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EFFECT OF FOOD TYPES AND HABITATS ON THE VALUE OF FEMALE MATURITY INDEX (FMI) AND GONADO SOMATIC INDEX (GSI) IN THE EGG PRODUCTION OF MANGROVE CRABS, *Scylla serrata*

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ABSTRACT

Mangrove crabs (*Scylla serrata*) is one of fishery commodities with high economic value for its good taste and nutrients content. Currently, increasing demand for this Crustacean species caused declining its population and for this reason, cultures of brooding crabs have been attempted. This study was carried out to investigate the egg development of mangrove crabs, with the main focus to study the effects of food types and habitats on the value of female maturity index (FMI) and gonado-somatic index (GSI). To investigate the effects of habitats, experiments were carrried out in the two habitats namely tidal flow of pond area and mangrove area. The spawning crabs were reared in a bamboo cage with the size of 2x1,5x1m^3 divided into three paralel partition for 9-12 crabs with body weight of 200-250 grams. The crabs in the three partition were fed with three different foods, namely fish for the first partition, squid for the second, and mussel for the third. The results showed that no significant effect of foods and habitats was observed on the value of FMI. However, squid and mangrove habitats affected the growth, such as: an increase the wide of fifth abdomen segment, the widest abdomen segment and body weight during egg development periods. On the other hand, no significant different value of GSI was found on different habitats, but the food types affected the value of GSI.

Key words : mangrove crabs, FMI, GSI, egg production

INTRODUCTION

Mud crabs, *Scylla serrata* is one of fisheries commodities, which is prospective to be developed due to it economic value and potential as an export commodity. They are living in the inter and subtidal mangrove habitats and are benthic carnivores (Hill, 1980). The genus *Scylla* has four species namely *serrata, tranquebarica, oceanica* and *paramamosain* (Keenan *et al*., 1998, Imai *et al*., 2004). Two groups of *Scylla* are found in Indonesia, one is reddish or brownish green, the other is greyish green. The former are *Scylla serrata* and S. *serrata* var. *paramimosain* (Moosa *et al.,* 1985). Both belong to the swimming crab family Portunidae, but the latter has been an incident product of brackish water fishpond. *S. serrata* is found in almost all coastal waters, and brackishwater ponds in Indonesia (Cholik & Hanafi, 1991).

Mud crab is well known for its wide range of environmental stress and attenuation of physiological homeostasis particularly with respect to changing salinity (Hai *et al*., 1998) and temperature (Hill, 1974; Chen & Chia, 1996; Hamasaki, 2003). As the mud crab could tolerate salinity range from 2-38 ppt (Hill, 1974), the crab are caught upstream too. Pond which is suitable for culturing shrimp are suitable also for crab culture. Ponds with muddy beds are preferred by crab. A salinity range of 10-25 ppt is considered optimal for the crab growth. Water temperature range from 28-33°C with pH value of 7.5-8.5, and DO value over 4 ppm are required (Samuel & Soundarapandian, 2010).

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Currently, increasing demand for this Crustacean species has caused declined population *S. serrata,* and for this reason culture of brooding crabs has been attempted. One of the efforts to overcoming these problems is cultivating *S. serrata* during their spawning. The purpose of the research is to study the effects of food types and habitats on the value of female maturity index (FMI) and gonado-somatic index (GSI). The FMI was determined to classify the developing gonad stages (Poovachiranon, 1991) and the GSI value is used as indicator for sexual development and reproductive cycle in aquatic organisms (Peranandam *et al.*, 2013).

MATERIALS AND METHODS

Cultivation of berried female

Increasing demand for egg-bearing female crab has stimulated berried female crab culture. Healthy gravid females of *S. serrata* with all the body parts intact and with early broods (transparant, white or yellowish coloured eggs) were collected from fishermen in coastal areas of East Lampung and brouhgt to the research location for 1 to 2 days acclimitation. Before experimentation female crabs were selected to observe their body completecity, weighed individually and measured the size of their abdomen segments. The berried female with the body weight average of 200-250 grams was selected.

