BIODIVERSITAS
Volume 17, Number 2, October 2016
Pages: 808-813

ISSN: 1412-033X
E-ISSN: 2085-4722
DOI: 10.13057/biodiv/d170258

The length-weight correlation and population dynamics of razor clams (*Solen regularis*) in Surabaya east coast, Indonesia

NINIS TRISYANI[1,2,♥], ENDANG YULI HERAWATI[3], MAHENO SRI WIDODO[3], DADUK SETYOHADI[3]
[1]Doctoral Program, Faculty of Fisheries and Marine Science, Universitas Brawijaya. Jl. Veteran, Malang 65145, East Java, Indonesia.
[2]Department of Fisheries, Faculty of Engineering and Marine Science, Universitas Hang Tuah. Jl. Arif Rahman Hakim No. 150. Surabaya 60111, East Java, Indonesia. Tel.: +62-31-5945864, ♥email: nisuht@yahoo.com
[3]Faculty of Fisheries and Marine Science, Universitas Brawijaya. Jl. Veteran, Malang 65145, East Java, Indonesia

Manuscript received: 29 April 2016. Revision accepted: 7 October 2016.

Abstract. *Trisyani N, Herawati EY, Widodo MS, Setyohadi D. 2016. The length-weight correlation and population dynamics of razor clams (*Solen regularis*) in Surabaya east coast, Indonesia. Biodiversitas 17: 808-813.* *Solen regularis* is a pelecypod species living in intertidal areas at sandy substrate. In Surabaya east coast, *Solen regularis* is exploited by the locals for consumption, both as fresh seafood or processed one. This research aims to analyze the length-weight correlation of the clams and the population dynamics, conducted from August 2014 to July 2015 in Surabaya east coast. The results show that the correlation is explained in the equation $W = 0.038L^{2.798}$ with the correlation coefficient of 0.9. Also, the allometric growth pattern is proven negative as the increase in body length is faster than that in weight. Growth is measured with von Bertalanffy growth model $Lt = 8.0$ (1-e $(-0.7^{(t+0.003)})$ and the result from the parameter analysis using ELEFAN I method in FISAT II software show that $L_\infty = 8.0$ cm and k = 0.7/year. The estimated weight at t_0 in Pauly's empirical formula is -0.003 cm. Mortality rates are shown as follows: natural mortality (M) is 2.05/year, fishing mortality (F) is 2.01/year, and total mortality is 4.05/year. Exploitation rate (E) is 0.50/year indicating that the exploitation of *Solen regularis* is in optimal condition. The B/R and Y/R value is 1.4%/year. It can be suggested from the findings of the research that knowledge on population dynamics may be useful for the utilization and management of *Solen regularis* in order to preserve its environmental and ecological sustainability.

Keywords: Growth, mortality, razor clams, *Solen regularis*, Surabaya east coast

INTRODUCTION

Solen spp. or also known as r*azor clam* or *kerang bambu* (Indonesian) or *kerang lorjuk* (Maduranese) is a species of mollusk clams widely consumed and highly traded as a commodity in international markets (Baron et al. 2004). This species varies in several species, such as *Solen dactylus* living along the coasts with muddy sandy substrate in Oman Sea and Persian Gulf (Bruyne 2003), *Solen regularis* in the western part of Sarawak, Malaysia (Rinyod and Rahim 2011), and *Solen marginatus* in the coasts of Atlantic, Europe, northwestern part of African coasts, and Mediterranean Sea buried under the sand and/or tidal areas, both in intertidal and sub tidal parts at mud substrates and the sands (Hmida et al. 2012). In Indonesia, *Solen* spp. can be found in the Maduranese coast of Pamekasan District (Nurjanah et al. 2008), Eastern coast of Surabaya (Trisyani et al. 1999; Trisyani and Irawan 2008), and Kejawanan Beach, Cirebon (Subiyanto et al. 2013). The locals call this type of clam *lorjuk* or *kerang bambu*. The findings from investigation conducted by the Indonesian Institute of Sciences (LIPI) show that *Solen regularis* is widely found in the Surabaya east coast, and the DNA analysis using RAPD indicates that *Solen regularis* in the Surabaya east coast exhibits 13.1% of similarity with *Solen* sp. found in Pamekasan coast (Trisyani and Budiman 2015).

