EFFECTS OF RAINFALL ON THE POPULATION OF SHRIMPS *Penaeus monodon* Fabricius IN SEGARA ANAKAN LAGOON, CENTRAL JAVA, INDONESIA

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ABSTRACT

Segara Anakan Lagoon (SAL) widely recognised as traditional fishing ground for many fisheries organism and is located at a area with a high rainfall. The objectives of the present study are to determine the effects of rainfall on the distribution of *Penaeus monodon* Fabricius in the SAL and/or mangroves waters and to explain the cause of the yearly fluctuations in the shrimp catch in this area during 13 years period (1998 -2011). The effects of rainfall on the local distribution and abundance of the shrimp in the SAL, Cilacap, Central Java, Indonesia, were examined for three periods by *Anco* method: first period (of commercial catch production, 1998 – 2011), second period (December 2010-November 2011) and third period (December 2011 – April 2012), as part of ~~a~~ shrimp fishery and eco-biology study in this region. The marked increase in the rainfall from 557 mm in East Monsoon (June-August) to 1,225 mm in second transition season (September-November) and West Monsoon (December- February) in the Segara Anakan region enhanced the seasonal movement of shrimp into the fishing ground zone IV and produced an initial increase in the abundance of adults (CL > 25 mm) in the region (312 to 2,630 individuals). This initial increase in adult abundance enhances the shrimp reproductive potential and the heavy rainfall indirectly assists the recruitment of young shrimp to the estuary and their growth and survival to increase shrimp abundance in the following year. Lower rainfalls (July-August-September) adversely affect shrimp population and usually result in smaller size of the population (312 individuals). Statistical analysis on relationship between shrimp catch with annual rainfall showed highly significant at 1% level.

Keywords: distribution, abundance, Segara Anakan Lagoon (SAL), *Penaeus monodon*, rainfall.

INTRODUCTION

Segara Anakan Lagoon (SAL) is ~~a~~ habitat for the variety of aquatic and terrestrial organisms, including various species of shrimp. Major shrimp species found in SAL are fine shrimp (*Metapenaeus elegans, M. ensis, M. affinis* and *M. dobsoni*), White shrimp (*Penaeus merguiensis* and *P. indicus*), Krosok shrimp (*Parapenaopsis* sp.) and Tiger shrimp (*P. semisulcatus* and *P. monodon*), which are involved in the family Penaeidae (Sukardjo, 2004, Saputra, 2008). Mangrove areas of (SAL) function as nursery areas for shrimps and fish, such as certain species of penaeids that are dependent on mangrove forests during their juvenille stages (Sukardjo, 2004). The shrimp (in Indonesia and local area known as udang windu), *Penaeus monodon* Fabricius inhibits in estuaries with silty clay and sandy clay substrates in the SAL (Toro & Sukardjo, 1987), and in inshore oceanic water of Hindian Oceans at Nusawere (Toro & Sukardjo, 1988a, Naamin, 1991). Though the shrimps has an extensive habitat or distribution specifically in estuarine habitat, large juvenile population of the shrimp are usually abundance in a few estuarine. Salinity decrease gradiently such as in large estuaine of Citanduy, Cibereum and Kawunganten (Toro & Sukardjo, 1988a).

In Indonesia, the relationship between the annual fluctuations in rainfall and the catch of Penaeid shrimps has not been examined. We have merely insufficient knowledge of the effects of rainfall on the behavior and abundance of the shrimp. The objectives of the present study are to determine the effects of rainfall on the distribution of *Penaeus monodon* Fabricius in the

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SAL and/or mangroves waters, and to clear the cause of the yearly fluctuations in the shrimp catch in this area during 13 years period (1998 - 2011).

MATERIALS AND METHODS

The area of study

The Segara Anakan area is located approximately at 7°40'00" – 7°45'00" N and 108°46'00" – 109°00'00" E in the southern coast of Java province (Figure 1). The Segara Anakan has many rivers and estuarine which carry the freshwater and sediments run-off from the high land (Napitupulu & Ramu, 1982, Sukardjo, 2004, Sutrisno & Prayitno, 2013). At this time SAL is facing some ecological problems. One of them is high sedimentation rate along the lagoon, which causes the narrowing the SAL which is coming from Citanduy, Cibeureum, and Cikonde Rivers (Sutrisno & Prayitno, 2013). In the past, Segara Anakan had around 4603 ha of mangrove areas. However, illegal logging had caused the decrease the area of mangrove forest. It was around 1454 ha between 1974 and 1987. In 1989, about 16.5 ha of mangrove forest in the Segara Anakan areas had been converted into shrimp ponds (Nuryanto & Susanto, 2010). According to Sutrisno & Prayitno (2013) calculation of mangrove extent resulted in 2002 the mangrove extent in SAL was 9.163,19 ha decreased respectively to 8.433 ha in 2003, 7.764 Ha in 2004, 7.252,72 Ha in 2005 and 6. 213,80 Ha in 2006. Further decrease occured in 2007 to 5.575,16 ha, 4.987 ha in 2008 and finally to 4.267,13 in 2009. Mangrove coverage in SAL decreased approximately 677 ha each year. The decreased of mangrove coverage in SAL followed bythe decrease of lagoon extent. According to Suryawati *et al.*, (2011), the extent of SAL, in the year 2001 was 1.178 ha decreased to 800 ha in the year 2007, which means that average decrease rate was 63 ha/year.This decrease was caused by the high sedimentation rate and caused to the decrease of mangrove extent in SAL (Dudley, 2000). Rohmat (2005) mentioned that sediment supply to SAL was estimated about 6 million cubic meters per year where a million cubic meter was settled down. The sediment accumulated in SAL was then filled the lagoon area and soon would turn into land (Sutrisno & Prayitno, 2013).

The high rate of exploitation and declining of the Segara Anakan areas are presumed to have direct impact on its animal communities, including fish assemblages and the ecological role of SAL (Setijanto & Rukayah, 2016). Moreover, due to fasted sedimentation and illegal occupation the mangroves area estimated to be 7.500 ha (Sukardjo (In preparation).

Segara Anakan has the largest single block of mangroves in Java. Moreover, the Segara Anakan mangroves are the richest in term of true mangrove species (Sukardjo, 1984a,b, Hardjosuwarno *et al.*, 1982, Sunaryo, 1982) with both primary and secondary succession actively occurred (Djohan, 2007), and are fishing ground for artisanal fishery (Amin & Hariati, 1991, Suwarso & and Wasilun, 1991). During the study periods we have listed 25 species of plants, 25 species of gastropods, 20 species of mollusks and 12 species of crustaceans.

Mangroves of Segara Anakan are inestimable economic value to Cilacap district and the Central Java province, notably as source of firewood (Sukardjo, 1984a) (illegal cuttings recorded as much as 12-18 m3/day was reported by BPKSA 2006), and as a recruitment ground for important fisheries (Naamin, 1991): an amount of shrimp export has been reported over US $ 1,13 million annually (BPS 2016).