Experimental conditions

To investigate the effects of habitats the experiments were carrried out in two habitats namely tidal flow of pond area and mangrove area. The research was conducted in Sidodadi coastal, Padang Cermin, Pesawaran District, Lampung Province during May-August 2013. The crabs were reared in a 2x1,5x1m^3 size bamboo cage, which is divided into three paralel partition for 9-12 crabs in each compartement. The crabs were fed with three different foods, such as fish for the first partition, squid for the second, and mussel for the third. Two sets of experiments were set for two different habitats of inter tidal flow which are pond area and mangrove area. The crabs were fed twice a day at 3-5% of body weight. During the experimental period, optimum environmental conditions were maintained (salinity 30-35 ppt, pH 7.8-8.2 and temperature of 27-30°C). The experiments were conducted for a period of 21-40 days until 70-90 percent of the harvested crab are ripe. Sampling was done at every 7-8 days to examine the ovarian status. Daily colour change if any, in eggs during incubation period was noted. The crabs were examined for ovarian maturity by looking through the transparent membrane between the junction of the first abdominal segment and carapace (Quinitio *et al.*, 2002). 5-10 crabs were measured for body weight and abdomen segment width (the wide of fifth abdomen segment and the widest abdomen segment) to calculate their FMI values. Female maturity index (FMI) is calculated as width of the widest part of the 5^{th} abdominal segment divided by the width of the widest part of the thoracic sternum between the base of the 5th pair of legs) (Poovachiranon, 1991)

At the end of the experiment, after weighing these crabs form each different food types (fish, squid and mussel) in both habitats (pond and mangrove areas), the crabs were dissected and ovaries were taken out, blotted with tissue paper and weighed to determine the gonado-somatic indicies. The morphological appearances and weight of ovary was deter-

mined. Gonado-somatic index (GSI) was expressed as percentage of the ovarian weight relative to the body weight (Keenan *et al.*, 1998; Mohapatra *et al.*, 2010).

RESULTS AND DISCUSSION

The results showed that there is no significant effect of food provision and habitats were observed on the FMI value of berried female *Scylla serrata* (Fig. 1). The highest FMI of 1.209 was found in mangrove and 1.140 in the pond, both with squid food type. FMI in mangrove with fish food treatment was 1.154 and mussel was 1.095. In the pond on the other hand, the FMI of mud crab was 1.098 with fish and 0.096 with mussel. The lowest FMI of 0.996 was found in the pond with mussel treatment. The FMI patterns in the two habitats were practically similar. Poovachiranon (1991) stated that the mud crabs are sexually mature when either the FMI values reach $\geq$ 1.00 or the abdomen is enlarged. In this study some berried female crabs had enlarged abdomens entirely covering the width of their thoracic sternum, with FMI value slightly more than 1.00.

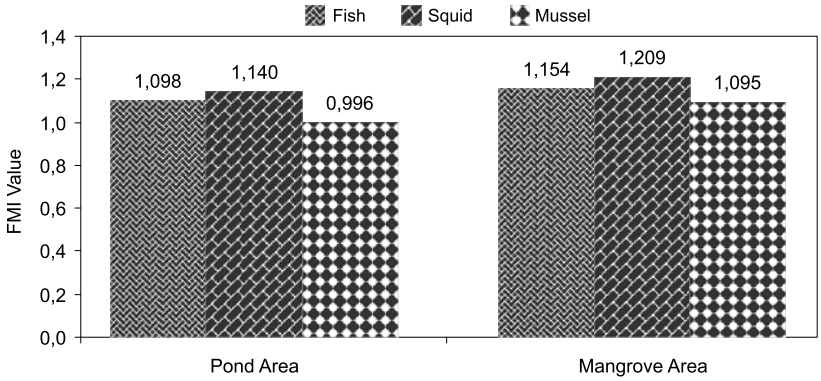

Figure 1. Female maturity index (FMI) of berried female *S. serrata* in pond and mangrove habitats with three different foods : fish, squid and mussel.

