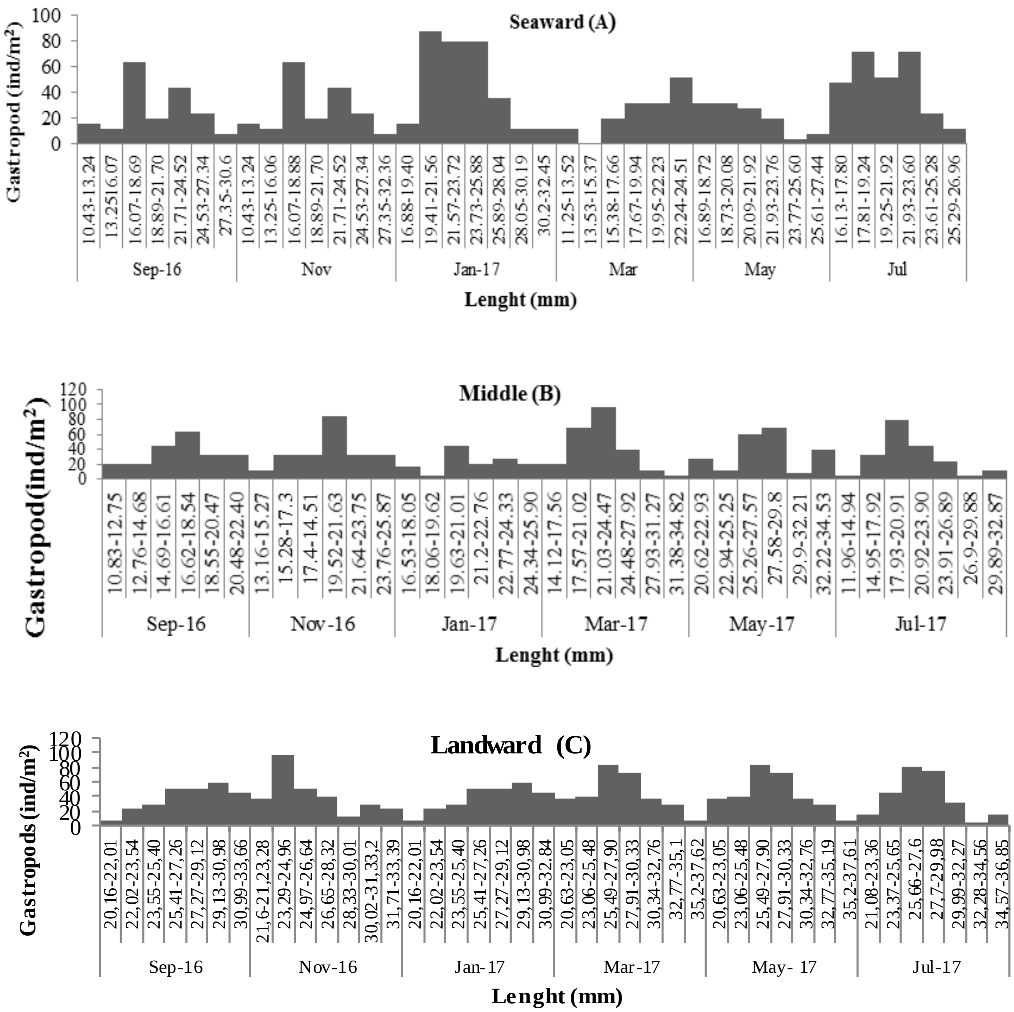

Figure 2. Lenght Distribution of *C. djadjariensis* on *A. marina* in Banggi Coast Rembang Central Java Indonesia

C Organic Matter, Total Phosphorus, Total Nitrogen

This study shows that C organic increased in July 2017 (Figure 3). In contrast to TN, and T P which increased in January 2017. Increased TN and TP indicated that it is affected by the rainy season. The rainy season will cause the flow of water from land and sea increased. Organic C increased in July caused by organic compound C source in sediment caused by leaf production period of *A. marina* increased in July 2017.

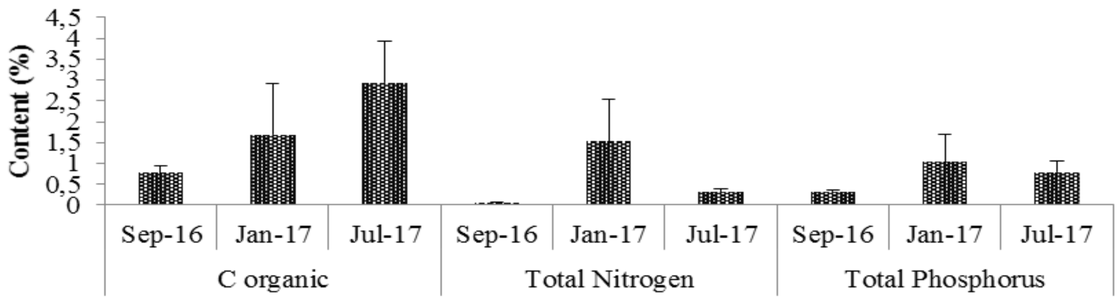

Figure 3. Distribution of C organic, TN, TP in *Avicennia marina* at Banggi Coast, Rembang, Central Java, Indonesia.

