Some Aspects of Fisheries and Biology of Spanner Crab (Ranina ranina, Linneaus) in Maluso, Basilan Province, Philippines

Some Aspects of Fisheries and Biology of Spanner Crab (*Ranina ranina*, Linneaus) in Maluso, Basilan Province, Philippines

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Key words: catch abundance, fecundity, fisheries, sex ratio, size composition, size at sexual maturity, spanner crab

Abstract

This study partly investigated the fisheries and some aspects of the reproductive biology of the spanner crab *Ranina ranina* in the Philippine waters of Maluso, Basilan Province from December 2006 to February 2007. Data were gathered using fishery-dependent survey. To provide indicators for sustainable utilization; abundance, sex ratio, size composition and size frequency distributions were monitored including occurrences of ovigerous females, gonad and gonadosomatic indices, fecundity as well as the size at sexual maturity to determine reproductive activity of *R. ranina* in the area.

Of the one thousand one hundred thirty one (1,131) individuals sampled, the population exhibited a 1:1.04 male to female ratio with males generally attaining larger sizes than females. The male population dominate in the bigger size classes (90-99 mm and above) while females dominated the two smaller size classes (70-79 and 80-89 mm). Of the total catch, medium (80-119 mm) and small (<80 mm) sized crabs were dominant representing 98.5% (75.42% medium +23.08% small), while only 1.50% represents large (>120 mm) sizes. The high number of medium sized crabs and low large sized crabs is indicative of increased exploitation pressures. These implied that the fishery is somewhat disturbed, hence, protection, and proper management to ensure long term viability through maintenance of spawning population are needed.

The relatively high incidence of ovigerous females in the population indicate breeding season from December to February. Breeding was conspicuous and more prevalent in the medium sized females (80-89 mm size class) which can be considered as the typical breeding sizes. Fecundity results further point out that as size increases, the number of eggs also increases. Based on GSI's and GI weighted values, and curved fitting of adjusted proportions of ripe females; a conservative length at massive maturity was estimated to be at 86 mm CL and therefore recommended as the minimum allowable size for catching to allow spawning prior to capture.

Introduction

Spanner crab or Red frog crab (*Ranina ranina* Linn.) are decapod marine crustaceans of the family Raninidae, characterized by elongated, anteriorly broad, reddish-brown carapace that is covered by low rounded scale-like spines with patterns of ten white spots on the body. This marine brachyuran is widely distributed throughout the subtropical and tropical regions, and inhabits offshore sandy areas ranging from shallow depths to 20 m or more.[1)]

In Zamboanga City, in the southern part of the Philippines, the meat of this crab is a delicacy and is the favorite of tourists. The increased demand of this species for domestic and foreign consumption had markedly increased its retail in the local market. *Ranina ranina* is now pegged at a price of PhP 200-300/kg in the local markets. As a result, *Ranina ranina* fisher folks especially those operating in the municipality of Maluso, Basilan province – an island located in the southern part of Zamboanga peninsula, had significantly increased their fishing efforts. They make use of baited traps that are similar in construction with that reported by Kennelly (1992).[2)] This gear is very efficient in catching crabs. These activities effectively took advantage the high market demand of the resource thus, augmenting the fishermen's daily income.

However, these crabs which used to be exported to neighboring Asian countries like Malaysia, Singapore, Japan and Taiwan are now only marketed locally. The local fishermen and stakeholders are experiencing a decline in their monthly average catch which they commonly associate with various illegal fishing activities and other destructive practices rampant in or near the fishing area.

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For the purpose of fishery resource management and conservation of biodiversity, some aspect of the characteristics of the *Ranina* population in the area needs to be investigated, especially their reproductive biology and abundance since the number of mature individuals in a given population is eventually responsible for the productivity of the future generations.[3]

Additionally, the sustainable utilization of this resource is influenced largely by catch pressure and management of the spanner crab population. Thus, examination of the sex ratio, fecundity and size at reproductive maturity can be used as indicators in the proper management of this resource.