The higher demands for *Solen* spp. as comestibles have led to the more intensified fishing for this species which is feared as the possible cause of decreasing population of the clam. This problem, however, has not been officially identified because of the absence of data for fishing production and industry. A research carried out by Trisyani and Irawan (2008) shows that *Solen* sp. found along the eastern coast of Surabaya lives in the muddy sand substrate with the organic content of approximately 0.22-0.54 ppm, water temperature of about 28-31ºC, salinity around 26-31 ppt, and soil pH at 7.0-8.5. The clams are fished using dredging tools and sticks whose ends are immersed into a mix of chalk and soap. Substrate is dredged and sticks are pushed into the hole to pull the clams out. As the stick end touches the clams, they are immediately captured by hand.

Trisyani and Hadimarta (2013) have conducted a research and found that *Solen*'s reproduction cycle by observing their Gonad Maturity Level (GML). It is discovered that the GML of the clams in the Surabaya east coast reaches the mature level (GML III) in Mays and starts the insemination (GML IV) in Junes. Gonad growth declines until the resting phase (GML 0) in Septembers, and in Octobers, GML gradually refrains to the mature levels (GML II and GML III). As the GML rises, it is followed by an increase in the diameter of the oocytes with the equation of GML = 0.522 ± 0.528 of oocyte diameter with correlation of 79.2 %

Previous researches related to the razor clams growth have been conducted by Baron et al. (2004) on *Ensis* *macha*, Saeedi et al. (2009) on *Solen dactylus,* and Otero (2014) on *Ensis arcuatus*. Growth is an important element as the information on age and shell size is beneficial for the precise management strategies in order to support the sustainable utilization of mollusk species (Peharda et al. 2007). Information on the growth level is required in order to recognize the age of which the individual becoming the part of biomass can be utilized and the time needed to achieve the commercial size (Haddon 2011). In addition, the growth data can be the reference to asses the status of fisheries and to determine the status of exploitation of a species (Hilbron et al. 1995). Considering the lack of regulations related to the fishing and industrial management of *Solen* spp. as a resource in Indonesia, it is entailed that studies on the length-weight correlation and population dynamics of *Solen regularis,* as we conducted in Surabaya east coast, to preserve the species for sustainable exploitation.

MATERIALS AND METHODS

This research carried out in the Surabaya east coast at the latitude of 07°08'33.5" and longitude of 113°35'27.1" starting from August 2014 to July 2015. Sampling on *Solen regularis* was made every two weeks. During the period of December to the beginning of March 2015, no sample was found in the location. There are 2929 specimens collected during the research and taken from intertidal areas at the sand substrate at the low tides. Samples were caught with a stick dipped in the chalk at its tip and penetrated into the substrate hole. As the clam peeps out, it is pulled out by hand and preserved in 5% of formaldehyde of sea water immediately after the fishing (Baron et al. 2004). The morphometric measurement consists of the length (L) and weight (W) of the clams. Length is measured using a calliper with the precision of 0.1 cm and weight is recognized by analytic scale with the accuracy of 0.01 gram.

Length-weight correlation

Analysis on the length and weight of *Solen regularis* was conducted using linear regression. The length-weight correlation is very important in the science of population dynamics, for example, in calculating the catch per recruit (yield per recruit, Y/R) and biomass (biomass per recruit, B/R). The weight of the clams can be considered as a function from their length and this correlation follows the cubic law stated with the formula $W = a L^b$**.** W is the weight (in gram) and L stands for length (in cm); a is the intercept (curve intersection of length-weight correlation with axis y and b is the probe of length-weight growth pattern. If b = 3 that shows isometric growth, it means that the length and the weight increase equally. Meanwhile, b ≠ 3 shows allometric growth, b < 3 shows that length increases faster than weight, and b> shows weight increases faster than length (Park and Oh 2002).