Sediment

The results showed that tektur more dominant on mangrove *A. marina* (Table 1). The size of the dust indicates that the area has a high food potential. The smoother the sediment the more nutrient content. This is due to the organic source in *A. marina* derived from the leaves. Mangrove leaves have a fast decomposition rate

Tabel 1. Distribution of sediment texture in mangrove *A. marina* at Banggi Coast, Central Java.

Time	Sand	dust	clay
Sep 2016	3.46 ±2.65	94.67 ±3.25	2.57 ±0.29
Jan 2017	0.02 ±0	96.38 ±0.73	3.60 ±0.73
Juli 2017	0.34 ±0.28	94.61 ±1.77	5.05 ±1.49

Water Quality

Table 2 shows the distribution of water quality parameters at various zone. Zone A (seward) has DO (7 ± 1.74 mg/l), salinity (28.11 ± 6.17 psu), pH (6.46 ± 2.2), temperature (30 ± 1.32 ^{o}C), redox potential (47.1 ± 26.96 mV) and conductivity (43.35 ± 22.58 mS/cm). Zone B (midlle) has DO value (6 ± 0.93 mg/l), salinity (30.05 ± 4.64 psu), pH (8 ± 0.15), temperature (32.36 ± 1.5 ^{o}C), redox potential (54.85 ± 46.28 mV) and conductivity (49.07 ± 12.81 mS/cm). Zone C (landward) has DO (5.66 ± 1.55 mg/l), salinity (28.9 ± 4 psu), pH (7.8 ± 0.32), temperature (29.48 ± 1.5 ^{o}C), redox potential (-36.71 ± 89.33mV) and conductivity (53 ± 29.33 mS/cm).

Table 2. Parameters of water quality on mangrove *A. marina* at Banggi Coast Rembang, Central Java, Indonesia

Parameters	DO (mg/l)	Salinity (psu)	pH	Temperature (^{o}C)	Redox(mV)	conductivity mS/cm
Sep 16	7.37±1.96	32.9±0.34	8.37±0.38	27.73±1.10	57.6±13.59	48.83±0.55
Nov 2016	5.71±0.45	33.2±0.17	8.09±0.07	27.17±0.11	11.33±66.94	52.33±5.77
Jan 2017	7.42±0.52	32.9±0.57	8.09±0.11	27.3±0.17	47.47±11.59	49.13±0.55
March 2017	6.19±1.32	32.93±0.25	8.02±0.30	26.87±0.41	34.6±9.23	48.77±0.35
May 2017	7.24±2.31	32.93±0.51	6.59±2.2	30.7±0.3	48.37±31.99	36.26±23.04
July 2017	4.86 ±0.36	31.73±0.79	8.15±0.13	30.2±2.3	80.86±44.35	51.77±0.9

Analysis of Principal Component Analysis (PCA)

Figure 3. shows distribution of *C. djadjariensis* in environmental characteristic in Coast of Bangg, Rembang, Central Java. The Principal Component Analysis result of total F1 and F2 showed 52.42 consisted of F1 (34.34 %) and F2 (18.09%). Based on factor loading showed organic matter (0.92), total phosphorus (0.92), dust (0.86), clay (0.86). and temperature (0.69).

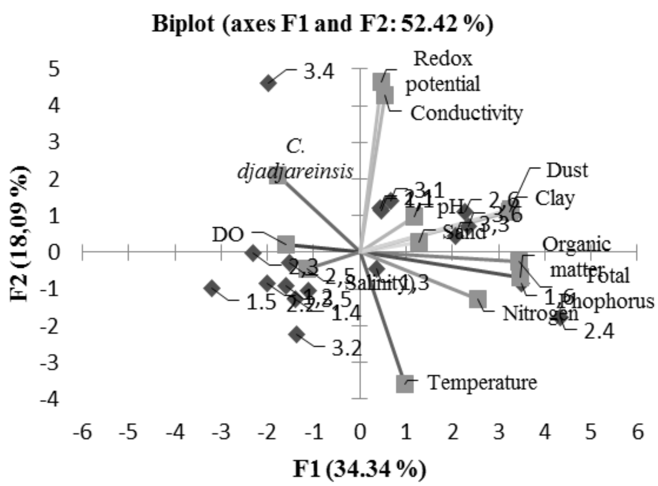

Figure 3. Principal Compnent Analysis of *C. djadjariensis* with physico-chemical characteristics

Temperature is an important factor in influencing chemical and biological reactions in water and physical activity of gastropod organisms on mangrove ecosystems. Temperature may affect gastropod habitat preference irrespective of resource availability. It is supported by high organic materials and subtle subtrates are more dominant. the sediment substrate the consumed ingredients become higher. Gastropods living in mangrove forests require a specific environment.