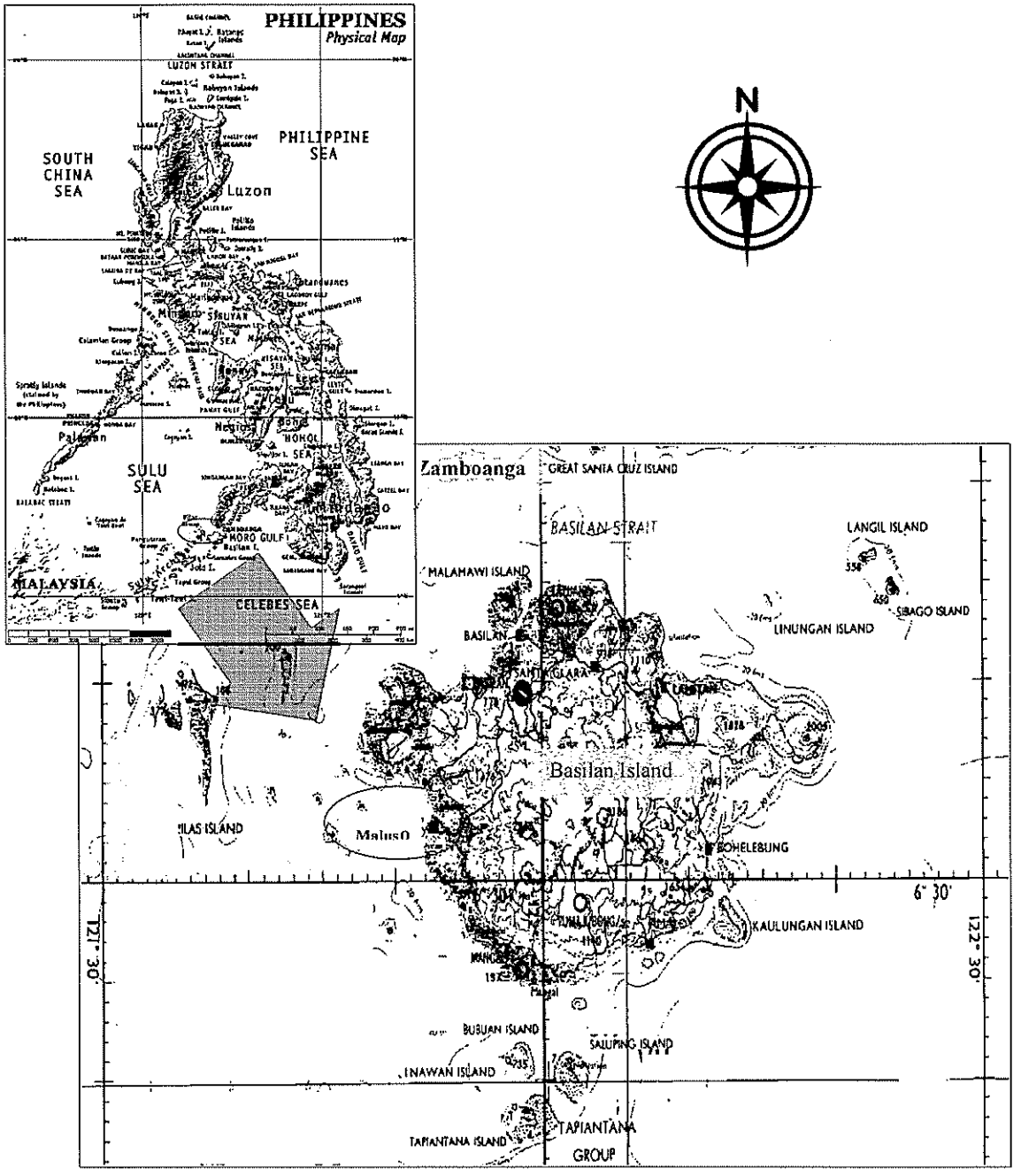

Plate 1. Map of Basilan Island showing the location of the study area.

Materials And Methods

Data collection was conducted in the landing points in Maluso, Basilan Province in the southern part of the Philippines (Plate 1). Information's regarding the fishing ground, mode of fishing, catch seasonality in relation to lunar phases and other important details were obtained by interview on December 2006 to February 2007 from the fishermen and stakeholders.

Sex ratio was determined by examining the external morphology of the abdomen of the specimen. Abdomens of male crabs could readily be distinguished from female by the possession of narrowly triangulate abdomen cover or tapering towards the distal segment while females are distinguished by the broad surface of their abdomen[4] as shown in Plate 2.