The difference of FMI value between treatments was most likely due to different food supplies and habitat conditions. Piranto (2007) suggested that physiologically crabs need energy from food for adaptation to maintain or replace cells or tissues, metabolism activity, reproduction (for grown adult crabs) and to accelerate gonad maturity. Squid diet gave significant increase in both width of the fifth abdomen segment (Fig. 2) and the widest abdomen segment (Fig. 3) (α=0,05) compared to the other food types of mussel and fish, both in pond and mangrove habitats. It was due to squid nutritious value which had the highest protein content of 71,5%. The results are in concordance with the works of Djuwito *et al.* (1992) and Bombea-Tuburan *et al.* (1999) who described that squid gives better influence on growth of fish or crab cultivation. According to Akiyama *et al.* (1991) and Djuwito *et al.* (1992), protein for growth and reproduction of mud crabs should contain the main essential amino acid, such as lysine, arginin, leusine, isoleusine, and valine. The amino acid contents in fresh-food from animals are very essential in crab diets (Jauncey & Ross, 1982). These essential amino acids cannot be synthesized in the body and should contain in the diets (Kanazawa, 1982).

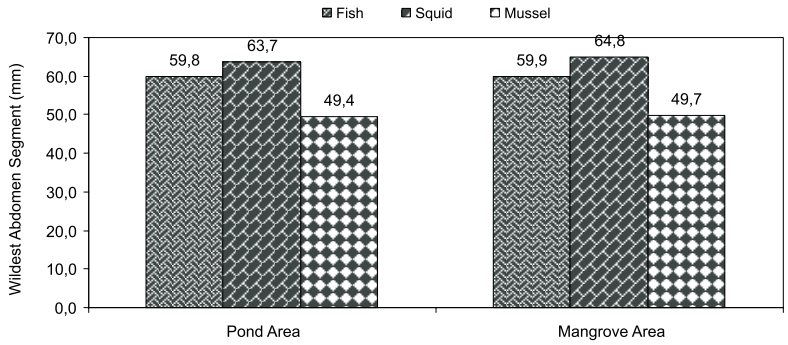

Figure 2. Average width of the fifth abdomen segment of berried female *S.serrata* in pond and mangrove habitats with three different foods : fish, squid and mussel

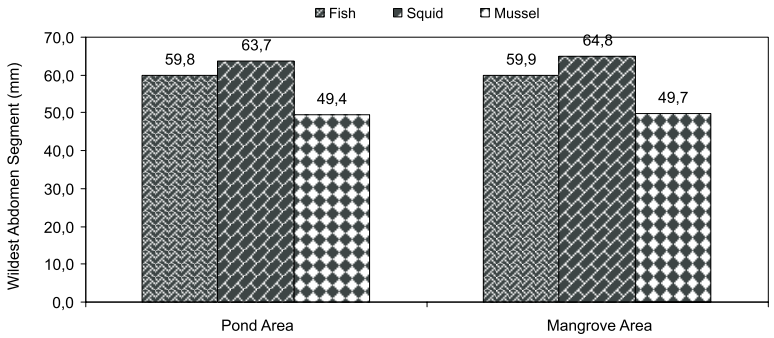

Figure 3. Average width of the widest abdomen segment of berried female *S. serrata* in pond and mangrove habitats with three different foods: fish, squid and mussel.

Food types and habitats showed significantly difference (α=0,05) in the increase of average body weight of berried female *S. serrata* during egg production. The difference of the body weight is found in both habitats and food types. The highest average body weight of 282.36 gram was found in mangrove with squid diet and the lowest of 211.20 gram in pond habitat with mussel (Fig. 4). The same results was found by Djuwito *et al*. (1992) and Bombea-Tuburan *et al*. (1999) that squid gives better influence on growth of fish or crab cultivation, especially in the the production of ripen or egg-bearing females, fattening and growout. The high protein content of squid can accelerate body weight increase and gonad maturition (Kuntiyo, 1994) and which also supported by the mangrove habitat for growth. According to Motoh (1979) mangrove is important as natural habitat of mud crabs *S. serrata* during their life cycle. In addition, the habitat quality management affects on the growth, gonad maturation and survival of mud crabs, especially during egg production (O'Connor, 2007).

