The potential used of Amphipod-Crustacea as live food for blue swimmer crab, *Portunus pelagicus* crablet

Herlinah, Sulaeman*, and Gunarto

Research Institute for Brackiswater Aquaculture and Fisheries Extension (RIBAFE), Jl. Makmur Dg. Sitakka 129, Maros 90511, Indonesia.

*e-mail: sulaeman.marhali@gmail.com

Abstract. The mortality rate at crablet stage of blue swimmer crab, *Portunus pelagicus* during weaning is still high. Insufficient in food availability can be a trigger to high cannibalism. On the other hands, the used of artificial feed often causes a decrease in water quality. Information on the use of live feed during the crablet weaning is not yet available. This study aims to look at the opportunity to use Amphipod-crustacea, *Grandidierella megnae* (Giles, 1888) as a live food at crablet-4 (C4) stage of swimmer crabs. The consumption rate of C4 against amphipod was tested at various density levels using glass containers with 1L volume. Each container was filled with 0.5 L of sterilized sea water with 30 ppt salinity and included one crab of C4. Five levels of amphipod density applied were 5, 10, 15, 20, and 25 ind.L⁻¹ with 10 replications each. The amount of amphipod consumed by a crablet during 10 hours of exposure is recorded and presented in tabular and graphical form. The results showed that the consumption rate of C4 against amphipod increases significantly (P<0.05) as the density of amphipod increase and reach the maximum value at 10 ind.crab⁻¹. Based on the consumption rate of C4 against amphipod, can be concluded that the *G. megnae* (Giles, 1888) is suitable as a live food during weaning of swimming crab. However, more detail about the effect of amphipod on growth rate of swimming crab is still need more detail study.

1. Introduction

The swimmer crab *Portunus pelagicus* is typically found throughout the Indo-West Pacific [1], where in some regions it is present in large numbers and contributes towards commercial fisheries. In Indonesian, swimmer crab has great potential to become a leading in non oil and gas export. Based on statistical data of Director General of Fisheries Product Processing and Marketing, in 2018 the value of crab exports ranked the third after shrimp and tuna [2]. As most of the crab export comes from wild catches, the aquaculture of swimmer crab need to be developed as an efforts to preserve the crab population in nature. Hatchery technique of swimmer crab is established, how ever the mortality rate during larvae and juvenile weaning stage is still high [3, 4].

*P. pelagicus* is a carnivorous animal that forages at the bottom of the water and eats various types of slow moving sessile and invertebrate animals. Food is highly dependent on locally available of prey. The main foods for *P. pelagicus* in intertidal zone are small crabs and gastropods and in subtidal zone are bivalves and ophiuroid. Dietary composition changes slightly with the size of crabs in broad taxonomic groups and prey species change with crab size, however the diet does not vary completely for young *P. pelagicus* in the intertidal region [5].

Commonly, crabs stop feeding during moulting and immediately after moulting, the gastric mill is filled with calcareous fragments. Once the crab's shell hardens, feeding on organic material begins, which becomes largest during the initial intermoult period and decreases in late intermoult [6]. In adult crabs, crustaceans constituted the dominant food source while juveniles and sub-adults were dominated by debris [7]. Moreover the points of the major food groups in percentage of points, Crustaceans was the most dominant food group, and was found in 28.57% of the stomachs ‘with food’. This fraction consisted primarily of decapods (parts of shrimps, like rostrum, parts of exoskeleton, appendages;
and crab exoskeleton fragments, appendages, and eggs), and further contained the remains of amphipods, isopods, and stomatopods.

The availability of the right food at the right time for most fish is crucial as starvation can lead to high mortality [8]. It has also been described that low larval survival commonly occurred during the initial feeding periods [9, 10], which is most affected by a delay in feeding [11, 12, 13].

Amphipod is a benthic fauna inhabiting marine and freshwater environment, which shows central part in the ecosystem [14]. Its ability to tolerate a wide range of environment parameters and reproduce rapidly with short life cycle, make it possible to be developed as a live food in aquaculture. As low trophic level position its also played a major role in the decomposition of algae inputs and facilitate the transfer of nutrients from the ocean to the coastline [15]. Additionally, in some places amphipods can be available all year round in high densities. It’s also contain satisfactory protein content and fatty acid, with high levels of useful polyunsaturated fatty acids (DHA and EPA) [16]. Previous studies have explored amphipods as alternative protein sources for Atlantic salmon, Salmo salar [17], Octopus maya [18] with promising results and has been a major food for Spotted Catfish (Arius maculatus), a common economic fish in Thailand [19].