Size composition of the male and female crab catches was recorded using Vernier caliper and were classified into 3 different size categories following Lasola and Samson (1993)[5] with slight modifications to suit the present category used by fishermen and buyers, namely: small (<80 mm), medium (from 80 to 119 mm), and large (120 mm and above).

Representative samples (30% of the total) of both sexes were randomly obyained including the ovigerous and non-ovigerous females. These were stored frozen and transported to the laboratory for dissection and analysis of fecundity, gonad index, sexual developmental stages and gonad-somatic index.

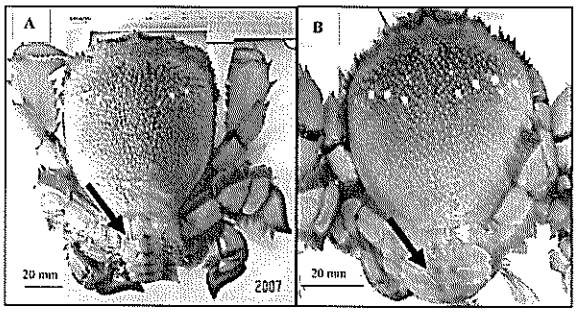

Plate 2. Representative species of male (A) and female (B) *Ranina ranina* showing (arrows) their abdominal cover shapes.

Prior to dissection, the crabs was thawed for 1 h in running water, inverted several times to drain excess water from their branchial chamber, then blot dry using absorbent paper towel. The weight of each crab was recorded and dissection involved the removal of the anterior half of the dorsal carapace for the determination of egg developmental stages and removal of the intact ovary for GSI/fecundity determination.

The reproductive developmental stages of the male and female crabs were determined by visual observation following the description provided by Minagawa *et al.* (1993)[6] and Krajangdara and Watanabe (2005).[7] For males, the stages used were the following: (i) stage I (immature), the testes are small and tubular, slender and white. They are located under the carapace hypodermis and over the midgut gland near the heart; and (ii) stage II (mature), the testes show increase size and have the form of two Y-shaped horns. They extend to the head region and milk white in color. In females, the descriptions are shown in Table 1.

Table 1. Female crab gonadal stages with its corresponding descriptions.

STAGES	DESCRIPTIONS
I (undevelop)	The ovaries are small, slender, tubular and pale yellow. They are located at the same position as the male testes.
II (developing)	The ovaries are yellow in color and extend to the anterior position region, forming an H-shape.
III (ripe)	The ovaries increase in size, inside yellow eggs can be clearly distinguished but cannot be separated. The anterior ovarian portion begins to spread to the head region.
IV (spawning)	The ovaries become dark orange or dark yellow and spread throughout the head region. They assume an X-shape egg that can be easily separated by manual dissection of egg mass.
V (recovery)	The ovaries decrease in size and become yellow or brown. The younger oocytes remaining inside the ovary.

The gonadosomatic index (GSI) was calculated following the procedures recommended by Brown *et al.* (1999)[8] using the formula $GSI=(GW/BW)\times100\%$, where; GW = gonad weight and BW = body weight. Prior to the computations and determination of the gonad index (GI) of the crab samples, the data obtained from the developmental stages through visual observations were used to establish the pre-weighted values following the Kennedy's scheme (Table 2) as employed by Batoy *et al.* (1987)[9] and Germano and Evangelio (2006).[10] The mean value of gonad indices (GI) were then calculated using the formula $GI=(n\times WV)/N$, where; n = number of individuals in a given developmental stage, WV = pre-weighted value for

the developmental stage and N = total number of crabs per monthly sample.

Table 2. Pre-weighted values for developmental stages

DEVELOPMENTAL STAGES	PRE-WEIGHTED VALUES (WV)
Resting and spent	1
Developing, spawning and redeveloping	2
Ripe	3

Adopted from Batoy *et al.* (1987)[9]

Fecundity estimation for each ovigerous female was determined using the method employed by Krajangdara and Watanabe (2005).[7] This was done by fixing and preserving the ovary in Gilson Fluid[11] until the oocytes can be readily counted. The number of eggs was estimated gravimetrically by multiplying the mean number of oocytes per gram of sub-sample by the ovary weight.