The climate in this area is defined as humid tropical within the climatic type A and B (Schmidt & Ferguson, 1951). The intensity of rainfall occurrence is in high along years. Rainfall data for 1998 -2011, December 2010- November 2011, and December 2011- April 2012 at both Candi and Cilacap meteorological stations were collected from the Meteorological and Geophysical Serial Report, Ministry of Transportation (1998-2012). Four locations in the SAL were used for the study area, namely, Zone I (mesotroph): representing the area significantly affected by two main rivers i.e. Cibereum and Citanduy, where low salinity and relatively high sedimentation are expected (sampling stations: approximately 0.6-0.9 km from Nusawere). Zone II (eutroph): representing the area located in the north-eastern part of the lagoon affected by the western channel, where highest sedimentation and low salinity is expected due to freshwater inflow from two rivers i.e. Kawunganten and Muara Dua (sampling stations: approximately 0.9-1.2 km from Nusawere). Zone III (eutroph):

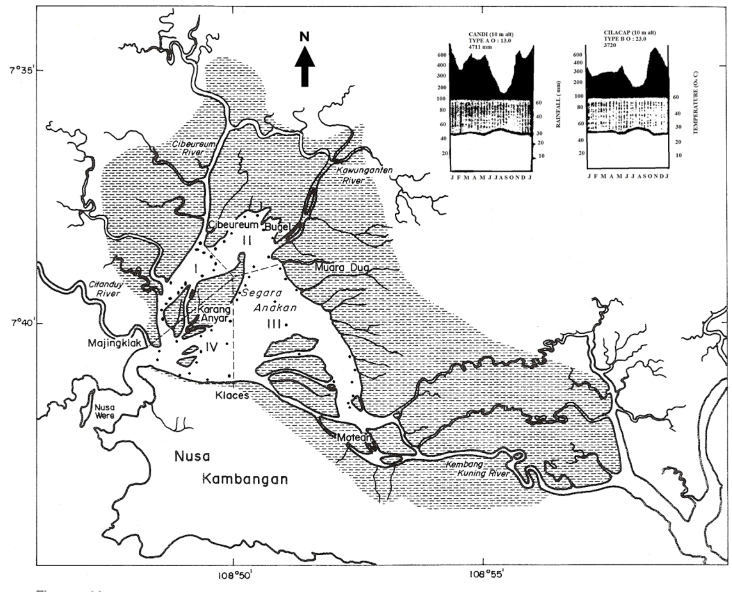

Figure 1. Map showing the SAL and its aquatic zones (I-IV) for the study area

Representing the area located in the south-eastern part of the lagoon, which is mainly affected by the eastern channel, inflow from the western channel might be having a minor effect from both channel. High sedimentation is expected (sampling stations: approximately 1.2-1.5 km from Nusawere). Zone IV (mesotroph): Representing the area near the western channel, where highest salinity ia 33 ‰ and relatively low sedimentation are expected due to prevailing strong tidal currents (sampling stations: approximately 0.4-0.7 km from Nusawere) (Figure 1).

Shrimps taken at the Zone I-IV study areas are arbitrarily referred to as adults, carapace length (CL) more than 25 mm, immature CL 18-25 mm, and post-larvae and juvenile CL: 3- 18 mm (Toro, 1996, Staples, 1989). The shrimp population referred as recruit population if they have CL ≤ 30 mm (Toro & Sukardjo, 1988). The distribution and relative abundance of adult, immature and post-larvae and juvenile shrimp *P. monodon* were investigated using *Anco* (a traditional stationed lift-net method) (Figure 2) sampling at selected 53 stations (Zone I: 15 stations, Zone II: 9 stations, Zone III: 16 stations and Zone IV: 13 stations) (Figure 1) during daylight hours in the SAL and its estuarine rivers at monthly intervals in December 2002-November 2003 and in August to November 2006**)**. The description of *Anco* (a traditional stationed lift-net) was given in Subani (1980). The net with 18 mm mesh-size collected effectively shrimps over 3 mm of carapace length (CL). The CL of all shrimps caught by *Anco* methods was measured by dial calipers and read to the millimeter unit below, and counted. Additional information was obtained from local fishermen directly in the fields.

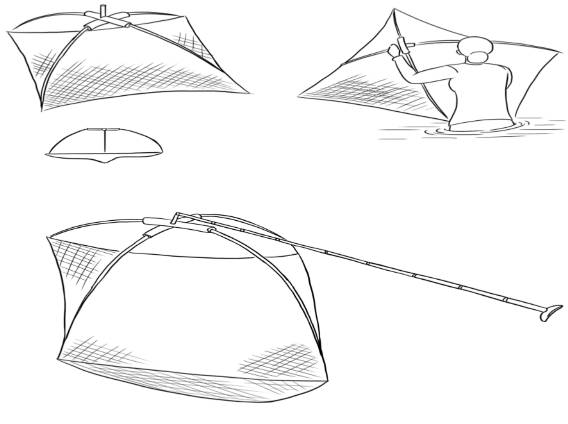

Figure 2. *Anco* (a traditional stationed lift-net method) (Subani, 1980)

The commercial shrimp-catch figures for 13 years (1998-2011) was used as an information (secondary data). *Anco* methods were permanently used elsewhere in SAL. Salinity was measured *in situ* by using *a refracto salinometer* and portable *Electronic Switchgear S-T bridge type MC-5* in every station with 5 replications.

RESULTS AND DISCUSSION

Size distribution and seasonal abundance

Throughout the 16 months of sampling periods, a total of 6,854 shrimps *P. monodon* were caught by *Anco* at all stations in the 4 zones at SAL, and female shrimp (3,384 or 49.37%) dominated the population. The carapace length (CL, mm) of the population ranged from 17.1 to 59.0 mm, for male the ranged was from 20.00-42.50 mm and for female it was 17.1 to 59.0 mm (Table 1).

Table 1 showed also the different CL sizes of shrimp between two substrates in the 4 zones, based on statistical test with significantly at 1% (Toro & Sukardjo, 1987, Toro & Sukardjo, 1988a, Toro & Sukardjo, 1995a). The CL size distribution of the population is presented in Figure 3, and it was shown that during the Transition Period I: March to May (Musim Peralihan I) the shrimp size was highest for both male (mean of 31.7 mm CL) and female (mean of 33.3 mm CL) (Table 2).

A shrimp *P. monodon* with 17.1-24.9 mm CL of juvenile and/or immature stages: (Staples, 1989, Toro, 1996, Toro & Sukardjo, 1988 b) enter the SAL from the Citanduy, Cibereum, Kawunganten and Muara Dua rivers during the Transition Period II (September to November) (Table 2, Figure 3). Individuals shrimp with 17.1-21.9 mm CL were apparently more tolerant of freshwater, and were found in both silty-clay (male: 20.0 mm CL, female: 17.1 mm CL) and sandy-clay

Table 1. The ranges of carapace length (CL) of *Penaeus monodon* Fabricius at each zone in both different substrates. Significantly at the p 1%.

Stations with	Size range (CL, mm)	
	Male	Female
Silty-clay substrate:	20.0-42.5	17.1-59.0
1. Zone I	22.7-41.5	21.4-53.5
2. Zone II	20.0-4.5	17.1-48.3
3. Zone III	21.5-4.3	22.5-48.8
4. Zone IV	23.6-4.5	23.9-59.0
Sandy-clay substrate:	21.9-4.1	21.4-54.5
1. Zone I	23.1-3.5	26.5-39.5
2. Zone II	21.9-29.7	21.4-33.3
3. Zone III	24.9-38.3	24.3-38.8
4. Zone IV	25.0-41.1	27.5-54.5

Table 2. Effect of rainfall to the local seasonal movement of *Penaeus monodon* Fabricius in term of their abundance during December 2010 to November 2011 in SAL.