The amphipod used in this experiment is currently proposed as Grandidierella megnae (Giles, 1888), based upon on its specific characters [20, 21, 22]. It is consider as a synonym of Microdeutopus gryllostalpa Costa (1853) (http://www.marinespecies.org/aphia.php?p=taxdetails&id=101471) is an Amphipod Crustacean (Figure 1AB) that distributed world-wide and occupy the bottom of marine environment. The size of the adult is <1 mm that make them easy to prey by the other crustacean like shrimp and crab. Hence, this amphipod has been claimed as an endemic species in Suppa, Pinrang Regency of South Sulawesi, Indonesia and named as “Phronima suppa” or Phronima sp. [23]. The same name has been used by different authors such as [24, 25, 26]. In the last few years it has been used as a live food in shrimp farming in Pinrang regency especially popular in Suppa Sub district.

This study aims to look at the opportunity to use Amphipod-Crustacea, G. megnae as a live food for swimmer crabs weaning.

Figure 1. Photograph of Microdeutopus gryllostalpa Costa (1853). Referred photograph from [27](A), considered as the synonyme of specimen used in this experiment, proposed as Grandidierella megnae Giles, 1888) (B)
2. Material and Methods
This experiment was performed following the Australian Code of Practice for the care and use of animals for scientific purposes.

2.1 Experimental crablet
The domesticated broodstock (F2) of blue swimmer crab (body weight 187 g; and carapace width 87 mm) was used in producing crablet at RICAFE hatchery’s. The procedure of mud crab hatchery techniques developed by [28] was adopted. The day-four crablets (C4) collected from a batch of mass production of swimmer crab at RICAFE (body weight 0.0213±0.0046 g; carapace width 6.38±0.65 mm) were used for feeding trial in this experiment. An individual crab was distributed in 5 1-L glassware filled with 0.5 L sterilized sea water (30 ppt). Each glassware equipped with slow aeration. The crablet keep unfeed for about four hours prior the amphipod is given. Each container then supply with numbers of Amphipod according to the treatment. The glassware were placed in water bath equipped with two 100-watt heaters to maintain water temperature at about 30°C.

2.2 Amphipod source
The amphipod used in this experiment is taken from natural population in outdoor concrete tank at RICAFE. Only the adult individual (body weight, 0.00059±0.00008 g; body length 3.79±1.02 mm) were selected. Five treatment were applied i.e.: 5, 10, 15, 20, and 25 amphipod per glassware. Each treatment is with 10 replications.

2.3 Amphipod consumption
After 10 hours exposed to amphipod, the crablet from each experimental unit was removed to a different containers. The remaining amphipod in the glassware then recorded. The different between the number of amphipod stocked and the remaining one is consider as amphipod consumption.

2.4. Data analysis
The data analysis was performed using the IBM SPSS-23 software package, and a significance level of p < 0.05 was used. One-way ANOVAs, followed by Tukey tests, were used to evaluate the differences in the means of the amphipod consumption. Results are shown as the mean±standard deviation of the mean (SD). Microsoft Excel version 2013 was used to perform regression analysis between the density of amphipod and the consumption rate of crablet. Based on the regression equation, the optimum density of amphipod which give the maximum consumption is calculated.

3. Results and Discussion
The amphipod consumption of blue swimmer crab is change according to the stocking density of amphipod applied. Roughly, the consumption rate increases significantly when the density of amphipod is increased. However, the consumption rate increase slower compare to the increase of the stocking density for example when the stocking density increases five times from 5 to 25 ind. 0.5 L⁻¹, the consumption rate increase only about 3 fold from 4 to 12 ind. 10 hour⁻¹ (Table 1).

From the quadratic line equation (Figure 2) the optimum density of amphipod is 29 ind. 0.5 L⁻¹) when the highest consumption rate reached at 11.43 ind. The amphipod consumption rate is change with the amphipod density. This may be related to the ability of crablet to catch amphipod. It is ease to catch amphipod in dense compared in scarce condition. The maximum consumption of swimmer crab (11.4 ind.) is equivalent with the food dosage of 32% of crablet body weight. The consumption rate reached here is in the range of feed dosages that usually recommended for mangrove crabs during weaning period that is 10-100% of crab body weight per day [29].
Table 1. Amphipod (*G. megnae* Giles, 1888) consumption of blue swimmer crab *P. pelagicus* crablet exposed at different stocking densities of amphipod for 10 hours.

| Amphipod densities (Ind.0. 5 L⁻¹) | Amphipod consumption (ind.) (mean±SD) |
|-----------------------------------|--------------------------------------|
| 5                                 | 4.10±0.57ᵃ                              |
| 10                                | 7.30±0.95ᵇ                              |
| 15                                | 8.50±0.85ᵇ                              |
| 20                                | 10.40±1.58ᶜ                             |
| 25                                | 11.10±1.66ᶜ                             |

Different superscript letters (ᵃᵇᶜ) in the same column at different amphipod densities indicate significant differences between treatments (ANOVA, p < 0.05).