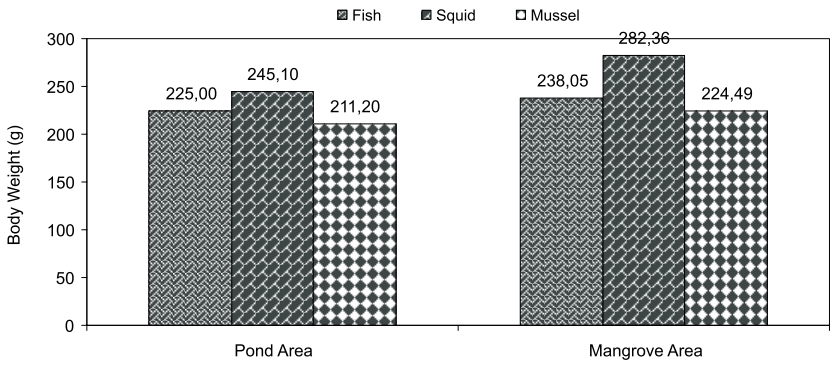

Figure 4. Average body weight of berried female *S. serrata* in pond and mangrove habitats with three different foods : fish, squid and mussel.

The gonado-somatic index (GSI) of the female crabs was measured based on the size and weight of the crab. No significant difference was found on the value of the GSI in both pond and mangrove habitats, but the food types, affect the value of GSI (Fig.5). The squid food gave the highest range of value of GSI (10.32-12.23%), followed by mussel (9.47-10.58%) and fish (8.55-9.74%) respectively. The GSI has the close relationship with the size and weight of the crabs. According to Djunaedi (2008), the composition and daily ransom affected gonado-somatic index of mud crab, significantly (P<0,05). He reported that the highest GSI (16.71%) was produced by giving a diet composition 25% formulated diet and 75% squid as much as 9% daily. This composition may contribute sinergically on gonad development of mud crab (*S. serrata*). Mohapatra *et al.* (2010) established a relationship among the carapace width, body weight and gonado- somatic index for the mud crab *S. serrata*. Higher the GSI indicates the progression of maturity and breeding period.

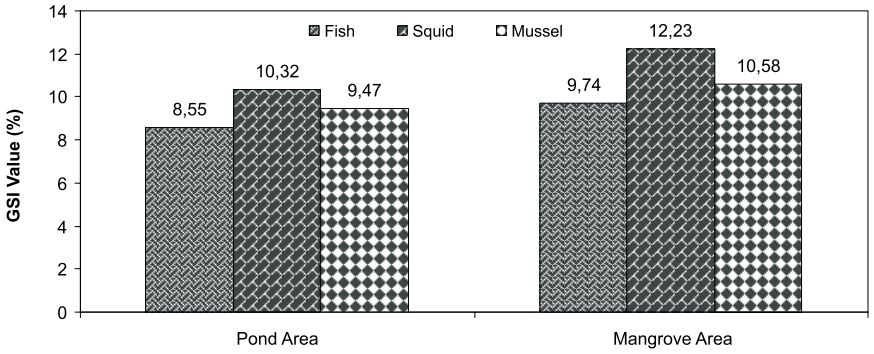

Figure 5. Gonado-somatic index (GSI) of berried female *Scylla serrata* in pond and mangrove habitats with three different types of foods : trash fishes, squids and mussels.

In addition, as the ovaries matured, the volume of ovaries is relatively increased due to the yolk accumulations of the oocytes. It was indicated by the increment of GSI of *S. serrata* in the present study. According to Poovachiranon (1991) the ovarian maturation of *S. serrata* was classified into four stages based on the area covering the body-cavity and coloration. In determination of ovarian maturation stage, few indicators had been used. Commonly, maturity in females is determined using the relationship between carapace size and ovarian status (Ikhwanuddin *et al*., 2010). However, matured crabs are not always available and the reproductive biology of crab is affected several factors such as diets, salinity and temperature (Ikhwanuddin *et al*., 2011). Overton & Macintosh (2002) used the pubertal molt as a morphological indicator of ovarian maturity with the shape of abdomen. Other potential indicators of female maturity in the Brachyura include the GSI and the distinct increase in abdomen width associated with the molt at maturity. The color and size of the ovary of mud crab are closely related to its cellular development (Overton & Macintosh, 2002).

