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Abundance And Composition of Freshwater Shrimp (Decapoda: Caridea) in the Selat Cina River, Sepuk Laut Village, Sungai Kakap District, Kubu Raya Regency

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Abstract

Sepuk Laut Village has high capture fisheries potential, especially freshwater prawns. This study aims to analyze freshwater shrimp's abundance and species composition and the relationship between freshwater shrimp abundance and water and substrate quality in the China Strait River. The research method used is systematic sampling with random start. The results obtained were 354 individual freshwater shrimp from 4 species belonging to the Palaemonidae family with the Macrobrachium genus, namely *Macrobrachium equidens*, *M. rosenbergii*, *M. mirabile*, and *M. nipponense*. The highest species abundance was *M. equidens* (D 2620 ind/km^2), while the lowest species abundance was *M. nipponense* (D 828 ind/km^2). The abundance of freshwater shrimp associated with water and substrate quality showed a strong to robust correlation (r>0.7) on several parameters, such as current speed, depth, brightness, and water temperature in the four identified freshwater shrimp species. The abundance of freshwater shrimp in the China Strait River is concentrated in the middle of the river, which is 2 km from the river mouth, dominated by *Macrobrachium equidens*.

INTRODUCTION

The China Strait River is a freshwater ecosystem in which the upstream and downstream areas are dominated by riparian nipah (Nypa fructicans) vegetation and the water flow is relatively slow. River conditions like this can be a habitat for aquatic biota, including freshwater shrimp. Therefore, the China Strait River is used by small fishermen to fulfill the supply of capture fisheries, especially freshwater shrimp, which are the mainstay of the community business sector in Sepuk Laut Village

Capture fisheries production in Kubu Raya Regency in 2017, and the most significant supplier came from Sungai Kakap District with a total of 6,144 kilos; this amount came from villages in the area, one of which was Sepuk Laut Village (Dikjen SDA, 2012). Sepuk Laut Village is a village that has the largest area in Sungai Kakap District and has a high potential for capture fisheries. The high potential for capture fisheries in Sepuk Laut Village has yet to be matched by scientific information regarding the abundance and

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composition of freshwater shrimp species. Meanwhile, high fishing activity can be an essential factor for shrimp populations—preliminary data regarding the abundance and species composition. Freshwater shrimp are needed to add to scientific information on freshwater shrimp populations in Sepuk Laut Village, specifically in the Straits of China.

MATERIALS AND METHODS

This research was conducted from October to November 2022. Sampling was conducted in the Selat Cina River, Sepuk Laut Village, Sungai Kakap District, Kubu Raya Regency. Identification and analysis were conducted at the Zoology Laboratory, Department of Biology, Faculty of Mathematics and Natural Sciences, Tanjungpura University, Pontianak. The tools used included a digital pH meter, tube traps (length 62 cm; diameter 20cm), umbrella traps (number of holes 6; diameter 70cm; height 29 cm), ping pong balls, Winkler bottles, Erlenmeyer 50 ml, DLSR cameras, looper, measuring tape, 1 ml dropper, Secchi pieces, seine (mesh size 1/2 cm; length 30 m; width 1.5 m), stopwatch, weight rope, thermometer and plastic jar. The materials used include 70% alcohol, starch indicator, pp indicator, H2SO4 solution, KOH-KI solution, and Na2S2O3 solution.

Sampling Point Determination

Determination of the sampling point using a systematic sampling method with random start. The starting point of sampling is determined randomly; then, the following point is based on predetermined intervals. The interval between station points is 2 kilometers from the length of the river, 8.12 kilometers (Figure 1).

Fig 1. Map of the research location of the China Strait River, Sepuk Laut Village, Sungai Kakap District, Kubu Raya Regency

Sampling

Samples were collected using fishing gear in the form of tube traps, umbrella traps, and trawls. Fishing gear is installed on the left and right banks of the river with a distance of 3 meters between fishing gear. The fishing gear that has been installed is left for 4 hours. The captured samples are photographed first, then preserved in a plastic jar containing 70% alcohol and replaced regularly until the alcohol solution is clear. Repetition was carried out randomly thrice with an observation time interval of 1 week.

Measurement of Water and Substrate Quality

Water quality parameters measured included water temperature, water pH, water brightness, current velocity, depth, electrical conductivity (DHL), salinity, dissolved oxygen (DO), free carbon dioxide (free CO_2), and substrate texture.