The consumption rate found in this experiment is in accordance to the suggested dosage for the first two week of mud crab weaning at 30% [30]. However, the consumption rate of swimmer crab crablet is much lower compared to the consumption rate of tiger prawn juvenile (body weight 0.5-1.0 g) at 68% body weight [31]. It seems swimmer crab has difficulty in catching amphipods whose movements are also agile by relying only on its two claws. Unlike the black tiger shrimp that can use all its legs to trap an amphipod and eat it within 2-4 minutes. This may be caused by the size of swimmer crab that are still too small where the carapace width is only 2 mm adrift longer than the length of the amphipod body.

Figure 2. The consumption rate of swimmer crab *P. pelagicus* crablet at different stocking density of *G. megnae* Giles (1888) in controlled condition.
No mortality was found for the blue swimmer crab during the experiment, but few was found for amphipod at different treatments. No clear pattern of the mortality rate occurred at different stocking densities of the amphipod during the experiment. This may be indicate that the cause of death was not related to the dense of the animal, but may have been killed by swimmer crab. Amphipods seem to move more actively compared to crabs that are more silent. The active amphipod movement has causes to increase a collision with crabs, including those that are eaten amphipod. Under these conditions, crab claws that don't hold food sometimes catch other amphipods immediately and then release one of them. This is believed to have caused some dead amphipod was not consumed during the observation. If this happened, the question is why the crab does not eat the death one? It is important to notice here that live food is more attractive compare to dead food. Another possible explanation is could be related to the maximum longevity of the amphipod which is only about a month [24, 25].

4. Conclusions

Based on the consumption rate of blue swimmer crab carblet C4 against amphipod, can be concluded that the *G. mejnae* Giles (1888) is suitable as a live food during weaning of swimming crab. The optimum stocking density of amphipod for maximum consumption is 29 ind./0.5 L at consumption rate of 11.47. However, the effect of amphipod on growth rate of swimmer crab and the biological aspect is still need more detail study.

Acknowledgements. The authors would like to acknowledge to Aswarudy and Syakaria, for technical assistance at RICAFE hatchery during the experiments.