Zone	Annual catch (number of individual)	Seasonal catch (number of individual)			
		West Monsoon (December 2010 - February 2011)	Transition Period I (March - May 2011)	East Monsoon (June - August 2011)	Transition Period II (September - November 2011)
I	1,041	284	142	94	521
II	1,123	345	257	81	440
III	1,169	356	258	67	488
IV	1,414	487	221	192	514
Total (I-IV)	4,747	1,472	827	354	1,963
I-IV	Male (Mean CL, mm)	30,431	31,706	29,330	28,976
	Female (Mean CL, mm)	31,741	33,321	29,706	29,770

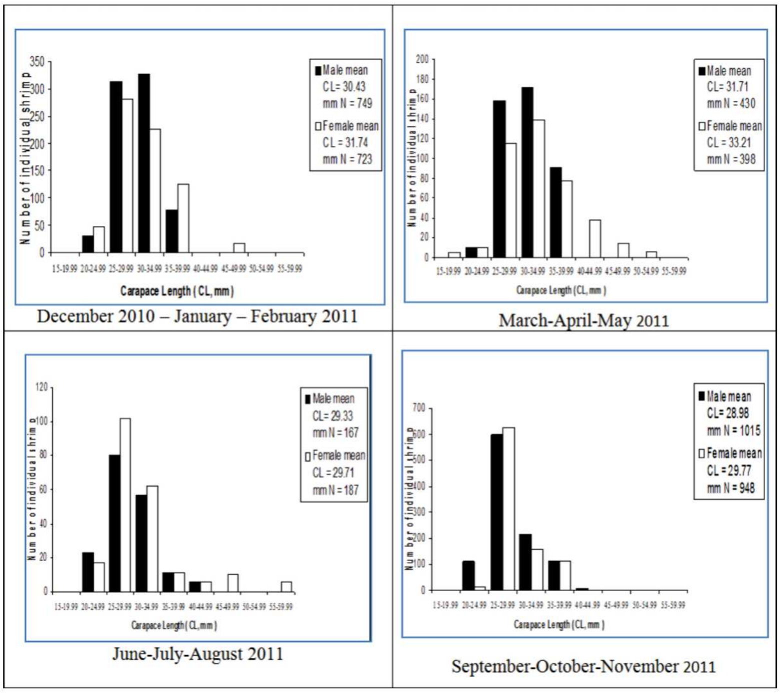

Figure 3. *Penaeus monodon* Fabricius length frequency distribution in SAL.

substrates (male: 21.9 mm CL, female: 21.4 mm CL) of the Zone II where salinity is invariably less than 14‰ due to freshwater discharge from the Kawunganten and Muara Dua rivers (Table 1, Figure 4).

Adult stages (>25 mm CL) of shrimp *P. monodon* in the SAL normally remain in the sandy-clay and silty-clay substrates of the estuaries and inhabit areas with a salinity more than 30‰ (cef. Toro & Sukardjo, 1987). During the high rainfall (>1,000 mm per 3 months), we found the adult shrimp move to zone IV (with salinity ranges 16-29 ‰) (Figures 4), usually inhabits site areas with a salinity less than 29 ‰. The highest number of individual shrimp *P. monodon* were found in the zone IV (1,41 individual shrimp) (Table 2), at the near mouth of channel to Hindian oceans and where most of the population have a CL ranging from 41.1 to 59.0 mm (Tables 1, 2). There were few shrimps with 54.5-59.0 mm CL for both male and female. The high number of shrimp population in the 4 zones of SAL correspond to the highest rainfall in the region (Table 3), and shown statistically significant at the p <0.01 (Table 4). Figure 5 demonstrates the seasonal fluctuation in abundance of adults (>25 mm CL).

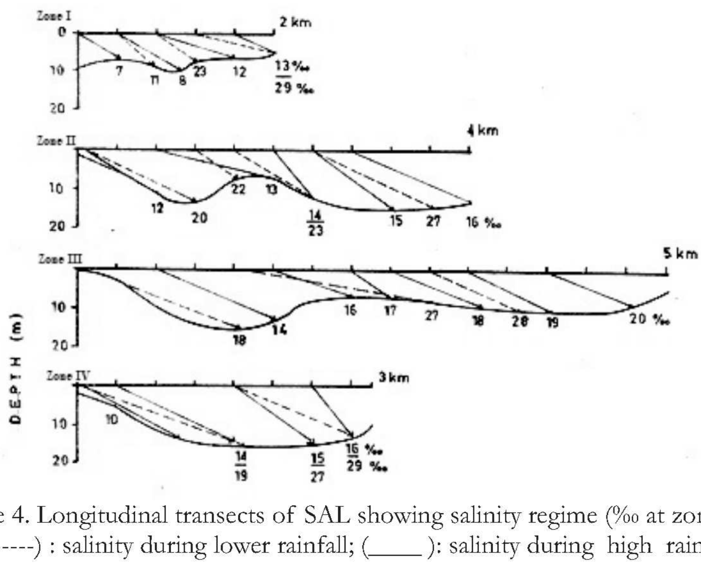

Figure 4. Longitudinal transects of SAL showing salinity regime (‰ at zone I-IV) (------) : salinity during lower rainfall; (_____): salinity during high rainfall.

Table 3. Abundance of *Penaeus monodon* Fabricius in the period of high rainfall to lower rainfall of December 2010 to November 2011 in the SAL, Cilacap.

Zone	Abundance of *P. monodon* (number of individual) during the		
	High rainfall (300-450 mm/month)	**Medium rainfall (200-300 mm/month)**	**Lower rainfall (100-200 mm/month)**
I	790	186	65
II	901	173	49
III	936	197	36
IV	972	392	50
Total (I-IV)	3,599	948	200

In SAL, the Transition Period II (Musim Peralihan II): September to November 2011) represent the season with highest population (1,963 individuals shrimp) but with CL, ranging from 28.98 to 29. 80 mm for shrimps population (Table 2). The shrimps grow rapidly with a mean of 1.69 mm CL as the waters warm (28.7 $\pm$ 1.75°C) in period September to November 2011 or Transition Period II. During the dry season (June to August 2011 or East Monsoon), the growth is virtually slow (mean of 0.38 mm CL). Furthermore, the direct evidence of growth during the period the end of West Monsoon (February) to the first of East Monsoon (June) five months increased in average wet weight occurred (15.0 g in February to 21.4 g in June).

Data of 12 months (December 2010 – November 2011) showed that the local movement of adults (male: mean of 28.1-31.8 mm CL, female: mean of 29.7-33.3 mm CL) shrimp continues throughout the year (Table 2). Table 1 shows the increased in the CL size of shrimp P. monodon, from zone I to the zone IV and from zone II to the zone III of the SAL, as result of the life history out line above. The maximum and average CL sizes of females in a sample are greater than those of males (Tables 1, 2).

Initial effect of rainfall and monthly-annual catches

According to Schmidt & Ferguson (1951), Segara Anakan areas fall under the climate type of A and B. During the periods of study, the average annual rainfall was 3,7 to 4,7mm with the ration between the number of dry month (<60 mm/month) and wet month (>100 mm/month) or Q ratio was 13.0-23.0 % (Figure 1).

The *Anco* sampling (December 2010-November 2011), it was indicated that the number of shrimp *P. monodon* in the SAL had increase by 124.2% after the flood (Figure 5), and adults shrimp (>25 mm CL) were most abundant (Table 2). A large catch (in term of more than 7,000 gram/month) by *Anco* sampling were taken in April, May and June of 2011 (Figure 5).