The size at the onset of sexual maturity and conservative estimates of size at massive maturity (L_{mass}) was determined using two methods: scatterplots of GSI's and GI's against carapace length and curve fitting of the adjusted proportions of ripe females in different length classes following King (2003)[12] as used by Germano and Evangelio (2006).[10]

To avoid overestimation of the length at sexual maturity, adjustment of the proportion of sexually mature individuals was done by multiplying the correction factor (100/maximum proportion ripe) with the proportion of ripe individuals where the curve was fitted to the adjusted proportion of ripe females in different length classes based on the highest R^2 to determine the mean length at which 50% of the sampled reproductive population is ripe.[10]

Results and Discussion

Fisheries

The coastal village of Main Shipyard where all *Ranina ranina* fishermen land their catch has more than one hundred inhabitant dependent on fishing. The residents are primarily engaged in catching benthic and pelagic fishes, squids, cuttlefishes, octopuses and *R. ranina* as their means of livelihood and are considered members of the low or poverty class. Many of them own motorized boats but unmotorized ones are also commonly used in fishing. These poor fishermen have daily income close to PhP 150-250.

About 12 fishermen are considered specific *Ranina* catchers and about 6 fishermen are engaged as part time catchers who only operate during the peak days and months. Generally, 1 or 2 out of the 7 nearby fishing grounds are visited every fishing operation located approximately 2-3 km away from their residence. Four (4) units of multiple traps consisting of 25 single traps each are set during the dawn and are retrieved 3-4 times per day operation. The most commonly used baits are meat from rays, which are cut into fillets or sliced into smaller pieces and clipped to the "X" frames of the trap by a small bamboo twig locally known as "sangbaw" (Plate 3).

The catches are bundled into 2-5 individuals comprising about 1 kg per bunch depending on the sizes. These are mainly delivered directly to the dealer, and later transported and sold in nearby municipalities (Isabela City) while others are exported to Zamboanga City if the catch volume is relatively high.

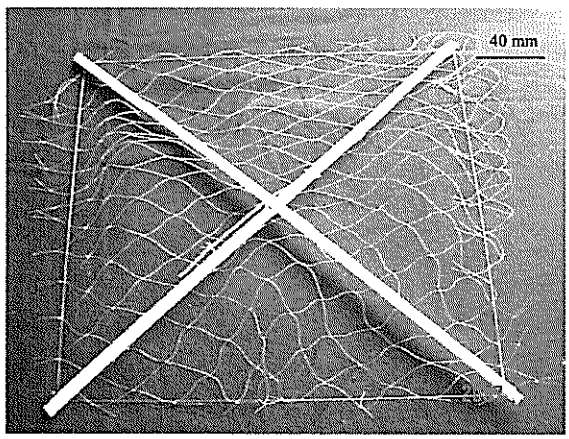

Plate 3. Photograph of a baited tangle net locally known as "sangbaw" used for catching *Ranina ranina*.

Catch abundance

A total of 1,131 *Ranina ranina* individuals were caught and landed in Barangay Shipyard during the three-month study period. Monthly catches showed that December obtained the highest with 482 individuals or 42.62%. Records of *R. ranina* catches during January and February are comparatively lower with 320 (28.29%) and 329 (29.09%), respectively.

The last quarter of lunar phases registered the highest catch representing 49.07% followed by first quarter with 30.95% and new moon (15.74%) while full moon registered the least with only 4.24% (Fig. 1).

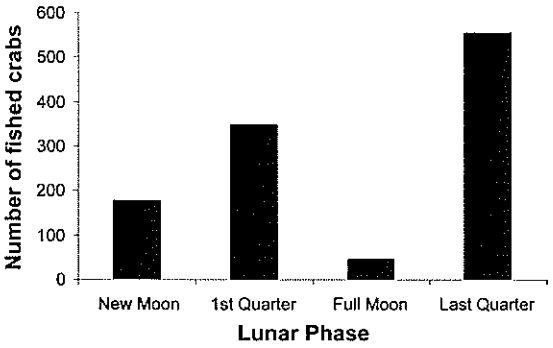

Fig. 1. Catch abundance of *Ranina ranina* fished in Maluso, Basilan Province relative to lunar phases

The low catch abundance value observed during full moon is presumed to be caused by unfavorable conditions during fishing operation where strong currents, high tides and sometimes strong winds prevailing in the area. Accordingly, these conditions make the crab populations inaccessible or difficult to catch. Thus, most of the fishermen do not go fishing during this season. Though this is one of the primary reasons for the "no fishing operation", unavailability of bait and navigational difficulty brought about by strong currents and winds cannot be discounted.