References

[1] Ikhwanuddin M, Mansor J H, Bolong A-M A and Long S M 2012 Improved hatchery-rearing techniques for juvenile production of blue swimming crab, Portunus pelagicus (Linnaeus, 1758) *Aquac Res* 43: 1251-9
[2] Perikanan D P d P H 2019 *Statistik Ekspor Hasil Perikanan Tahun 2018*. (Jakarta: Kementrian Kelautan dan Perikanan)
[3] Effendy S, Faidar., Sudirman., dan Nurcahyono, E 2005 Perbaikan Teknik Pemeliharaan Larva pada Produksi Massal Benih Rajungan (*Portunus pelagicus*) Penelitian Balai Budidaya Air Payau Takalar 6: 1-10.
[4] Tanti J T H Y and Sulwartiwi L 2010 Teknik pemeliharaan benih rajungan (*Portunus pelagicus* Linn.) di Balai Besar Pengembangan Budidaya Air Payau Jepara Kabupaten Jepara Provinsi Jawa Tengah *Jurnal Ilmiah Perikanan Indonesia* 2: 87-95
[5] Williams M J 1982 Natural food and feeding in the commercial sand crab *Portunus pelagicus* Linnaeus, 1766 (Crustacea : Decapoda : Portunidae) in Moreton Bay, Queensland *J Exp Mar Biol Ecol* 59: 165-76.
[6] Chande A I and Y.D.Mgaya 2003 The fishery of Portunus pelagicus and the species diversity of portunid crabs along the coast of Dar es Salaam *West Indian Ocean J Mar Sci* 2: 75-84.
[7] Josileen J 2011 Food and feeding of the blue swimmer crab, *Portunus pelagicus* (Linnaeus, 1758) (Decapoda, Brachyura) along the coast of Mandapam, Tamil Nadu, India *Crustaceana* 84: 1169-80
[8] Dou S, Masuda R, Tanaka M and Tsukamoto K 2002 Feeding resumption, morphological changes and mortality during starvation in Japanese flounder larvae *J Fish Biol* 60: 1363-80
[9] Bisbal G A and Bengtson D A 1995 Effects of delayed feeding on survival and growth of summer flounder, *Paralichthys dentatus* larvae *Mar Ecol Prog Ser* 12: 301-6
[10] Yang Z 2007 Effect of timing of first feeding on survival and growth of obscure puffer (*Takifugu obscurus*) larvae *J Freshw Ecol* 22: 387-92
[11] Dou S, Seikai T and Tsukamoto K 2000 Cannibalism in Japanese flounder juveniles, *Paralichthys olivaceus*, reared under controlled conditions *Aquaculturae* 182: 149-59
[12] Gisbert E, Conklin D B and Piedrahita R H 2004 Effects of delayed first feeding on the nutritional condition and mortality of California halibut larvae J Fish Biol 64: 116-32
[13] Peña R and Dumas S 2005 Effect of delayed first feeding on development and feeding ability of Paralabrax maculatofasciatus larvae J Fish Biol 67: 640-51
[14] Rattanama K, Pattaratumrong M S, Towatana P and Wongkamhaeng K 2016 Three new records of Gammarid Amphipod in Songkhla Lake, Thailand Tropical Life Sciences Research 27: 53-61
[15] E H, AE S, FA A-R, Zaid MMA and TAA M 2014 Habitat preference by the marine amphipod Cymadusa Filosa (Savigny, 1816) (Amphipodidae), using different artificial substrata from northern Hurghada, Red Sea, Egypt. International Journal of Development Research 4
[16] Baeza-Rojano E, Hachero-Cruzado I and Guerra-García J M 2014 Nutritional analysis of freshwater and marine amphipods from the Strait of Gibraltar and potential aquaculture applications J Sea Res 85: 29-36
[17] Suontama J, Kiessling A, Melle W, Waabg E and Olsen R E 2007 Protein from Northern krill (Thysanoessa inermis), Antarctic krill (Euphausia superba) and the Arctic amphipod (Thamnisto libellula) can partially replace fish meal in diets to Atlantic salmon (Salmo salar) without affecting product quality Aquac Nutr 13: 50-8
[18] Baeza-Rojano E, Domingues P, Guerra-García J M, Capella S, Noreña-Barroso E, Caamal-Monsreal C and Rosas C 2013 Marine gammarids (Crustacea: Amphipoda): a new live prey to culture Octopus maya hatchlings Aquac Res 44: 1602-12
[19] Angsupanich S, Chiayvareesajja S and Chandumpai A 1999 Stomach contents of the banana prawns (Penaeus indicus and P. merguiensis) in Tammalang Bay, Southern Thailand. 12(3): 257–265. Asian Fish Sci 12: 257-65
[20] Chilton C 1921 Fauna of the Chilka lake. Amphipoda. Memory of Indian Museum 5: 521-58
[21] Myers A 1970 Taxonomic Studies on the Genus Grandidierella Coutière (Crustacea: Amphipoda), with a Description of G. Dentimera, sp. nov Bull Mar Sci 20: 135-47
[22] Koraon W, Pongrat D, Myung-Hwa S and Chaichat B 2020 Grandidierella gilesi Chilton, 1921 (Amphipoda, Aoridae), first encounter of non-indigenous amphipod in the Lam Ta Khong River, Nakhon Ratchasima Province, North-eastern Thailand Biodiversity data journal 8:1-17
[23] Fattah M H, Saenong. M., Asbar and Busaeri S R 2014 Production of endemic microcrustacean Phronima Suppa (Phronima sp) to Substitute Artemia salina in Tiger Prawn Cultivation Journal of Aquaculture Research & Development 5: 1-5
[24] Hamka, Gafur A, Bahri S and Sirajuddin 2018 Pemijahan Phronima sp. hasil domestikasi pada wadah terkontrol Jurnal Perekayasaan Budidaya Air Payau 4: 156-65
[25] Hamka, Lideman, Khairil, Sirajuddin and Hartanto N 2018 Domestikasi Phronima sp. pada bak terkontrol yang hidup secara endemi di tambak tradisional Suppa Jurnal Perekayasaan Budidaya Air Payau 4: 144-55
[26] Hamka, Saichudin, Gafur A and Sirajuddin 2018 Karakteristik lingkungan hidup Phronima (Phronima sp.) pada tambak tradisional Suppa Jurnal Perekayasaan Budidaya Air Payau 4: 135-43
[27] Lazo-Wasem E A 2016 Yale Peabody Museum of Natural History.
[28] Gunarto, Herlinah and Andi P 2014 Pembenihan kepingan bakau, Scylla spp (Maros: Balai penelitian dan pengembangan budidaya air payau)
[29] Burhanuddin and Hendrajat E A 2018 Pentokolan Kepeiting Bakau Scylla tranquebarica pada Substrat Berbeda In: Prosiding Simposium Nasional Kelautan dan Perikanan V Universitas Hasanuddin, 5 Mei 2018, Makassar
[30] Usman, Kamaruddin, Neltje Nobertine Palinggi and Laining A 2016 Performa pertumbuhan krablet kepingan bakau, Scylla olivacea, yang diberi pakan dengan dosis berbeda selama periode pendederan Media Akuakultur 1: 19-26
[31] Sulaeman, Herlinah, Gunarto and Parenrengi A 2020 The consumption rate of tiger prawns (Penaeus monodon) on alive Amphipod-Crustacean (in review for publication)