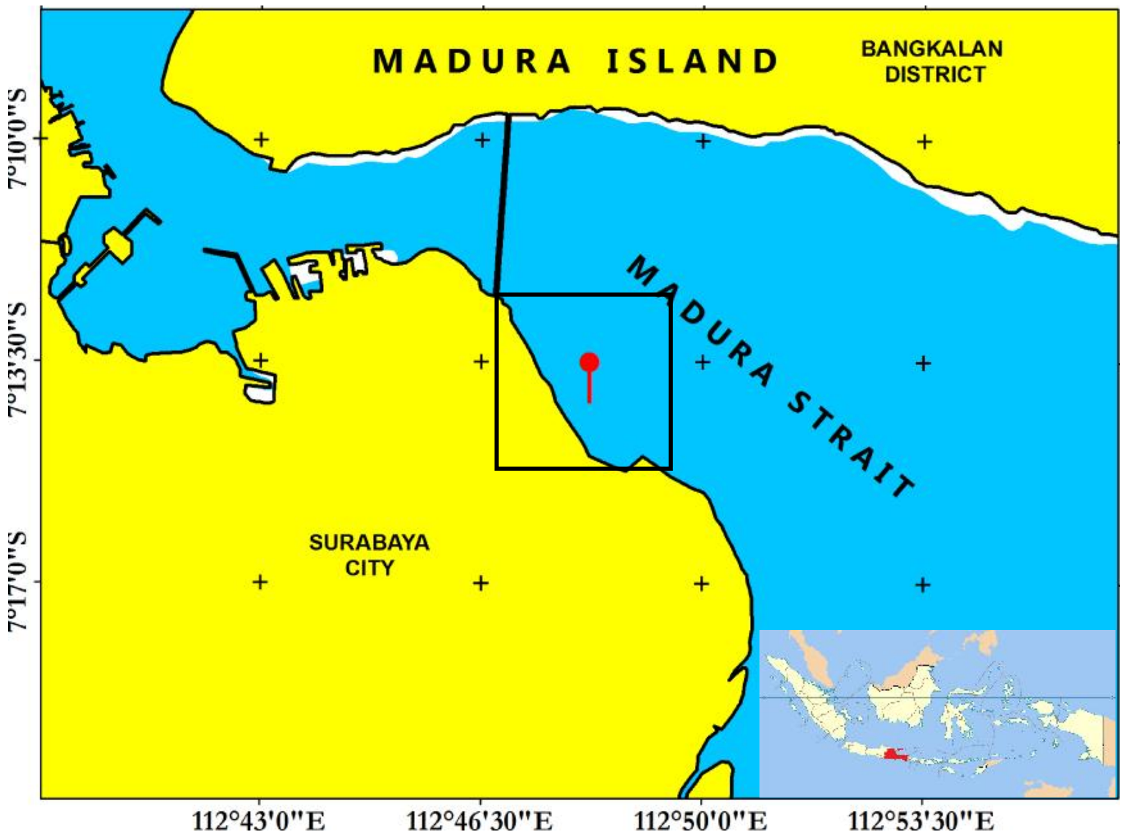

Figure 1. Study site at Surabaya East Coast, East Java, Indonesia

Von Bertalanffy's growth model

The growth of the clams measured with Von Bertalanffy's growth model (Sparre and Venema 1999) was $L_t = L_\infty (1-e^{-k(t-t0)})$. "t" is the number of growth checks marked by the clam since the beginning of shell formation, "Lt" is the valve's length (L) at growth check "t", L_∞ is the maximum length of *Solen regularis* theoretically (asymptotic length), k is the coefficient of growth rate (per time unit), and t_0 is the theoretical age of *Solen regularis* as the total length of the shell is equal to zero, Pauly's empirical equation (1984) is Log ($-t_0$) = 0.3922-0.2752 (Log L_∞)-1.038 (Log k).