Figure 6 (Data 1998 – 2011) showed that the annual total catch from SAL has fluctuated between 4.80 ton, taken in 2011 after a long period of dry season, and 190 ton, recorded in 1998 after a year of very heavy rainfall and peak at Citanduy, Cibereum, Muara Dua and Kawungaten rivers discharge (Meteorological Stations in Cilacap 1998 -2011). Figure 6 showed also that the higher or lower than average catches were recorded clearly. Figure 7 showed average of

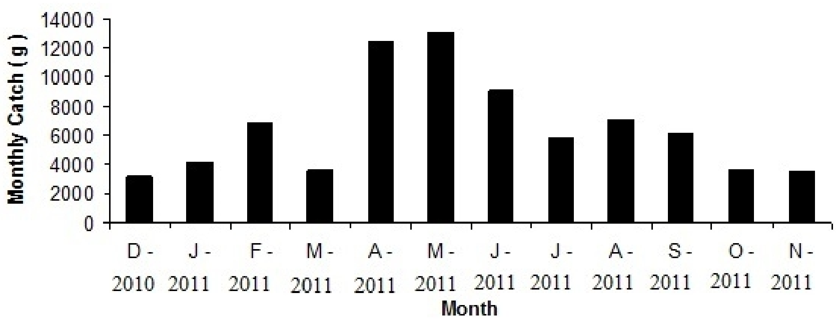

Figure 5. Monthly fluctuation in *Penaeus monodon* Fabricius caught during the study period.

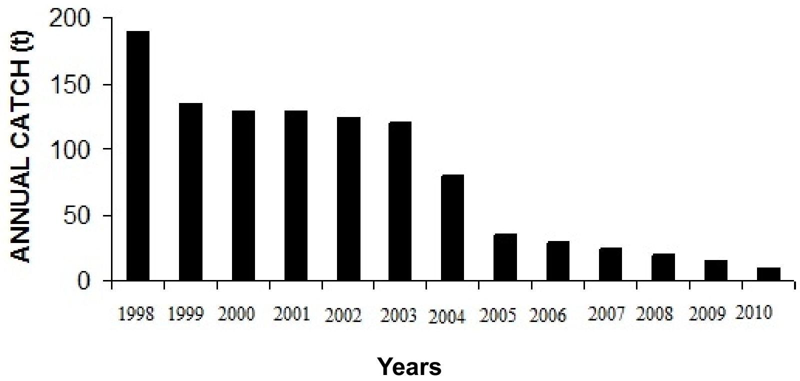

Figure 6. Annual fluctuation index in *Penaeus monodon* Fabricius

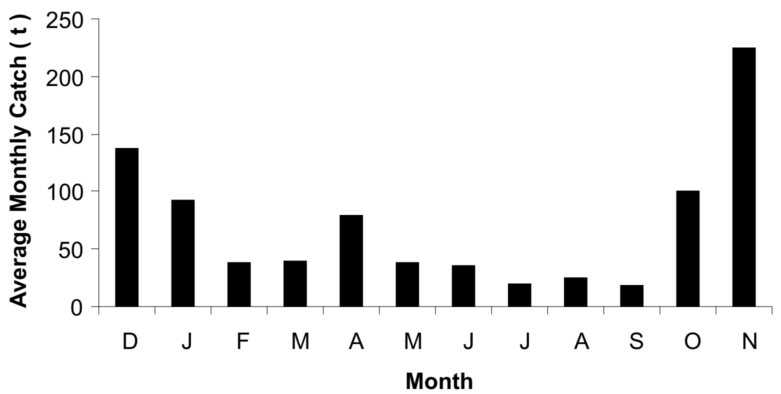

Figure 7. *Penaeus monodon* Fabricius seasonal fluctuation in abundance of adult (determine from average catch for 1998 – 2011).

Table 4. Correlation coefficient between annual catch of *Penaeus monodon* Fabrcius and rainfall in SAL, Cilacap. (Sources: +++: Annual report, Fisheries Services Cilacap District 1998-2011 plus additional data collected directly in the field by communication with fishermen, ++: Data in December 2010 to November 2011, +: Data in December 2011 to April 2012, Data for 1990-1994: not available) (** Significant at p<0.01).

Comparison	R	Degree of freedom
1. Shrimp catch with rainfall of 1998 -2011 +++	0.939**	13
2. Shrimp catch with rainfall of December 2010 to November 2011 ++	0.956**	12
3. Shrimp catch with rainfall of 2012 (Desember to April) +	0.922**	4

monthly catch from December 1998 – November 2011, and the large catches (>100 ton) was taken in SAL in November (West Monsoon) and December (Transition Period II). The monthly catch of the period 1998-2011 (13 years) in October and November after a large-scale flood in the Citanduy, Cibereum, Muara Dua and Kawunganten rivers were increased 124.1% (October-November) (Figure 7). The monthly records catch in 1998 (190 ton) after repeated large scale flooding of the Segara Anakan region in October, November, December and January (see: Meteorological Data in 1996), were 23.1 tons, 51.9 tons, 30.2 ton and 21.3 ton, respectively. Those record caculated 1 to 2.5 times of the January average (21.3 ton).

It shows that annual rainfall correlated significantly with annual catch of shrimp *P. monodon* (Table 3 & 4). The effectiveness of the annual rainfall to the catch production of the preceding year was shown by their positive correlation ($r_{1998\text{-}2011} = 0.939$, $r_{2010\text{-}2011} = 0.956$, $r_{\text{Des-April } 2012} = 0.922$) (Table 4). The figure from December 2010 to November 2011 (12 months) and December 2011 - April 2012 (4 months) shrimp *P. monodon* catch is also significantly corelated with rainfall (Tables 4 & 6). For the period of December 2010 to November 2011 (12 months) the equation of the relationship between monthly catch (Y, individual-g) and monthly rainfall (X, mm) was Y = 13.246 + 5.386 X (r = 0.956) (Figure 8) .

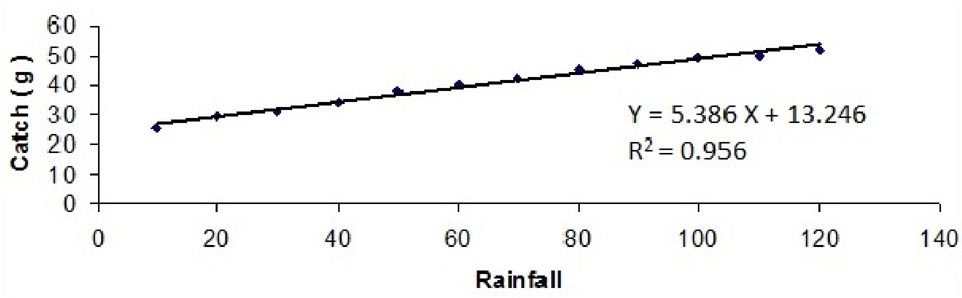

Figure 8. The relationships between monthly rainfall (x, mmm) and monthly catch (y, individu, g) of *Penaeus monodon* Fabricius in the SAL during December 2010 – November 2011.

Rainfall and abundance

The normal seasonal abundance (Figure 6,7) and the CL sizes (Figure 3) of shrimp *P. monodon* changed considerably soon after rainfall with sufficient intensity as shown in the period 13 years (1998 -2011). Figure 4, 5 for the period 1 year (2010 -2011) indicated that initial duration to produce shrimp production substantialy increase in the zone I-IV by freshwater flow into the SAL.