Size composition and Size frequency distribution

In terms of sizes, the males are significantly larger than the females (T-test at α=0.05) with a mean carapace length of 91.16 mm over the 84.55 mm registered by females. The small-sized samples (<80 mm) constitute about 23.08% of the total catch, medium with 75.42% (80-119 mm; dominant size group) and large size (>120 mm) having the least percentage composition of 1.50% (Table 3). Furthermore, size composition by sex, also revealed that for medium sized samples, the males are slightly abundant with 52.17% than the females with 47.83% while in the large size class, the males are relatively more abundant than the females (94.12% males: 5.88% females).

Table 3. Percentage size composition of *Ranina ranina* caught in the waters of Maluso, Basilan Province

Size Category	*Size Range (mm)*	*No. of Males*	*No. of Females*	*Total Number*	*Percentage to Total Catch (%)*
Small	< 80	93	168	261	23.08
Medium	80-119	445	408	853	75.42
Large	>120	16	1	17	1.50
Total				1,131	100

The high number of medium sized crabs and low number of large class in the present study indicate that the population showed sign of increased exploitation pressures, since larger crabs are the usual target of the gear used. This reason is similar to the experiences in New South Wales as pointed out by Kennelly and Craig (1989).[13] In contrast to other studies, the largest size range encountered (134 mm) in the present study was lower, compared to the result of Lasola and Samson (1993)[9] and Tahil (1983)[4], where the largest reported carapace length reaches 170 and 150 mm, respectively. This is an indication that smaller individuals are caught as increasing fishing pressures do not allow individuals to attain full maturity before capture.

For size frequency distribution, the different size ranges manifest variable abundance result. Females dominate in the 70-79 mm and 80-89 mm categories, while male dominate in the bigger size classes starting from 90-99 mm and above (Fig. 2). This is caused by the sexual dimorphism in size exhibited by the species wherein males grow faster than females as cited by Krajangdara and Watanabe (2005).[7]

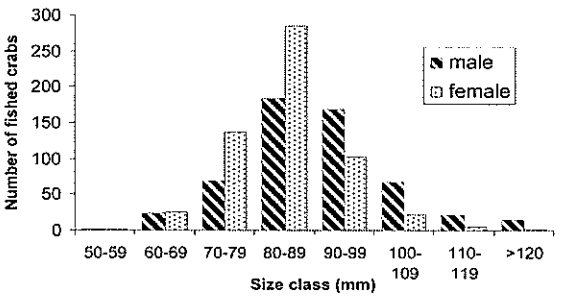

Fig. 2. Size frequency distribution of male and female *Ranina ranina* in Maluso, Basilan Province.

Sex ratio and Occurrences of ovigerous individuals

Collectively, the *R. ranina* population in the study area showed that for every 1 male individual, there are 1.04 females or approximately 1:1 sex ratio.

Since gravid females are important in the sustainabil-

ity of future generations, their incidence was monitored. Occurrence of ovigerous females were highest in January representing 88.65%, followed by February which registered 83.07% and lowest in December with 79.76% (Table 4). Brown *et al.* (1999)[8] and Tahil (1983)[4] reported that the crabs spawning season is once a year and the most prevalent period for reproduction occurred steadily from November to December. In the present study, the breeding season seemed to peak in January.

The observed high incidence of ovigerous over the non-ovigerous *Ranina ranina* in this study coincides with the breeding period reported by Tahil (1983)[4] for the Tawi-tawi population in the southernmost part of the Philippines, a few hundred kilometers southwest of the present study site. Furthermore, the months of October to February is considered to be the breeding and spawning season of this species (Tahil, 1983)[4] which also correspond to the peak high frequency of occurrence of ovigerous females reported by Brown *et al.* (1999)[8] and Krajangdara and Watanabe (2005)[7] in southern Queensland and Andaman Sea off Thailand, respectively. Thus, there is high possibility that similar reproductive activities occur between the present stocks and those found in other areas.