Mortality rate

Total mortality rate (Z) is the stock's declining rate. Mortality rate was determined by Gulland's formula (1971) with the equation $Z = \frac{k(L\infty - L)}{L - Lc}$. Normal mortality rate (M) was counted using Pauly's (1984), Log M =-0.0066-0.279 Log L_∞ + 0.6543 Log k + 0.4634 Log T. "T" is the average water temperature being measured every two weeks during the study. Fishing mortality rate (F) can be measured by subtracting M value to Z with the formula F = Z-M.

Exploitation rate (E)

To determine the rate of utilization or exploitation, Beverton and Holt (1957) formula was used by comparing the fishing mortality rate (F) and total mortality rate (Z). E>0.5 shows high exploitation level (over fishing); E<0.5 shows low exploitation level (under fishing), and E=0.5 shows optimal exploitation (Sparre and Venema 1999).

RESULTS AND DISCUSSION

Length-weight correlation

Length-weight correlation is generally used in researches in fisheries to explain changes in individual size, to show the growth pattern of the organism, to acquire the index of physical condition of the population, and to evaluate the quality of the habitat (Albuquerque et al. 2009).

From the analysis on the length-weight correlation of *Solen regularis,* it is acquired $W = 0.038\ L^{2.798}$ with the correlation coefficient of 0.95 (Figure 1). The b value shows negative allometric value (b < 3), which means that the length of the shell increases faster than the weight. This result is similar to that from a research by Saeedi et al. (2009) observing *Solen dactylus,* which is $W = 0.0001\ L^{2.5921}$ with correlation coefficient = 0.96 for all the analyzed specimens with p < 0.001. The b mean is 2.57 ± 0.1 for one year. The t student value determines that the length-weight correlation of this species is negative allometric. On *Ensis arcuatus,* the correlation coefficient from the length-weight correlation is 0.97 (Fahy et al. 2001) and on *Solen strictus* is 0.91 (Park and Oh 2002) with the average b value of 2.57 ± 0.1. The length-weight correlation of this species forms a negative allometric pattern. The difference on the growth patterns represented by the b value on length-weight correlation is affected by the growth phase, the size, food supply, sex, gonad growth, health, and breeding period (Miranda et al. 2006).

Attributes specifically found in fish and mollusks, such as the body shape, can be a reference for explanation on particular species' survival ability in waters and a guide to environmental factors that fish can adapt to (Allan and Castillo 2007). The length-weight development is influenced by several factors, such as food and environmental adaptation (Effendie 1997). Food supply in sandy substrate in the intertidal area relatively low, depends on the streams carrying planktons as clams are benthic organisms and suspension feeder. The ability to adapt with the body shape that is elongated in the intertidal areas dominated with sand enables *Solen* sp. to dig faster immediately as the passing waves translocate animals from substrate. Normally, *Solen* sp. has a tiny slender body with parts cleverly modified for the purpose of digging faster. Shortly after the organisms are pulled out of the substrate by the passing wave, they dig it back before the water sways them out. An example of organism with such ability is donax clam and razor clam (Nybakken and Bertness 2005). The research site is an exposed, therefore this adaptation process in the area requires a considerable amount of energy which causes declining weight development and single length growth that leads to negative allometric growth. Meanwhile, a fore-and-aft body type in some species such as razor clam allows them to dig deeper with less energy for protection from predators (Urban 1994). In addition, its lightweight shape prevents them from going too deep in the hole, and stability to go against the undercurrent is essential for survival (Stanley 1970). Such body type and shape as found in *Ensis macha* including *Solen regularis* has the proportion of length more superior than the weight that facilitates stability against the current, as well as adaptive strength to become an effective digging organism.