These results showed that prolonged and heavy rainfall is required over a substantial area of Segara Anakan catchment to produce a noticeable increase in the abundance of shrimps. In the December 2010 - November 2011 study, the well above average shrimp catch of December 2010 - January 2011 (>524 individuals) was most likely due to the heavy rainfall (328-448 mm/month) and major flood recorded in October in that year (2010). Also, it was happening for the annual production in 1998 to 2011 (> 65 ton) (Figure 6).

In one-year (2010 -2011) period, local movement of shrimp *P. monodon* after prolonged heavy rainfall have been observed in the zones of SAL (Tables 2 & 3). The increased river flow after high rainfall (300-448 mm/month) enhanced the local seasonal movement from the zone I (790 individuals) to zone IV (972 individuals), and zone II (901 individual) to zone III (936 individuals) (Table 3). Monthly sampling for the December 2010-November 2011 revealed that a moderate rise in the freshwater flow into the lagoon enhances the local movement of only the shrimp *P. monodon* with 25 to 35 mm CL after heavy rainfall.

Figure 3 showed that the striking changed in the CL frequency distribution of samples from 53 stations in SAL observed in December 2010 to November 2011. The decrease in the mean CL for both sexes (female: 33.3 to 29.7 mm, male: 31.7 to 28.2 mm), and the increased frequency of the small size (25.0-30. 0 mm CL) (female: 4.1 to 48. 5%, male: 14.3 to 37.5%) adults in the sample taken during the 2002-2003 period of study were attributed to a large influx of the smaller to medium (30.0-34,0 mm CL) size group of adult shrimp *P. monodon* which have moved locally with the flood from the upper rivers reaches of the estuary in each zone of the lagoon. The strong uni-modal size distribution of the shrimp males and females illustrated the usual occurrence of shrimps in mangroves waters as a result of heavy flooding and a very high freshwater flow into SAL. Also, the areas of Segara Anakan mangrove waters represent a both nursery and feeding grounds of shrimp *P. monodon*. There was no sample of a re-entry of these smaller shrimp into the estuarine habitat after the flood waters receded. This is indicated that rainfalls affect the local movement of shrimp (Table 5).

In Cilacap region, it was reported that marketable size of adult shrimps was 27.5-94.6 mm CL. This is based on the result of inshore catch of trawl (Naamin, 1982). However, shrimps with 17.1-59.0 mm CL were normally also considered as local marketable sized, and abundant in the SAL during the 12 months study period (Figure 5).

The above results on the size distribution and seasonal abundance confirm a general account of the bio-ecology of shrimp *P. monodon* Fabricius with 17.1-59.0 mm CL in the SAL and its different seasons (Tables 1, 2). This is an indication that the shrimp population in the lagoon at the 4 zones with two different substrates are in mixed juvenile (CL <18.00 mm) to immature (CL 18-25 mm), adult stages (CL > 25 mm) and include recruitment size (CL > 30.0 mm) (cf. Staples, 1980a, b, 1989, Toro, 1996, Toro & Sukardjo, 1995 b). Within the estuaries with dense mangrove trees in the Citanduy, Cibereum, Kawunganten and Muara Dua, *P. monodon* is closely associated with those dense mangrove vegetation, and their abundance have a significant correlation with rainfall (r= 0.956) (Table 4). This correlation appears to be due to the cumulative effect of rainfall on the shrimps' bio-ecological aspects (e.g. reproductive potential, recruitment, growth, and survival) (Toro & Sukardjo, 1988a), and condition factor (Toro & Sukardjo, 1990). These indicated also that *P. monodon* are estuarine-dependent throughout the CL range of the species. It is supported by the fact that Segara Anakan is a tropical shallow lagoon with salinity regime less than 33‰, very active sedimentation process typified by clay particle (Napitupulu & Ramu, 1982), and therefore represent an ideal silty-clay and sandy-clay substrates for the *P. monodon* (17-59 mm CL) growth and nurseries, and suggested facilitate burying for juveniles. These finding confirm those of Hughes (1966), Branford (1981a, 1981b), Freitas (1986), Subramania *et al.* (1983) and Naamin (1991). The sediment preferences and morphometric equations for *P. monodon* from estuarine at the 4 zones in the lagoon need to be studied in detailed (Table 5) (Toro & Sukardjo, 1987). In general, burrowing by shrimp *P. monodon* in the substrate of silty-clay is well established by Toro & Sukardjo, (1988a), which suggests that SAL represent their natural habitat as shown by analysis of variance using randomized block (Tables 5 & 6).

The male adults were smaller than the females in CL size at all season (Table 2). This might be regarded as a general characteristic of Penaeid shrimp in SAL with predominantly by mangroves lined at their coasts (cf. Motoh, 1981). It is also interesting to note that males were sexually mature at a smaller CL size than female by 29.0 mm CL. Juvenile (CL 17-18 mm) and adolescent *P. monodon* were recorded from surface waters in the 4 zones of SAL (cf. Hughes, 1966). Therefore, spawning of *P. monodon* does not require a particular water depth in SAL (Figure 5) (cf. Staples, 1981, 1982). It is quite possible that the juveniles could cope with high temperatures of particular water depth due to their burying behavior (e.g. Joshi, *et al.* 1979). Thus, Segara Anakan mangroves areas represent a nursery ground for the post larval and early juvenile stages (17-25 mm CL) of *P. monodon*. Consequently, the recruitment of the young shrimp (<30 mm CL) to the mangroves estuarine environments of Citanduy, Cibereum, Kawunganten and Muara Dua is critical stage of their life history, and the estuarine discharge of fresh or brackish water play an important part of this process. Also in the low salinity (7-11‰) habitat (Figure 4), there were fewer potential predator for young shrimp (e.g. Robertson, 1988), and, hence, this areas favorable for juvenile (CL 17 -25 mm) *P. monodon*.

The local movement of shrimp (Tables 2, 3) from the estuarine environment (Citanduy, Cibereum, Kawungaten and Muara Dua) in each zone after flood was due to the decreased salinity (Figure 5) (e.g. Mair, 1980, Primavera, 1996). A strong fresh water inflow from those rivers will enhance the reproductive success of *P. monodon*. This supported by the tidal periodicity of movement of adult shrimp from zone I into the zone IV, and zone II into the zone III which are shown by the changes in the number of prawn

Table 5. ANOVA showing the result of *Penaeus monodon* Fabricius catch in 2 substrate types (silty-clay and sandy clay) in 12 randomized blocks by rainfall in mm/month with (p>0.05).

Source of variance	Df	SS	MS	$F_{cal.}$	$F_{0.05}$	$F_{0.01}$
Among treatments (Rainfall/month)	11	669,217.125	60,837.921	1.499 <	2.28	4.46
Block (substrate types)	1	30,317.042	30,317.042	0.757 <	4.84	9.65
Error	11	446,285.458	40,571.405			
Total	23	1,145,819.625				

Table 6. ANOVA showing the result of catch of 8 locations of *Penaeus monodon* Fabricius in 12 Randomized Blocks by rainfall in mm/month with 9 missing values (p<0.01).