Sample Identification

Characteristics of freshwater shrimp observed included carapace morphology, arrangement of the second abdominal segment, extremities, and caudal parts. Sample identification using the help of the identification book Wowor *et al*. (2004) and Cai (2006), as well as previous research articles.

Data analysis

The abundance of freshwater shrimp at each station was calculated based on the volume of fishing gear and the area analyzed using the following abundance formula (Michael, 1984):

$$D = \frac{\Sigma ni}{A}$$

Information:
D: Density of freshwater shrimp
Ni: Number of individual xfreshwater prawns
A: Fishing gear volume or area

Relative abundance is analyzed using the following formula (Michael, 1984):

$$DR = \frac{\Sigma ind{-}i}{\Sigma \text{total ind}} \times 100\%$$

Information:
observation time interval of 1 week.
DR: Relative density of freshwater shrimp
Ind-i: Number of individual species of freshwater shrimp it-i
Total ind: Total number of individual freshwater prawns

Analysis of the relationship between water quality and substrate with the abundance of freshwater shrimp using Pearson's linear correlation analysis with the help of PAST version 3.0 software. The level of relationship is determined based on the value of the correlation coefficient (r), according to Sugiyono (2013).

RESULTS AND DISCUSSION

The highest composition and abundance of freshwater prawns were found at stations II and III. Four species of freshwater shrimp identified at this station were dominated by *M. equidens* and followed by *M. rosenbergii*. The composition of a habitat is influenced by migration and environmental stability (Sugiharto, 2005). Research by Aji *et al*. (2014), habitat which shows the conditions of interaction between populations related to environmental conditions and natural food needs and the presence of currents.

The high abundance of *M. equidens* at this station can be attributed to the abundance of available natural feed. According to Darmono (1991) plankton is a natural food for shrimp, so the presence of plankton will affect the abundance of the shrimp itself. Shrimp natural feed preferences depend on the age or phase of the shrimp itself. According to Lavens *et al*. (2000) the larval phase of shrimp is carnivorous with food in the form of zooplankton, especially small crustaceans, while in the post-larvae and adult stages shrimp are omnivorous which can eat algae, aquatic plants, molluscs, aquatic insects, worms and other crustaceans (Ismael and New, 2000).

Tabel 1. Abundance of freshwater shrimp in the Selat Cina River, Sepuk Laut Village

Species	Abundance of fishing gear (ind/m³)		Σ	Abundance per station (ind/km²)*				Σ
	BT	BP		I	II	III	IV	
Macrobrachium equidens	2.600	3.333	5.933	310	1034	1000	276	2620
M. mirabile	600	1.900	2.500	552	190	155	293	1190
M. nipponense	1.500	600	2.100	0	379	397	52	828
M. rosenbergii	2.300	1.000	3.300	86	517	362	345	1310
Total	7.000	6.833	13.833	948	2120	1914	966	5948

Information: BT) tube trap; BP) umbrella trap; *) rounded numbers

Shrimp tend to cluster or cluster in a habitat, thus enabling the high abundance of a species. This habit, apart from aiming at getting enough food for the larvae, is also to get a suitable habitat as a shelter (Adli *et al*., 2022). Stations II and III are suitable habitats for the life of *M. equidens* which can support the needs of natural food and shelter. Stations II and III have nipah vegetation that is still maintained because not many local people have activities that reach this area, therefore there are still many places for freshwater shrimp to take shelter. The results of previous research on *M. equidens* were found to be less than this study (Suwartiningsih *et al*., 2020; Adli *et al*., 2022; Rahayu and Annawaty, 2019). This can be caused by different environmental factors such as current speed, water temperature and depth.

Stations II and III have relatively slow current speeds with water temperatures that are still classified as optimum for freshwater shrimp, very few of these species are found at fast current speeds with water temperatures below the optimum range Adli *et al*., (2022) research results only found 8 individuals of *M. equidens* with fast current conditions. Firdaus (2016) states that the ideal current speed for shrimp life is in the range of 0.11-0.30 m/sec and the range of water temperatures that is good for the growth of freshwater shrimp is around 28-31^{0}C (New, 2002). Depth may also have an effect on the abundance of *M. equidens* at this station, comparing with previous research at depths below 2 m only found 6- 20 individuals of this species (Rahayu and Annawaty, 2019; Annawaty *et al*., 2022). The high abundance of *M. equidens* in this study was also influenced by sea water. It is known that the China Strait River is connected to two river mouths in the downstream and upstream parts of the river which are directly adjacent to sea waters. According to Johnson (1973) this species is rarely found inhabiting fresh waters that are not influenced by sea water. Wowor and Choy (2001) also stated that this species is widespread in estuaries and mangrove waters.