Von Bertalanffy's growth model

The result from parameter analysis on *Solen regularis* growth with ELEFAN I method in FISAT II is L∞ = 80 mm and k = 0.7/year. Estimation on t_0 is acquired from Pauly's empirical formula (1979) with the value of t_0 =-0.003. It can be deduced that the von Bertalanffy's growth equation is Lt = 8.0 (1-e $(-0.7^{(t+0.003)})$ (Figure 2)

Saeedi et al. (2009) found that *Solen dactylus* Persian Gulf, Iran might grow approximately 22-29 mm every year, and transects both near to and far from the coast have parameter estimation of L_∞: 101 and 108 mm respectively, k value of each transect is 0.27/year, and 0.28/year, and t_0 of each transect are-0.99 and-0.94. Baron et al. (2004), whose research was on *Ensis macha* living in Argentine and Chile, came up with L_∞ 154-153 mm, k = 0.27/year-0.28/year, and t_o =-0.08-0.72. Meanwhile, observation conducted by Fahy et al. (2001) on *Ensis arcuatus* showed in L_∞ 145-159 mm, k = 0.28-0.43/year, and t_0 =-0.26-0.3.

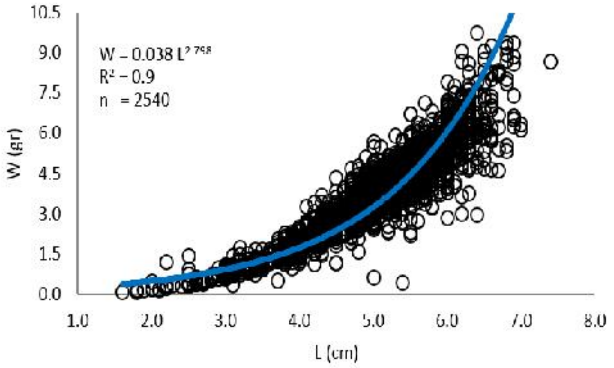

Figure 1. Graph of length-weight correlation in Solen regularis in Surabaya east coast

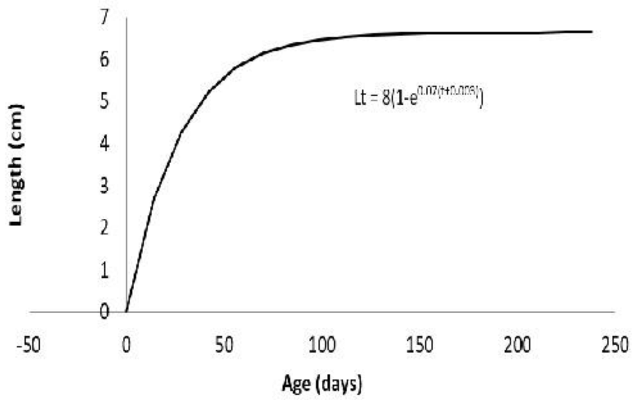

Figure 2. Solen regularis growth in Surabaya east coast

As researched by Otero et al. (2014) on *Ensis arcuatus,* the clams display a swift growth in the first three years of life. The rise on the first year is 50-80 mm; 33-37 mm between the first and second year, and14-18 mm between the second and third year. From there, the growth gradually declines between the forth to sixth year (with estimated rise only 5-10 mm), and finally will undergo asymptotic phase at 8-9 year (with growth rise less than 5 mm per year). The asymptotic size (L_∞) varies between 140 and 174 mm, while the growth constancy (k) is around 0.24 and 0.57 per year. The longest living expectancy of the species is approximately 13 years.

The *Solen regularis* growth in Surabaya east coast has relatively smaller L_∞ value compared to that in *Solen* sp. or *Ensis* sp. in other countries, but the growth coefficient is relatively faster, 0.7 per year. It is found that during the research, *Solen regularis* may grow as long as 15.2-75.4 mm. The difference growth pattern in the same species is caused by several components, such as the number of the samples, and other external factors, such as convenient environmental condition for the development of this species (Innal et al. 2015). *Solen regularis* living in tropical areas generally have smaller shell. In Malaysia, as observed by Rinyod and Rahim (2011), *Solen regularis* show similar size of shell as those observed in Surabaya, 60.72 ± 9.77 mm in Asajaya Laut, and 58.44 ± 5.65 mm in Kampong Buntal. The growth coefficient on *Solen regularis* is higher presumably due to the fact that tropical countries facilitate maximum metabolism as there is no seasonal problems. In subtropical areas such as the northern part of Persian Gulf, sea clams may grow and reproduce well due to seasonal winds, high nutritional concentration, and phytoplankton supply (Saaedi et al. 2009).