Source of variance	Df	SS	MS	Fcal.	F0.05	F0.01
Among treatments (Rainfall/month)	11	143,527.029	13,047.912	7.217 >>	1.916	2.489
Block (Locations)	7	16,244.696	2,320.671	1.284 <	2.126	2.882
Error	77	139,198.895	1,807.777			
Total	95	298,970.6201				

with 18-25 mm CL (sub-adult) caught in a set *Anco* at the mouth of Cibereum and Citanduy, and Kawunganten and Muara Dua rivers (Table 2). This is coinciding with the report of Hughes, (1966) that juvenile and adolescent *P. monodon* were recorded from surface waters in estuaries. It can be concluded that the shrimp *P. monodon* with CL 25-59 mm belong to the hypo-osmo-regulators species (e.g. Dall, 1981). These finding suggest that rivers flooding in each zone would not produce an osmotic stress in adult shrimps. This is also in agreement with Toro & Sukardjo, (1988a) that found the adult (37.2 $\pm$ 5.8 mm CL) shrimp *P. monodon* can tolerate large fall in salinity. In shallow waters up to water depth around 5 m, fine sediment comprising clayey silt cover the shrimp *P. monodon* substrates. This implies also serve to protect fisheries interest in the SAL. This suggestion is supported by the catch production in the period 1998-2011, December 2010 - November 2011 and December 2011 -April 2012 (Tables 4, 5, 6). The linear relationship observed between monthly rainfall and monthly catch (Figure 8) suggest that the enhanced local movement of *P. monodon* after effective rainfall was a response to the increased river flow and the subsequent disturbance of the bottom sediment (cf. Robertson, 1988). Tables 4, 5 & 6, and Figure 7 showed an association between the catch of *P. monodon* in SAL and the regional rainfall (annual and monthly) with highest coefficient of correlation (r) ($r_{1998\text{-}2011}$: 0.939, $r_{\text{December 2010 -November 2011}}$: 0.956, $r_{\text{December - April 2012}}$: 0.922). The correlations (Table 4) was attributed to the cumulative effect of rainfall on the shrimp reproductive success, on the recruitment of young to the estuaries in each zone, and on the growth and survival of all life history stages (cf. Buckworth, 1992). As it was happened for *P. monodon* in the Godavari estuarine system in India (Subrachmanyan, 1966).

The mangrove forests in Segara Anakan produced litterfall of about 270-791 dry t/ha/year (Sukardjo, 1984b). This material will be processed and feed by most mangrove crabs (e.g. Ashton, 2002, Skov & Hartnoll, 2002, Dahdouh-Guebas *et al.* 1999), and decomposed on the surface of the mud in the mangrove forests (e.g. Camilleri & Ribi, 1986), and will transport (e.g. Boto & Bunt, 1981, Sukardjo, 1995a) to the SAL by tides, which greatly benefit the growth and survival of *P. monodon*. These indicated that the lagoon has highest DOM (dissolved organic matter) (Sukardjo & Toro, 1995b). Previous studies have emphasized the importance of mangrove detritus (Leh & Sasekumar, 1984) in the diet of juvenile *Fenneropenaeus merguiensis* Fabricius This detrital material plays also a particularly important part in the nutrition of juvenile *P. monodon* (e.g. Motoh, 1981, Tiews, 1976, Dall, 1968, Chong & Sasekumar, 1981). And, the rainfall indirectly contributes to the food supply for all life history stages (17.1-59.0 mm CL) of *P. monodon* in the 4 zones of SAL. TE-FPIPB (1984) stated that the food investigation and water conservation purposes in the upper reaches of lagoon has probably had little or no adverse effect on the *P. monodon* in the Citanduy, Cibereum, Kawunganten and Muara Dua estuaries. Therefore, a moderate or high discharge of water from the Kawunganten, Muara Dua (Zone II), and Cibereum, Citanduy (Zone I) rivers, and the large tidal fluctuations in salinity of the lagoon from each zone to the mouth of the estuary (Figure 3) would facilitate the local movement of larval and post larval (CL 17.10-25 mm) *P. monodon* (cf. Buckworth, 1992, Mair, 1980).

Estuaries of the Citanduy, Cibereum, Kawunganten and Muara Dua are important for study of SPM (Suspended Particulate Matters) and substrate preferences of juvenile shrimps *P. monodon* Fabricius (CL 17.1-25.0 mm) (e.g. Rulifson, 1981, Primavera, 1998), as through this conduit, rivers borne material, water and sediment; enter into SAL (Napitupulu & Ramu, 1982). Deposition of suspended matters is controlled largely by sediment concentration; settling velocity and fluid shear (cf. Mazda *et al.* 2007, Purba, 1991). Deposition occurs in slack water conditions when shear stress falls bellows certain critical values. It is a common observation that clay particles come under stress when they come in contact with water of high salinity and tend to flocculate and precipitate out of suspension, e.g. in zone IV. Most probably this process is very active in Citanduy estuary where a decreasing trend of SPM is observed towards high salinity region near the mouth.

Table 2 confirms the similarity in the fluctuations of rainfall and catch demonstrated by Figure 7, and shows that the correlation coefficient between the annual rainfall or monthly rainfall and the catch of the same year, is significant at the 1% level (Table 4) as humid tropical domain for species sustainability. Also, the highest correlation between rainfall and the catch was found between the annual catch and the total rainfall of the 2010-2011 plus the 2012 study at the 1% level of significant. The significance of the results in Table 2 increases when it is noted that *P. monodon* is adult in the SAL of about in CL 25-35 mm, and they comprise a distinct recruitment stock (CL $\geq$ 30.0 mm) each year. This strong correlation between rainfall and the catch of the December 2010 -November 2011 and 2012 suggested that there may be a causal relationship between the two.

The year – to - year changes i.e. increase or decrease (Figure 6) in shrimp catch agrees with the preceding yearly changes in rainfall from 2,6 mm to 5,7 mm per year in Cilacap district. In 1998 -2011, the Cilacap district rainfall was slightly below the yearly average (<2,5mm), and the Citanduy, Cibereum, Kawunganten and Muara Dua rivers was subjected to small-scale flooding, may account for the large shrimp catch of 1998 (190 ton) (Figure 6). This is an indication that the fluctuation of shrimp catch may be due to salinity changes as a result of rainfall. Figures 6, 7 suggest that *P. monodon* fishery declined up to 80 ton to 100 ton per year indicated the less influx of fresh waters carrying by rivers. Finally, continued diminution of the fresh water flow into many of the estuaries in the SAL will probably have a long-term detrimental effect on the *P. monodon* stocks. Thus, the effects of dry or rainy seasons on the population ecology of *P. monodon* through hydrology of the lagoon should be studied intensively. There has been long term lower trend in catch from 1998 to 2011 (Figure 6), but a remarkable correlation of the fluctuation in SAL catch, and the Cilacap district annual rainfall (Tables 4, 6) corresponding to the maxima and minima in monthly rainfall, as shown in the December 2010 to November 2011 study (Figure 5).

Moreover, the high number of shrimp in the SAL, especially in zone IV also suggest that *P. monodon* may mover/migrate short distances (Tables 2 & 3). These moving patterns underline three key points about the SAL management: First, increasing regulation of water flow is increasingly devastating to natural fisheries. Second, the benefits of mangrove forest in SAL are felt at some considerable distance from their locations. Third, such are the links between mangrove forest, rivers, SAL and the open sea of Cilacap region (Hindian Ocean) that up-setting the water regime which normally maintains a mangrove system and flooding cycle can have considerable not on effects.

CONCLUSIONS

It is very important to be noted in SAL that rainfall is very important factor for distribution, abundance and reproductive success of *Penaeus monodon*. Also, SAL with mangrove vegetation play important role for the develompmnet and growth of shrimps *Penaeus monodon* population. This is should be interesting to be studied in detail for longterm population development of *Penaeus monodon* to characterized their variation of sizes during in and around the mangrove habitat (*cf.* Hugesh, 1966) . Our study also prove that SAL is very important fisheries resources (*cf* . Amin & Hariati, 1991).