DISCUSSION

Zone C (Landward) has the largest size 34.57-36.85 mm and 96 ind (Fig 2). Abundances of macrofauna may also vary in relation to patchiness in quality or quantity of food. e.g. cover of litter in mangroves for species that feed on fallen leaves. fungi or other components of decomposition **(Camilleri, 1992)**. **Guest *et al.* (2004)** reported gastropod species inhabiting the perimeter of saltmarshes and mangrove forests. The distributions of some *Cerithideopsilla* species extend beyond the northern limit of mangroves in Japan and Korea **(Hong *et al.*, 2010; Liu *et al.*, 2010)**. *C. djadjariensis* are reported to be planktotrophic with a length of larval life of about 11–20 days **(Kojima *et al.*, 2006)**. Infaunal species are considered to be key organisms in the detection of ecosystem changes as well as human impacts. due to their short life span and low mobility **(Chapman, 2007)**. Factors that have significant influence on gastropod abundance are mangrove age. affecting mangrove structure and function. **Morrisey *et al.* (2003)** showed that there were differences in the abundance and composition of younger fauna (3-12 years older) and older (> 60 years older) mangrove areas.

Mangroves can represent an important cross boundary subsidy of organic matter to coastal and continental shelf food webs. through the production of litterfall. its export and subsequent decomposition **(Lugo & Snedaker, 1974)**. Gastropod tend to occupy different microhabitats in terms of sediment grain size. shading by trees. tidal level and salinity **(Plaziat & Woujdan, 2005)**. **Penha-Lopes *et al.*, (2009)** reproted that te nutrient cycling by consuming large amounts of *Avicennia marina* (Forsk.) It can also regulate microphytobenthic primary productivity through feeding and crawling activities **(Cannicci *et al.*, 2009; Lee *et al.*, 2015)**.

Table 2 shows salinity value 31.73 – 33.2 psu and temperature 26.87-30.7 (ºC). High temperatures result in high drying and mortality processes caused by overheating **(Sokolova & Berger, 2000)**. **Skilleter & Warren (2000)** suggest the impacts were caused by human activity can cause changes in tidal dynamics and subsequently affect the distribution of leaves in the substrate and result in abundance of gastropods. Gastropode mode of life was epi fauna **(Safahieh *et al.*, 2012)** reported the distribution of macrobenthos were primarily determined by grain size of sediment. salinity. and water availability. Physical fluctuations may decline the abundance of benthic species **(Kathiresan *et al.*, 2018; Ariyanto *et al.*, 2018c)**. Texture of sediments determine gastropods in food-search strategies by adjusting for sediment types **(Zhuang *et al.*, 2004)**. **Davis *et al.* (2003)** states that the more soft in the sediment substrate becomes higher in the organic matter content. **Chapman & Tolhurst (2004)** recently found strong differences in both benthic patterns and sediment characteristics. **Cannicci *et al.* (2009)** repoorted that the amount of sediment displaced by *T. palustris* depended significantly on the gastropod size (weight). environmental conditions (sediment characteristics and availability of different food types) and especially on anthropogenic influence (sewage). which altered the intensity and periodicity of animal activity.

Gastropod has a tolerance capabilities for difficult conditions in the mangrove ecosystem (and gastropods have a high abundance and distribution in mangrove ecosystem because of their movement characteristics **(Kabir *et al.*, 2014**). Gastropods are poorly developed in mangrove forests that were dominated by sandy substrates with poor food conditions. whereas adult gastopods may have grown in muddy mangrove forests as rich sources of food **(Nishihira *et al.*, 2002)**.

Physico-chemical conditions such as temperature, salinity, tidal, substrate texture and vegetation cover as a driver for distribution gastropod abundance and food availability. Figure 3 has highest correlation in organic matter (0.92) and total phosphorus (0.92). Interactions such as predation and habitat change have also been shown to be important factors in the distribution of gastropods **(Belgrad & Smith, 2014)**. **Soundarapandian *et al.* (2009)** revealed that temperature variations are one of the factors in the mangrove ecosystem that may affect physico-chemical characteristics and also affect the distribution and abundance of flora and fauna.

The distribution of gastropod depends on the habitat. shelter. food. predation and individual competition. **Reid *et al.* (2008)** suggest that most potamidides depend on trees for substrates. shelter or food). *Cerithideopsilla cingulata* is predicted to have proximity to the Avicennia mangrove for survival. *Cerithideopsilla cingulata* is found abundantly in the expanse of sand that is sheltered. intertidal. muddy and always adjacent to mangroves **(Plaziat & Woujdan, 2005**).

CONCLUSION

Distribution of *C. djadjareinsis* in environmental characteristic on *A. marina* at Coast of Banggi. Rembang. Central Java such as organic matter. total phosphorus. dust texture. clay texture. conductivity. temperature. and redox potential. Abundance of gastropods *C. djadjareinsis* was obtained by seaward (zone A) (214 indv/ m^2), zone middle (zone B) (102 ind indv/m^2), and land ward (zone C) (224 ind/m^2).

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