Mortality rates and exploitation

Normal mortality rate (M) during the research with average annual water temperature 28^{o}C is 2.05/year. The average normal mortality is 2.05/year which indicates that deaths occur regularly in the research location as Pauly (1984) states that such number is higher than the maximum mortality rate, 1.5/year.

Fishing mortality rate (F) on *Solen regularis* during the observation is 2.01 per year. The number indicates intensive fishing activities. Pauly (1984) developed an optimum fishing rate concept that it may be achieved if the value is the same as the that of natural mortality rate (Foptimum = M). It also point to the fact that deaths of the clams in Surabaya east coast are mainly caused by fishing. Gulland (1971) states that if F > M, the status of fishing can be categorized as overexploited, while Amani et al. (2011) find that if fishing activities cause more mortality than the normal, it can be concluded that imbalance has occurred in the stock.

Analysis on the total mortality (Z) using the equation from Beverton and Holt (1957) in the FISAT II software shows that the total mortality number is 4.05 per year. Laudien (2002) find the total mortality (Z) in immature donax clams at 4: 26 per year. The high mortality caused by predation shore birds. The number is acquired from both normal mortality (M) and fishing mortality (F). A graph on mortality can be seen in Figure 3.

According to Sparre and Venema (1999), the considerable number of mortality from fishing is caused by the activity particularly those using fishing gears, the absence of operational area boundaries, lack of information from the local government or related institutions to the fishers on the importance of preservation, and the unavailability of regulations on the size of the fish allowed for fishing and trading. Those factors apply to fish and alike, such as clams. Regarding to this problem, Bahtiar (2005) states that when fishing activities in an area are massive or exactly equal to the number of parent population, the schools will lose their members gradually and at a certain level, the organisms are threatened to extinction.

The exploitation rate (E) of *Solen regularis* during the research is 0.50/year. This informs than 50% of the sample population are taken away by fishing activities. It is based on the concept of exploitation rate developed by Gulland (1971) and Pauly (1984) that the optimum exploitation rate value is 0.5/year (Eoptimum = 0.5/year). Also, referring to the concept, the exploitation rate of *Solen regularis* in the Surabaya east coast has achieved the exact optimum value of Eoptimum.

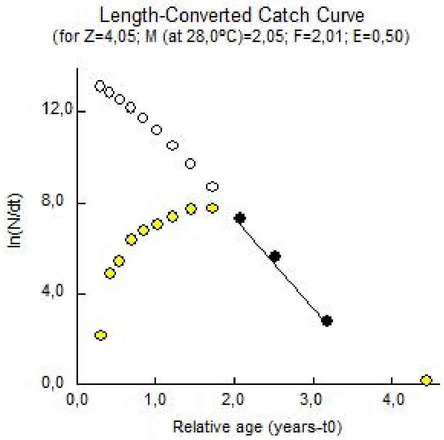

Figure 3. Mortality rates and exploitation of *Solen regularis* in Surabaya east coast

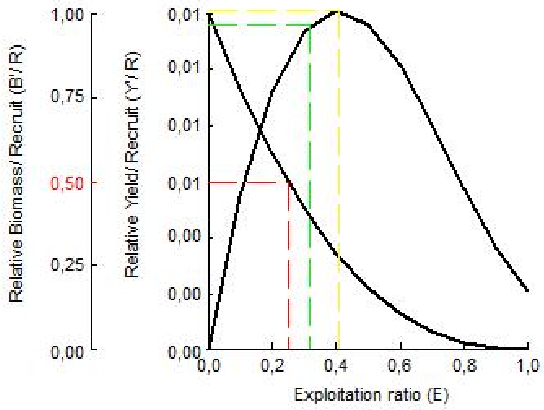

Figure 4. Y/R dan B/R value of *Solen regularis* in Surabaya east coast

Figure 4 shows the B/R value of 0.014/year that indicates the number of *Solen regularis* population in the water, 1.4%/year. Meanwhile, the Y/R value also displays the same number, meaning that 1.4%/year of *Solen regularis* is captured in the eastern coast. The same number of B/R and Y/R implies that the number of fishing is the same as that of biomass in the water.