Table 4. Percentage of ovigerous and non-ovigerous females caught

Month	*Number of ovigerous individuals*	*% of ovigerous*	*Number of non-ovigerous individuals*	*% of non-ovigerous*	*Total (ovig. and non-ovig.)*
December	197	79.76	50	20.24	247
January	125	88.65	16	11.35	141
February	157	83.07	32	16.93	189
Total	**479**		**98**		**577**

Additionally, sizes of females manifesting signs of first egg production were analyzed. Results show that at 59 mm females can already produce eggs and participate actively in the breeding period. Gravid female individuals are more common and more prevalent in the medium (80-89 mm) size class (Fig. 3). Females of varying sizes that is from 50-59, 60-69 mm and those 100-109 and 110-119 mm also take part in the breeding activity but only in small numbers. Furthermore, very few female crabs initiate egg laying at size class of 60-69 mm in all lunar phases except during full moon where no representative samples for this particular size class were encountered. The smallest crab (59 mm) recorded which was already ovigerous was collected during the first quarter of January, however, due to the limited number of samples (1 individual only) for this particular size class, no further analysis were made.

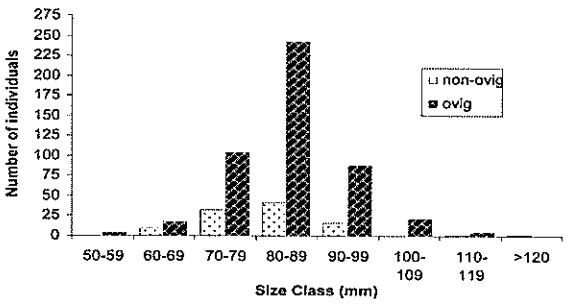

Fig. 3. Size frequency of ovigerous and non-ovigerous female *Ranina ranina* in Maluso, Basilan Province

Fecundity

Ovigerous female crabs with carapace length range of 60 to 110 mm carry an estimated 33,325 to 250,980 egg mass with a mean of 89,800 eggs on their pleopods. Regression analysis showed that the relationship between the size of the carapace (CL) and number of eggs is positively correlated with an r value of 0.7094 (Fig. 4). This means that as carapace length increases, the number of eggs also increases.

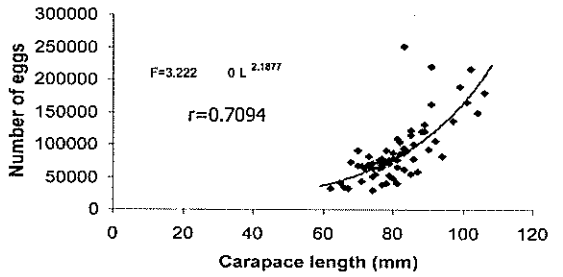

Fig. 4. Relationship between number of eggs and carapace length of *Ranina ranina* in Maluso, Basilan Province.

The observed number of eggs revealed that they are comparatively lower than the findings reported by Krajangdara and Watanabe (2005).[7] This observation is expected considering that the sampling period of the present study falls during the end of the breeding season for this species. Egg mortality as observed by Balsundaran and Pandian (1982)[14] can also occur during incubation period when the eggs are still attached on the female pleopods.

Gonad and Gonadosomatic Indices

Monthly mean GI's were observed to be highest in January with a value of 0.69 followed by a value of 0.54 in December and 0.47 in February. This also corresponds with the occurrence of high percentage of ripe and spawning individuals.

Percentage of gonad developmental stages for sexually mature crabs showed that most female ovaries are on stage IV while lesser on stage I (Table 5). The mean GSI value was also observed to range from 1.52 to 5.89 for females, while 0.90 to 2.03 for males (Table 6). GSI of females are higher than those of males indicating higher gonad weight relative to body weight in females. It is known that female *Ranina ranina* held in aquaria are capable of producing at least two batches of eggs per spawning season as reported by Brown *et al.* (1999)[8] and it is therefore possible that as late as early January a significant proportion of ovaries were still in advance state of development, where some ovigerous crabs had ripe stages perhaps as an antecedent for a second ovulation event. Similar results were also reported by Krajangdara and Watanabe (2005)[7], where most ovaries showed stage IV between November and February and GSI decreased slightly coinciding with the release of ova between January and February.

Table 5. Percentage of gonad developmental stages in sexually matured female *Ranina ranina*

Stages	*December*	*%*	*January*	*%*	*February*	*%*
I	1	1.78	0	0	3	11.54
II	0	0	0	0	0	0
III	13	23.21	6	24.0	5	19.23
IV	40	71.43	15	60.0	13	50.0
V	2	3.57	4	16.0	5	19.23
Total	56		25		26	

Table 6. Monthly mean gonadsomatic index (GSI) values of male and female *Ranina ranina* in Maluso Basilan Province.