The lowest composition and abundance in this study occurred at station I, but more *M. mirabile* was found at this station than at the other stations. The low abundance at station I could be due to the lower number of other species found compared to the other three stations, in fact *M. nipponense* was not found at this station. The dominating *M. mirabile* at this station can also be caused by the water conditions that are suitable for the life of this species. This species can be found in brackish waters, river estuaries and in rivers that are affected by tides (Hossain *et al*., 2015; Wowor *et al*., 2010; Wowor and John, 2007; Gopalakrishnan, 1971). The results of Rais and Wulandaris (2014) study found that *M. mirabile* was found to have a high composition in river habitats connected to river mouths.

Station I is known to be a downstream river connected to a river mouth so that this species has a high abundance. This habitat is suitable for *M. mirabile* due to the life cycle of this species which requires brackish waters. According to Gopalakrishnan (1971) stated that *M. mirabile* is a freshwater shrimp species that is abundant in fresh waters and sometimes moves to brackish waters. The distance of station I which is closer to the river mouth and the current is faster than other stations helps *M. mirabile* to be more efficient in using energy for swimming. The abundance of *M. mirabile* could also be affected by the presence of the other three species found at this station. The body size of *M. mirabile* is much smaller compared to other species, if other species dominate, *M. mirabile* will become prey for other species (cannibalism). This statement is indicated by the decrease in the abundance of *M. mirabile* at the other three stations. The results of research by Alston and Sampaio (2000), shrimp can behave cannibally when the density of a habitat is high and food is insufficient. This behavior can cause stress and death, especially in susceptible shrimp individuals. *Macrobrachium nipponense* or hanging shrimp is a species not found at station I, but can be found at three other stations. Factors that may affect the absence of this species are the level of water brightness which is affected by depth. It is known that station I has a low level of brightness compared to other stations. This is supported by the research results of Tantri (2016) *M. nipponense* which found only 1 individual with a river that has a brightness of 0.11 m. The brightness of the water will affect the presence of natural food such as molluscs and plankton which are known to be natural food for *M. nipponense* (Mirzajani *et al*. 2020; Darmono, 1991). According to Khairun and Amir (2003) stated that water that has a brightness between 0.1-0.25 m causes a small amount of plankton because the optimal brightness for aquatic biota is >0.45 m. Another factor that reduced the abundance of *M. nipponense* at station I came from local community activities such as fishermen or the community cutting down nipa vegetation on the banks of the river. This is reinforced by Irianto (2017) which states that human activities can affect biotic and abiotic components in the waters.

The abundance and composition of freshwater prawns based on the use of fishing gear did not show a significant difference between tube traps and umbrella traps. Trawlers in this study did not get caught freshwater shrimp because there was no feed used as bait and the mesh size was larger than the size of the shrimp's body so that it could escape the trap. According to Zamri (2015) species of fish or shrimp that actively search for food at night usually rely on their sense of smell and touch to get their food, therefore fishing gear that has feed as bait will be more efficient to use.

Tabel 2. Abundance of freshwater shrimp per fishing gear in Selat China River, Sepuk Laut Village

Fishing Gear	Abundance per station (ind/m^3)				$\bar{X} \pm SD$
	I	II	III	IV	
BT	1200	2650	2350	800	1750 ± 890
BP	1033	2333	2133	1333	1708 ± 624
$\bar{X} \pm SD$	1117 ± 118	2492 ± 224	2242 ± 153	1067 ± 377	

Information: BT) tube trap; BP) umbrella trap

The sex ratio of freshwater shrimp in this study revealed that three types of freshwater shrimp were found to have a higher number of female shrimp, except for *M. equidens*. The sex ratio for shrimp found was 1:2 and for M. equidens 1:1. The results of other studies revealed that female *M. rosenbergii* were found to dominate compared to males (Sofian and Sari, 2018; Indarjo *et al*. 2021). According to Kutty (2010), in general the proportion of female *M. rosenbergii* was higher than the male, therefore in this study female *M. rosenbergii* were also found more frequently than males. Based on the results of Harahap (2020), male prawns dominate compared to females in a habitat, it can be said that the habitat is in a disturbed condition and allows for a population decline. A balanced ratio of males and females or females that are more dominating means that the shrimp population in the Straits of China is still ideal to maintain its sustainability.