The B/R value of 1.4%/year gives use information of then tiny number of population of *Solen regularis* in the Surabaya east coast, that it is highly encouraged that efforts on limiting fishing activities should be taken into consideration to restore the number of biomass in the water. The parameter that may be controlled is the fishing mortality rate (F) or time and number management of fishing outputs.

Solen regularis capture on Surabaya east coast must consider the existing stock, because the value is already optimal exploitation. Management is done with the cooperation between local governments and local communities for the clam sustainable use.

ACKNOWLEDGEMENTS

Author would like to thank Indonesian government for financial support of this study.

REFERENCES

Albuquerque FS, Peso-Aguiar MC, Assuncao-Albuquerque MJT, Galvez L. 2009. Do climate variables and human density affect *Achatina fulica* (Bowditch) (Gastropoda: Pulmonata) shell length, total weight and condition factor. Braz J Biol 69: 879-885.

Allan JD, Castillo MM. 2007. Stream ecology, structure and function of running waters. 2nd ed. Springer, the Netherlands.

Amani AA, Amin SMN, Arshad A, Aminun RM. 2011. Population dynamics of sergestid shrimps *Acetes japonicus* in the Estuary of Tanjung Dawai, Kedah, Malaysia. J Fish Aquat Sci 6 (7): 751-760.

Bahtiar. 2005. Study on population of Pokea clams (*Batissa violacea celebensis* Martens, 1897) in Pohara River, Kendari, Southeast Sulawesi. [M.Sc.-Thesis]. School of Graduates, Institut Pertanian Bogor, Bogor. [Indonesian]

Barón PJ, Real LE, Ciocco NF, Ré ME. 2004. Morphometry, growth and reproduction of an Atlantic population of the razor clam *Ensis macha* (Molina, 1782). J Sci Mar 68(2): 211-217.

Beverton RJH, Holt SJ. 1957. On the dynamics of exploited fish population. Fish Invest London Series 2. 19: 1-533.

Bruyne RH. 2003. The Complete Encyclopedia of Shell. Rebo Production. Lisse, the Nederland.

Effendi MI. 1997. Fish Biology. Yayasan Pustaka Nusantara. Bogor. [Indonesian]

Fahy E, Norman M, Browne R, Roantree V, Pfeiffer N, Stokes D, Carrol J, Hannaffy O. 2001. Distribution, population structure, growth, and reproduction of the razor clam *Ensis arcuatus* (Solenacea) in coastal waters of western Ireland. Irish Fish Invest 10: 1-24.

Gulland JA. 1971. Manual of methods for Fish Stock Assessment. Part I: Fish Population Analysis. FAO, Rome.

Haddon M. 2011. Modelling and quantitative methods in Fihrie, 2nd ed. CRC Press, Boca Raton.

Hilborn R, Micheli F, De Leo GA. 2006. Integrating marine protected areas with catch regulation. Can J Fish Aquat Sci 63: 642-649

Hmida L, Fassatoui C, Ayed D, Ayache N, Romdhane MS. 2012. Genetic characterization of the razor clam *Solen marginatus* (Mollusca: Bivalvia: Solenidae) in Tunisian coasts based on isozyme markers. J Biochem Syst Ecol 40: 146-155.

Innal D, Ozdemir F, Dogangil B. 2015. Length-Weight relationships of *Oxynoemacheilus theophilii* (Teleostei: Nemacheilidae) from Turkey. Intl J Fish Aquacult Sci 2: 249-250.

Laudien J. 2002. Population dynamics and ecology of the surf clam *Donax serra* (Bivalvia, Donacidae) inhabiting beaches of the Benguela upwelling system. Ber Polarforsch Meeresforsch 432 (2002). Alfred-Wegener-Institut fur Polar- und Meeresforschung, Germany.