The water quality in both pond and mangrove habitats, includes temperature, pH, salinity, and dissolved oxygen is good during the experiment to support the cultivation of the egg production of mangrove crabs *S. serrata*. The environmental factors may vary with wide range of temperature (18-31°C), salinity (1-33 ppt), alkalinity (70 to 119 mg l^{-1}) and dissolved oxygen (4-10 mgl^{-1}) content (Mohapatra *et al*., 2007; Panigrahi *et al*., 2007). The water quality and food are important criteria in rearing berried crabs, and if they are not maintained properly disease may rise and lead to hatching of unhealthy larvae and mortality in their early

stage (Samuel & Soundarapandian, 2010).

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REFERENCES

Akiyama, D.M., W.G. Dominy and A.L. Lawrence. 1991.Penaeid shrimp nutrition for the commercial feed industry: Revised. Proceedings Aquaculture Feed Processing and Nut Workshop. Singapore, American Soy Bean Association.

Bombeo-Tuburan, I., E.B. Coniza., E.M. Rodriguez and R.F. Agbayani. 1999. Culture and Economic of Wild Grouper (*Epinephelus coioides*) using three types of feed in pond. *Aquacul*. 131 (1-2) : 229-240.

Chen, J. and P. Chia. 1996. Oxygen uptake and nitrogen excretion of juvenile *Scylla serrata* at different temperature and salinity levels. *J. Crust. Biol*.16 : 437-442.

Cholik, F. and A. Hanafi. 1991 . A review of the status of the mud crab (*Scylla sp*.) fishery and culture in Indonesia. A report on the seminar the mud crab convened in Surat Thani, Thailand.

Djunaedi, A. 2008. The gonad somatic index (GSI) of the mudcrab (*Scylla serrata*) given different composition and daily ransom diets. *J. Ocean*. 13 (4) : 181 -184.

Djuwito, S.R., A/ Hartoko, and B. Sulardiono. 1992. Technology development of mud crab culture for hatchery and grow-out ponds. Fisheries Department, Faculty of Animal Husbandry, Diponegoro University.

Hai, T.N., A.B. Hassan, A.T. Law and N.A.M. Shazili. 1998. Effect of reduced water salinity of juvenile of the mud crab *Scylla serrata*. International Forum on the Culture of Portunid Crabs, Boracay, Philippines, Asian Fisheries Society, Quezon City, Philippines p. 57

Hamasaki, K. 2003. Effect of temperature on the egg incubation period, survival and development of larvae of the mud crab *Scylla serrata* (Forskal) (Brachyura: Portunidae) reared in the laboratory. *Aquacul*., 219 : 561-572.

Hill, B.J. 1974. Salinity and temperature tolerance of the zoea of the Portunidae crab *Scylla serrata*. *Mar. Biol.* 25 : 21-24.

Hill, B.J. 1980. Eûects of temperature on feeding and activity in mud crab *Scylla serrata*. *Mar. Biol.* 59. 189–192.

Ikhwanuddin, M., Z. Bachok, W.W.Y. Mohd Faizal, G. Azmie, and A.B. Abol-Munafi. 2010. Size of maturity of mud crab *Scylla olivacea* (Herbst, 1796) from mangrove areas of Terengganu coastal waters. *Journal of Sustainability Science and Management* Vol. 5 (2): 134-147.

Ikhwanuddin, M., G. Azmie, H.M. Juariah, M.Z. Zakaria and M.A. Ambak. 2011. Biological information and population features of mud crab, genus *Scylla* from mangrove areas of Sarawak, Malaysia. *Fisheries Research* 108 Vol. 2-3: 299-306.