Tabel 3. Sex ratio of freshwater shrimp in the Selat Cina River, Sepuk Laut Village

Spesies	**Gender**		**Ratio**
	Male	**Female**	
Macrobrachium equidens	82	70	1:1
M. mirabile	26	43	1:2
M. nipponense	18	30	1:2
M. rosenbergii	24	52	1:2
Total	150	195	

Darmono (1991) stated that shrimp in normal waters had a male and female ratio of 1:1, which is consistent with the results of other studies which stated that *M. equidens*, *M. mirabile* and *M. nipponense* had a ratio of 1:1 and in certain months the ratio of females will be higher than males (Maciel *et al*., 2011; Aye and Sein, 2012). The dominance of female shrimp will benefit the population because the chances of success during the mating season will increase so that the chance to maintain the population is greater (Darmono, 1991). The 1:1 ratio can change due to differential sex ratios at birth or metamorphosis, besides that the use of various fishing gear can also cause one male or female shrimp to dominate (Aye and Sein, 2012).

Based on the table of correlation coefficient values quoted from Sugiyono (2013), Pearson's linear correlation analysis results showed that the four freshwater shrimp species were correlated with water quality parameters. However, only a few water quality parameters have a strong to robust correlation (r>0.7), namely current speed, depth, brightness, and water temperature. All freshwater shrimp species showed a robust correlation with current speed parameters. According to Arshad (2010), the current speed is one factor controlling the species, distribution, and abundance of organisms, including crustaceans. In addition, current velocity influences the life of aquatic biota in an area because it plays an essential role in determining the distribution of plankton organisms, dissolved gases, and salt content. The ideal current speed for shrimp life is around 0.11-0.30 m/second (Firdaus, 2016). Current speeds exceeding the optimum will affect the abundance of shrimp and harm *M. mirabile* because the small body size compared to other freshwater shrimp will make it difficult for this species to control a fast-flowing body. Previous studies showed that fewer shrimp were found in rivers with swift currents (Mangesa and Annawaty, 2016; Suwartiningsih *et al*., 2020; Adli *et al*., 2022).

Tabel 4. The average value of water and substrate quality parameters in the Selat China River, Sepuk Laut Village

Water and Substrate	Value per station			
Quality Parameters (n=12)	I	II	III	IV
Water pH	6,03 ± 0,06	6,00 ± 0,00	6.03 ± 0,06	6,00 ± 0,00
DO (mg/L)	3,24 ± 0,66	3,24 ± 0,60	3,25 ± 0,50	3,22 ± 0,43
CO^2 free (mg/L)	0,59 ± 0,03	0,58 ± 0,05	0,57 ± 0,05	0,57 ± 0,05
Current speed (m/sec)*	0,17 ± 0,01	0,22 ± 0,03	0,24 ± 0,05	0,20 ± 0,03
Depth (m)*	4,47 ± 0,06	5,12 ± 0,23	4,57 ± 0,15	4,10 ± 0,17
Brightness (m)*	0,24 ± 0,01	0,32 ± 0,01	0,33 ± 1,01	0,36 ± 0,01
Salinity (‰)	0,02 ± 0,01	0,02 ± 0,01	0,03 ± 0,01	0,03 ± 0,01
Water temperature (ºC)*	29,26 ± 2,32	28,13 ± 1,46	28,80 ± 2,70	27,87 ± 1,62
Conductivity (µmho/cm)	138,67 ± 20,13	139,33 ± 24,19	128,67 ± 11,37	140,00 ± 34,70
Substrate texture (%) (n=1)				
Sand	5,37	12,00	16,49	16,50
Slit	82,87	72,31	61,94	63,89
Loam	11,76	15,69	21,57	19,61

CONCLUSION

The results obtained found four species of freshwater shrimp in the China Strait River, namely *Macrobrachium equidens*, *M. rosenbergii*, *M. mirabile*, and M. *nipponense*. The abundance of freshwater shrimp in the China Strait River is concentrated in the middle of the river, which is 2 km from the river mouth, dominated by *Macrobrachium equidens*.

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