Miranda R, Oscoz J, Leunda PM, Escala MC. 2006. Weight-length relationships of cyprinid fishes of the Iberian Peninsula. J Appl Ichthyol 22: 297-298.

Nurjanah, Kustiariyah, Rusyadi S. 2008. Nutritional characteristics and potential development of the razor clams (*Solen* spp.) in the waters of Pamekasan, Madura. Jurnal Perikanan dan Kelautan 13(1): 41-51. [Indonesian]

Nybakken JW, Bertness MD. 2005. Marine Biology: An Ecological Approach, 6th ed. Benjamin Cummings, San Francisco

Otero AH, Gaspar MB, Macho G, Vázquez E. 2014. Age and growth of the sword razor *Ensis arcuatus* in the Ría de Pontevedra (NWSpain): Influence of environmental parameters. J Sea Res 85: 59-72.

Park K, Oh CW. 2002. Length-weight relationship of bivalvia from coastal waters of Korea. ICLARM Quart 25: 21-22

Pauly D. 1979. Some simple methods for the assessment of tropical fish stocks. FAO Fisheries Technical Paper No. 234. FAO, Rome.

Pauly D. 1984. Fish population dynamics in tropical waters : A manual for use with programmable calculators. ICLARM Studies and Reviews 8, Manila.

Peharda M, Richardson CA, Mladineo L, Sestanovic S, Popovic Z, Bolotin J, Vrgoc N. 2007. Age, growth and population stucture of *Modiolus barbatus* from the Adriatic. Mar Biol 151 (2): 629-638.

Rinyod AMR, Rahim SAKA. 2011. Reproductive cycle of the razor clam *Solen regularis* Dunker, 1862 in the western part of Sarawak, Malaysia, based on gonadal condition index. J Sustain Sci Manag 6: 10-18.

Saeedi H, Raa S.P, Ardalan AA, Kamrani E, Kiabi BH. 2009. Growth and production of *Solen dactylus* (Bivalvia: Solenidae) on northern coast of the Persian Gulf (Iran). J Mar Biol Assoc UK 89 (8): 1635-1642.

Sparre P, Venema SC. 1999. Introduction to tropical fish stock assessment. Part 2. Examples. Rev. 2. FAO Fish Tech Pap 306/2 (Rev.2). FAO, Rome.

Stanley SM. 1970. Relation of shell form to life habits in the Bivalvia. Geol Soc Amer Mem 125: 1-296.

Subiyanto, Hartoko A, Umah K. 2013. Sedimentary structures and distribution of the razor clams (*Solen lamarckii*) in Kejawanan Beach, Cirebon, West Java. J Manajemen Sumberdaya Perairan 2 (3): 65-73. [Indonesian]

Trisyani N, Budiman K. 2015. Genetic diversity of razor clam (*Solen* sp.) at Pamekasan beaches and Surabaya east coast Indonesia based on RAPD markers. J Biod Environ Sci 7(6): 267-274

Trisyani N, Hadimarta F. 2013. The maturity level of the *Solen* sp. gonads on the East Coast of Surabaya. Jurnal Ilmu Kelautan 18 (1): 39-44. [Indonesian]

Trisyani N, Irawan B. 2008. Abundance of razor clam (*Solen* spp.) in East Coast of Surabaya. Jurnal Ilmu Kelautan 13 (2): 67-72. [Indonesian]

Trisyani N, Prasetyo R, Sunoto H. 1999. The commercial aspects of *Solen grandis* in the coastal water of east Surabaya, Indonesia. Proceeding the tenth International Congress & Workshop of the Tropical Marine Mollusc Programme. Hanoi & Haiphong/Catba, October 19-30 [Vietnam]

Urban HJ. 1994. Adaptations of six infaunal bivalve species of Chile: Coexistence resulting from differences in morphology, burrowing depth and substrate preference. Arch Fish Mar Res 42: 183-193.