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REFERENCES

Amin E.M & Hariati T. 1991. The capture fisheries of Segara Anakan, Indonesia. *In*: L.M. Chou *et al.* (eds.), Towards on Integrated Management of Tropical Coastal Resources, 51-56. ICLARM Contribution No.552.

Annual Report of The Fisheries Service, Cilacap District. 1988-2002. Fisheries report statistics. Unpublished Report.

Ashton E.C. 2002. Mangrove Sesarmid crab feeding experiments in Peninsular Malaysia. *J. of Exp. Mar. Biol and Ecol.* 272:97-119.

Boto K.G, Bunt J.S. 1981. Tidal export of particulate organic matter from a northern Australian mangrove system. *Estuarine, Coastal and Shelf Science* 13:247-255.

BPKSA. 2006. Pengelolaan hutan mangrove di kawasan Segara Anakan. Paper presented at the Lokakarya Nasional Pengelolaan Ekosistem mangrove, Jakarta 17-18 July 2006.16pp.

BPS. 2016. Statistik Indonesia. BPS Jakarta.

Branford J.R. 1981a. Sediment and the distribution of Penaeid shrimp in the Sudanese Red Sea. *Estuarine Coastal and Shelf Sciences*. 13:349-354.

Branford J.R. 1981b. Sediment preferences and morphometric equations for *Penaeus monodon* and *P. indicus* from Creeks of the Red sea. *Estuarine, Coastal and Shelf Sciences* 33:473-476.

Buckworth R.C. 1992. Movements and growth of tagged blue Endeavour prawn *Metapenaeus endeavouri* (Schmitt 1800) in the western Gulf of Carpentaria Australia. *Aust. J. Mar. Freshwater Res*. 43:879-912.

Camilleri J.C, Ribi G. 1986. Leaching of dissolved organic carbon (DOC) from dead leaves, formation of flakes of DOC and feeding on flakes by crustaceans in mangroves. *Mar. Biol. (Berl.)* 91:337-344.

Chong V.C, Sasekumar A. 1981. Food and feeding habits of the white prawn *Penaeus merguiensis*. *Mar. Ecol. Prog. Ser*. 5:185-191.

Dahdouh-Guebas G., Giuggioll M., Oluoch A., Vannini A, Cannicci S. 1999. Feeding habits of non-ocypoidid crabs from two mangrove forests in Kenya. *Bull. Mar. Sci*. 64:291-297.

Dall W. 1968. Food and feeding of some Australian Penaeid shrimps. FAO Fish. Rep. 57:251-258.

Dall W. 1981. Osmoregulatory ability and juvenile habitat preference in some Penaeid prawns. *J. of Exp. Mar. Biol and Ecol*. 54:55-64.

Djohan T.S. 2007. Mangrove succession in Segara Anakan Cilacap. *Berkala Ilmiah Biologi* 6(1):53-62.

Dudley, R.G. 2000. Segara Anakan fisheries management plant. Cilacap: Segara Anakan Conservation and Develompment Project.

Freitas A.J.DE. 1986. Selection of nursery areas by six southern African Penaeidae. *Estuarine, Coastal and Shelf Science* 23:901-908.

Hardjosuwarno S., Notohadiprawiro T, Suryowinoto M. 1982. The Cilacap mangrove ecosystem. *In*: E.C.F. Birds, A. Soegiarto and K. Soegiarto (eds.), Proceeding of the Workshop on Coastal Resources Management in the Cilacap Region, 57-66. LIPI Jakarta and the UNU Tokyo.

Hugesh D.A. 1966. Investigations of the nursery areas and habitat preferences of juvenile Penaeid prawn in Mozambique. *J. Appl. Biology* 3:349-354.

Joshi P.K., Kulkarni G.K, Nagabhushanam R. 1979. Studies on the behaviour and substratum preference in juveniles of the marine prawn *Metapenaeus monoceros* Fabricius. *Hydrobiologia* 65(3):195-198.

Leh C.M.U, Sasekumar A. 1984. Feeding ecology of prawns in shallow waters adjaoining mangrove shores. *In:* E. Soepardmo, A.N. Rao and D.J. MacIntosh (eds.), Proceedings Asian Symposium on the mangrove environment: Reswearch and Management, 331-353. Unesco, Kuala Lumpur.

Mair J. McD. 1980. Salinity and water-type preferences of four species of postlarval shrimp Penaeus from West Mexico. *J. of Exp. Mar. Biol and Ecol*. 45:69-82.

Mazda Y., Wolanski E, Ridd P.V. 2007. The role of physical processes in mangrove environment. TERRABUB, Tokyo. 598pp.

Motoh H. 1981. Studies of the fishetries biology of the giant tiger prawn *Penaeus monodon* in the Philippines. SEAFDEC Technical Report No.7:1-128.

Naamin N. 1982. Shrimp fishery on the south coast of Java and some problems of its management. *In*: E.C.F. Birds, A. Soegiarto and K. Soegiarto (eds.), Proceeding of the Workshop on Coastal Resources Management in the Cilacap Region, 51-56. LIPI Jakarta and the UNU Tokyo.

Naamin N. 1991. The ecological and economic roles of Segara Anakan, Indonesia, as a nursery ground of shrimp. *In*: L.M. CHOU *et al.* (Eds.), Towards on Integrated Management of Tropical Coastal Resources, 119-130. ICLARM Contribution No.552.

Napitupulu, Ramu K.L.V. 1982. Development of the Segara Anakan area of Central Java. *In*: E.C.F. Birds, A. Soegiarto, Soegiarto K. (eds.), Proceeding of the Workshop on Coastal Resources Management in the Cilacap Region, 66-82. LIPI Jakarta and the UNU Tokyo.

Nuryanto A, Susanto A.H. 2010. Genetic variability of *Polymesoda eros* population in the Segara Anakan, Cilacap. *Biotropia* 17, 22-30.

Primavera J.H. 1998. Mangrove as nurseries: shrimp populations in mangrove and non-mangrove habitat. *Estuarine, Coastal and Shelf Science* 46:457-464.

Primavera J.H. 1996. Stable carbon and nitrorgen isotop ratios of Penaeid juveniles and primary producers in a riverine mangrove in Guimaras, Philippines. *Bull. Mar Sci*. 58 (3): 675-683.

Purba M. 1991. Impact of high sedimentation rates on the coastal resources of Segara Anakan, Indonesia. *In*: L.M. Chou *et al.* (eds.), Towards on Integrated Management of Tropical Coastal Resources, 143-152. ICLARM Contribution No.552.

Robertson A.I. 1988. Abundance, diet and predators of juvenile banana prawns *Penaeus merguiensis* in a tropical mangrove estuary. *Aust. J. Mar. Freshwater Res*. 39:467-478.

Rohmat, D. 2005. Pemantapan kelembagaan konservasi tanah dan air pada masyarakat pedesaan kawasan hulu menuju kestabilan daerah aliran sungai (Pengalaman empirik dari anakan). *Jurnal Geografi GEA* 5(2): 1-9.

Rulifson R.A. 1981. Substrate preferences of juvenile Penaeid shrimps in estuarine habitats. *Contributions in Marine Science* 24:35-52.