Sexes	*December*	*January*	*February*
Male	2.0332	1.0658	0.9005
Female	5.8871	3.1137	1.5254

Size at sexual maturity

Scatterplots of pooled monthly GSIs versus carapace lengths of female *Ranina ranina* are depicted in Fig. 6. Beginning with carapace length of 60-70 mm, the crab gonad starts to develop signs of reproductive activity. The wide fluctuations in GSI among different size classes indicate active gonadal development for this population. GI weighted value for ripe stages (GI = 3) was noted to commence at around 66 mm CL. Table 7 shows that the maximum proportion of sexually mature individuals is 50%, hence, the correction factor used was 2.0 (100/max. proportion ripe). Curve fitting of adjusted ripe females in different length classes as shown in Fig. 7 yields an L_{mass} value of 86 mm which is also close to the values obtained using the GSI and GI weighted values of females. Considering that the reported minimum size at maturity ranges from 50-60 mm CL as reported by Minagawa *et al.* (1993)[6] for *Ranina* population in Japan and the size at first maturity is 72.2 mm reported by Krajangdara and Watanabe (2005)[7] in Thailand, a conservative estimate of L_{mass} would therefore be higher which is 86 mm for the population in this study.

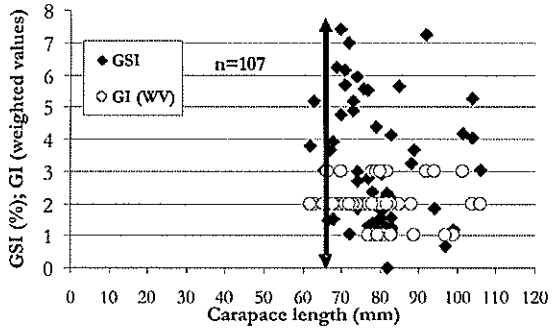

Fig. 5. Scatterplots of GSI and GI weighted values of female *Ranina ranina* showing sizes (arrow) at which active gonadal development occurs.

Table 7. Number of female crabs with ripe ovaries expressed as a proportion of the number of females in different length classes

Size ranges (mm)	*Number of female individuals*	*Number of ripe individuals*	*Proportion of ripe ind. (%)*	*Adjusted proportion of ripe ind. (%)*
60-69	11	2	18	36
70-79	36	7	19	38
80-89	38	9	24	48
90-99	14	3	21	42
100-109	4	2	50	100
110-119	1	0	0	0

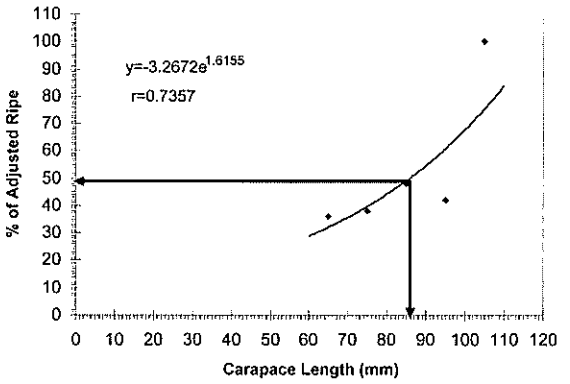

Fig. 6. Relationship between CL and the adjusted proportions of ripe female *Ranina ranina*

Conclusion and Recommendations

Conclusion

A total of 1,131 *Ranina ranina* individuals were caught in the waters of Maluso, Basilan Province from December 2006 to February 2007 with highest catches around the last quarter of the lunar cycle. The male catches are comparatively equal with that of females with sex ratio of approximately 1:1.

Present stocks in the area are presumed to be under pressure considering that catches comprised mostly of the medium (75.42%) and small (23.08%) sized classes. Females dominate in the 70-79 and 80-89 mm size classes, while males dominate in the bigger size class (90-99 mm and above).

Breeding was conspicuous and more prevalent in the medium sized females (80-89 mm size class), which are considered as active breeding sizes. Fecundity was estimated to range from 33,325 to 250,980 eggs (mean= 89,800 eggs), with indication that as carapace increases, number of eggs also increases. Result also indicates higher gonad weight relative to body weight in females. GSI are highest in December for both sexes and GI noted to be highest in January coinciding with high number of ripe and spawning individuals.