Imai, H., J. Cheng, K. Hamasaki and K.Numachi. 2004. Identification of four mud crab species (genus *Scylla)* using ITS-1 and 16S rDNA markers. *Aquat. Living Resour*., 17 : 31-314

Jauncey, K., and B. Ross. 1982. *Tilapia Feed and Feeding*. Institute of Aquaculture, University of Stirling, Scotland, UK

Kanazawa, A. 1982. Penaeid nutrition. *In:* Pruder, G.D., C.J. Langdon, and D.E. Conklin. (editors). *Proceedings of the Second International Conference on Aquaculture Nutrition: Biochemical and Physiological Approaches to Shellfish Nutrition*, Baton Rouge, LA, Louisiana State University, 87–105.

Keenan, C.P., P. J. F. Davie and D. L. Mann. 1998. A revision of the genus *Scylla* de Haan: 1833 (Crustacea: Decapoda: Brachyura : Portunidae. *Raffles Bull. Zool.* 46 : 217-245.

Kuntiyo, A. Zaenal and T. Supratno. 1994. *Culture of mudcrab* (*Scylla serrata*) *with progressive system in the pond.* Annual report of brackishwater aquaculture 1994-1995. Directorate General of Fishery, Department of Agriculture, Jakarta.

Mohapatra**,** A., R.K.Mahanty, K.S. Bhatta and M.R. Das. 2007. Fisheries enhancement and biodiversity assessment of fish, prawn and mud crab in Chilika lagoon through hydrobiological intervention. *Wetland Ecol. Manage*. 15 : 229-251.

Mohapatra, A., R. K. Mahanty, S. K. Mohanty and S. K. Dey. 2010. Carapace width and weight relatonships, condition factor, relative condition factor and gonado-somatic index (GSI) of mud crabs (*Scylla spp*.) from Chilika lagoon, India. *Indian J. Mar. Sci.* 39 (1) ; 120-127.

Moosa, M.K.M., I. Aswandy and A. Kasry.1985. *Mangrove crab* (*Scylla serrata*, *Forskal.* 1775). LON-LIPI, Jakarta.

Motoh, H. 1979. *Edible Crustaceans In The Philipinnes*, 11th . In A Series Asian Aquaculture. 2 (10): 5.

Overton, J. L and D.J. Macintosh. 2002. Estimated size at sexual maturity for female mud crabs *(*genus *Scylla)* from two sympatric species within Ban Don Bay, Thailand. *J. Crust. Biol*. 22(4): 790-797.

O'Connor, N. 2007. Aspects of the general biology and fishery of the mud crab *Scylla serrata* (Forskål) in Moreton Bay. Ph.D. *Thesis*, University of Queensland.

Panigrahi, S., R. C. Panigrahy, K. Banarjee and S. K. Sarkar. 2007. Anthropologic impact on water quality of Chilika lagoon RAMSAR site: A statitical approach. *Wetlands Ecol. Manage.* 15: 113-126.

Peranandam, R., I. Palanisamy, M. Natesan, A. V. Lourduraj, K. Muthukalingan. 2013. Bioaccumulation of tributyltin and its impact on spermatogenesis in mud crab *Scylla serrata* (Forskal). *Turk. J. Biol*. 37: 296-304.

Poovachiranon, S. 1991. Biological studies of the mud crab *Scylla serrata* (Forskal) of the mangrove ecosystem In the Andaman Sea. A report on the seminar the mud crab convened in Surat Thani, Thailand.

Prianto, E. 2007. *Role of crabs as a keystone spesies in mangrove ecosystem. Proceeding of the Indonesian Aquatic Resources* Forum IV. Research Center for Aquatic Fishery Resources, Banyuasin, South Sumatera..

Quinitio, E. T. Fe Dolores Parado-Estepa and Eduard Rodriguez. 2002. Seed production of mud crab *Scylla spp. Aquacul. Asia*. Vol. VII No. 3: 29-31.

Samuel, N. J and P. Soundarapandian. 2010. Embryology of commercially important portunid crab *Scylla serrata* (Forskal). *Asian J. Exp. Biol. Sci.* Vol 1 (1) :178-82