Saputra, S.W. 2008. *Biologi, dinamika populasi dan pemgelolaan udang Metapenaeus elegans de Man 1907 di Laguna Segara*

Anakan Cilacap. Badan Penerbit Universitas Diponegoro Semarang. 168 hal.

Schmidt F.H, Ferguson J.H.A. 1951. Rainfall types based on wet and dry period ration of Indonesia with western New Guinea. Kementrian Perhubungan, Jawatan Meteorologi dan Geofisik. *Verhandelingen* No.42.

Setijanto, Rukayah S. 2016. Segara Anakan Lagoon (SAL): Fish Biodiversity and the Ecological Role. *OmniAkuatika,* 12 (1): 13–21.

Skov M.W, Hartnoll R.G. 2002. Paradoxical selective feeding on a low nutrient diet: why do crabs eat leaves? *Oecologia* 131:1-7.

Staples D.J. 1980a. Ecology of juvenile and adolescent banana prawn *Penaeus merguiensis* in a mangrove estuary and adjacent off-shore area of the Gulf of Carpentaria. 1. Immigration and settlement of post-larvae. *Austr. J. Mar. Freshwater Res.* 31:635-752.

Staples D.J. 1980b. 2. Emigration, population structure and growth of juveniles. *Aust. J. Mar. Freshwater Res.* 31:653-665.

Staples D.J. 1989. Second IOC-FAO Workshop on recruitment of Penaeid prawns in the Indo-West Pacific region, Phuket Thailand, 25-31 September 1989. UNESCO-IOC Workshop Report No.64: 41.

Subani W. 1985. Alat tangkap traditional di Indonesia. LPPL Jakarta.

Subrachmanyan M. 1966. Fluctuations in prawn landings in the Godavari estuarine system. Proceeding of the Indo-Pacific Fish Council 11:44-51.

Subramania P, Sambasivam S, Krishnamurty K. 1983. A survey of natural communities of juveniles of Penaeid prawns. Proceedings of the First National Symposium on Shrimp farming. *MPEDA Cochin*: 53-60.

Sukardjo S. 1984a. The present status of the mangrove forest ecosystem of Segara Anakan, Cilacap Java. Tropical Rain forest – The Leeds Symposium, UK:53-67.

Sukardjo S.1984b. Mangrove ecosystem. *In*: TE-FPIPB (eds.), Ecological aspects of Segara Anakan in relation to its future management, 54-71. Institute of Hydraulic Engineering in cooperation with Faculty of Fisheries BAU, Bogor.

Sukardjo S. 1995a. Structure, litterfall and net primary production in the mangrove forests in the East Kalimantan. *In:* E.O. BOX *et al.* (Eds.), Vegetation sciences in forestry, 558-661. Kluwer Academic Publisher, The Netherlands.

Sukardjo S, Toro A.V. 1995b. Makna ekologi hutan mangrove untuk menunjang pengembangan perikanan di Banyuasin Sumatera Selatan. *In:* Fuad Cholik (eds), Prosiding Simposium Perikanan Indonesia I, 419-453. Badan Penelitian dan Pengembangan Pertanian Pusat Penelitian dan Pengembangan Perikanan, Jakarta.

Sukardjo, S. 2004. Fisheries associated with mangrove ecosystems in Indonesia: A view from a mangrove ecologist. *Biotropia*, 23: 13-39.

Sukardjo S. (In preparation). Ecological status of mangrove in Segara Anakan.

Sunaryo I. 1982. A floristic study of mangrove forest in Segara Anakan. *In*: E.C.F. Birds, A. Soegiarto and Soegiarto K. (eds.), Proceeding of the Workshop on Coastal Resources Management in the Cilacap Region, 132-145. LIPI Jakarta and the UNU Tokyo.

Sutrisno, B.O. , S.B. Prayitno. 2013. The change of mangrove coverage in Segara Anakan Lagoon of Cilacap- Central Java. *Ind. Fish. Res. J.* 19: 81-84.

Suryawati, S.E. E. Soetarto, L. Adrianto, A.H. Purnomo. 2011. Identifikasi sistem insentif pengelolaan sumberdaya di Laguna Segara Anakan. *J. Kebijakan Sosek KP*. 1 (1): 45-61.

Suwarso, Wasilun. 1991. The crab fishery around the mangrove areas of Segara Anakan Cilacap Java Indonesia. *In*: L.M. Chou *et al.* (Eds.), Towards on Integrated Management of Tropical Coastal Resources, 57-64. ICLARM Contribution No.552.

Tiews K., Bravo S.A, Ronquillo I.A. 1976. On the food and feeding habits of some Philippines shrimps in Manila Bay and San Miquel Bay. IPFC Proceedings 13(3):85-92.

TE-FPIPB. 1984. Ecological aspects of Segara Anakan in relation to its future management. Institute of Hydraulic Engineering in cooperation with Faculty of Fisheries BAU, Bogor. 97pp + 26 App.

Toro A.V. 1996. Kajian morphometriks udang-kepiting (Crustacea: Decapoda: Penaeidae – Portunidae) niaga laut mewarnai corak penelitian biologi-ekologi merupakan wujud nyata dalam menunjang peruntukannya. Orasi Ilmiah Research Professor. Puslitbang Oseanologi LIPI Jakarta. 38pp.

Toro A.V, Sukardjo S. 1987. Substrat udang windu *Penaeus monodon* Fabricius di perairan mangrove Segara Anakan Cilacap. *In*: S. Anantawirya and S. Notosudarmo (eds.), Prosiding Seminar Ilmiah Ekologi Tanah dan Ekotoksikologi, 42-61. UKSW Press, Salatiga.

Toro A.V, Sukardjo S. 1988a. Perairan mangrove Segara Anakan Sumber perikanan dan habitat udang Penaeidae. *In*: Z. Jangkaru *et al.* (Eds.), Prosiding Seminar Nasional Perbenihan Ikan dan Udang, 454-481. Badan Litbang Pertanian dan Universitas Padjadjaran Bandung.

Toro A.V, Sukardjo S. 1988b. Penelitian tentang penangkapan, pemijahan dan recruitment udang windu *P. monodon* Fabricius di perairan mangrove Segara Anakan Cilacap. *In*: Z. Jangkaru *et al.* (Eds.), Prosiding Seminar Nasional Perbenihan Ikan dan Udang, 644-671. Badan Litbang Pertanian dan Universitas Padjadjaran Bandung.

Toro A.V, Sukardjo S. 1990. The relative condition factor and carapace length-weight relationship of udang windu *Penaeus monodon* Fabricius in the Segara Anakan mangrove waters, Cilacap, Central Java, Indonesia. *J. Mar. Biol. Ass. India* 32 (1-2):150-153.

Toro A.V, Sukardjo S. 1995a. Kesukaan substrat dan morfometri udang Windu, *Penaeus monodon* Fabricius, di perairan parit alam hutan mangrove Cikeperan, Cilacap. *In*: Fuad Cholik (eds), Prosiding Simposium Perikanan Indonesia I, 496-521. Badan Penelitian dan Pengembangan Pertanian Pusat Penelitian dan Pengembangan Perikanan, Jakarta.

Toro A.V, Sukardjo S. 1995b. Pengelolaan dan eksploitasi udang Windu, *Penaeus monodon* di perairan mangroves Segara Anakan, Cilacap. *In:* Fuad Cholik (eds), Prosiding Simposium Perikanan Indonesia I, 335- 343, Badan Penelitian dan Pengembangan Pertanian Pusat Penelitian dan Pengembangan Perikanan, Jakarta..