Female size at sexual maturity was 86 mm CL, which is recommended as the minimum allowable size for catching to allow spawning prior to capture.

Recommendations

The results of the study help augment the information needed for policy formulation and management options for the *Ranina* fishery in Maluso, Basilan Province. The other information gathered from this study may also be utilized as baseline information for a more comprehensive research in the future. Thus, the following are recommended:

1. Establishment and implementation of closed fishing season or reduction of fishing efforts during the months of December, January and February to protect the *Ranina ranina* spawning populations.
2. Prohibit the catching of berried females and imposition of minimum legal size of 86 mm CL to ensure that crabs have spawned prior to being caught.

3. Development and use of environment friendly fishing practices and gears designed to catch only legal sized crabs.
4. Year round population monitoring covering the other fishing grounds should be considered.
5. Comprehensive studies on hatcheries and aquaculture of *Ranina ranina* should be done for possible grow-out commercialization of this species.

Acknowledgement

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References

1) Skinner, D.G. and B.J. Hill (1987). Feeding and reproductive behavior and their effects on catchability of the Spanner Crab *Ranina ranina*. *Marine Biology*. **94**: 211-218.

2) Kennelly, S.J. (1992). Distributions, abundance and current status of exploited populations of Spanner Crabs *Ranina ranina* of the East Coast of Australia. *Marine Ecology Progress Series*. **85**: 227-235.

3) Leme, M.H. de A. (2005). Size at sexual maturity of female crab *Sesarma rectum* Randall (Crustacea, Brachyura) and ontogenic variation in the abdomen relative growth. Revision. *Brasil Zoology*. **22(2)**: 206-209.

4) Tahil, A.S. (1983). Reproductive period and exploitation of the Red Frog Crab, *Ranina ranina* (Linneaus, 1758) in Central Tawi-Tawi, Philippines. *The Philippine Scientist*. **20**: 57-72.

5) Lasola, N. and R. Samson (1993). Size composition and length-weight relationship of Red Frog Crab (*Ranina ranina*, Linneaus) in Basilan, Sulu, Tawi-Tawi and Zamboanga City. *Currents*. **1**:104-115.

6) Minagawa, M., J-R. Chiu, M. Kudo, F. Ito and F. Takashima (1993). Female reproductive biology and oocyte development of the Red Frog Crab, *Ranina ranina*, off Hachijojima, Izu Islands, Japan. *Marine Biology*. **115**: 613-623.

7) Krajangdara, T. and S. Watanabe (2005). Growth and reproduction of the Red Frog Crab, *Ranina ranina* (Linneaus, 1758), in the Andaman Sea off Thailand. *Fisheries Science*. **71**: 20-28.

8) Brown, I., J. Kirkwood, S. Gaddes, C. Dichmont and J. Ovenden (1999). Population dynamics and management of Spanner Crabs (*Ranina ranina*) in Southern Queensland. Project Report QO99010, Department of Primary Industries, Queensland Southern Fisheries Centre, QLD, Australia. 145 pp.

9) Batoy, C.B., T.F. Sarmago and B.C. Pilapil (1987). Breeding season, sexual maturity and fecundity of the Blue Swimming crab: *Portunus pelagicus* (L.) in selected coastal waters in Leyte and vicinity, Philippines. *Annals of Trop. Res*. **9(3)**: 157-177.

10) Germano, B. and J. Evangelio (2006). Reproduction and growth of the Blue Crab *Portunus pelagicus* in Eastern Visayas fishing grounds and management implications. In: Abstract, 38th Annual Convention of the Federation of Institutions for Marine and Freshwater Sciences (FIMFS). October 19-21, 2006. University of San Carlos, Cebu City, Philippines.

11) Ricker, W.E. (1968). Method for assessment of fish production in freshwaters. Williner Brothers Ltd. Birkenhead. 313 pp.

12) King, M. (2003). Fisheries biology, assessment and management. Fishing New Books, Blackwell Publishing. 341 pp.

13) Kennelly, S.J. and J. Craig (1989). Effects of trap design, independence of traps and bait on sampling populations of Spanner Crabs *Ranina ranina*. *Marine Ecology Progress Series*. **51**: 49-56

14) Balsundaran, C. and T. J. Pandian (1982). Egg loss during incubation in *Macrobrachium nobilii* (Henderson and Mathias). *Journal of Experimental Marine Biology and Ecology*. **59(2,3)**:289-299.