Research Article

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Some Aspect on the Biology of Pen Shell Atrina Pectinata (Linneaus, 1767) In Coastal Waters of Maqueda Bay, Philippines

Renato C. Diocton* and Eula Patrish C. Adalla

College of Fisheries and Marine Sciences, Mercedes Catbalogan City - Philippines

***Corresponding author**
Renato C. Diocton, College of Fisheries and Marine Sciences, Mercedes Catbalogan City - Philippines; Tel: 09771363572, E-mail: rdiocton2004@yahoo.com

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Abstract

A Total of 379 pen shells Atrinapectinata were collected from February 2017 to January 2018 in the coastal waters of Maqueda Bay. Measurement and analysis of length and weight were done using FiSAT software. Population parameters were assessed to evaluate the stock status which includes the asymptotic length (L_∞) and growth coefficient (K) to be 34.65 cm, 0.77 year−1 respectively. Specimens of A. pectinata reached a mean length of 20.98 cm. Length-weight relationship resulted to "negative allometric" $0.0462L^{2.6533}$ $R^2 = 0.7823$; signifying pen shells growth was faster in length than on weight. The recruitment pattern was continuous over the year with one major peak during rainy season (July). In addition, the highest catch based on collected sampling date catch was during summer, which suggest as the peak season of the species in the area. Furthermore, the average catch annually of hookah diver was 17.69208. Higher condition index was recorded from April to May, September and January, indicating the high quality of pen shell meat and is recommended as the best period to harvest pen shell whereas June to August and October to December can be concluded as the spawning period of the pen shell and the ideal period to institute close season. Further analysis revealed that the pen shell was nearly facing overexploitation with the exploitation rate (E = 0.46) mainly due to lack of a minimum limit size and also due to an increase in the harvesting effort. The estimated total mortality (Z), natural mortality (M) and fishing mortality (F); 1.36 year−1, 1.01year−1 and 0.62 year−1, respectively. Using the mentioned (Z), (M), (F) and (E), the total population resulted to 84725.7 suggesting that half of the population has been exploited due to overfishing

Keywords: Pen shell, Asymptotic length, Recruitment, Virtual Population Analysis

Introduction

Marine bivalve of the family *Pinnidae* or pen shell are locally known as "Sarad" in Catbalogan City. It is a popular food source with a high commercial value in a number of Asian Pacific areas due to its adductor muscle (tinga) local gleaners calls it. It is the primary source of livelihood among the local gleaners in the coastal waters of Maqueda Bay particularly in Brgy. Bunu-anan. The pen shell, *Atrinapectinata* (Linnaeus 1767), belongs to the Pinnidae family and is a large (shell length up to 30 cm) suspension-feeding bivalve common along the coasts of Korea, Japan, and China [1]. *A. pectinata* is an in faunal bivalve found in habitats ranging from muddy to sandy sediment and from tidal flats to shallow subtidal environments up to 20 m in depth [2].

The significant of this pen shell that lies in silent shallow waters is considerably wide however, is unknown and overlooked by many. From its shell wherein certain researcher studied the shell of *A. pectinata* contains the chitin and chitosan. Benefits of chitin and chitosan in various fields of modern industry are quite a lot, including in the pharmaceutical industry, biochemistry, biotechnology, biomedical, food, nutrition, paper, textile, agriculture, cosmetics, and healthcare membrane [3]. Moreover, *A. pectinata* though not used in pearl farming industry but has potential to make pearls "black pearl" because it has thick and beautiful nacre inside the shell [4]. Pen shell also has a tremendous potential as a way to help cleans the murky water because they are filter feeder and more over 60 species of marine life rely on the pen shell for its habitat [5]. It also acts as fertilizer [6].

Scarcity and limited studies were the very reason why chosen this research study. The aforementioned uses of pen shell will be of less importance if no measures will be taken to conserve this resources from possible future overexploitation. No policy was made by local officials to mitigate the continuous declining population of the pen shell over the past several decades hence this study was conducted [7]. Scientific study is an important aspect in formulating a policy regulation to prevent from getting depleted or overexploited. The mean problem of the pen shell fishery is the absence of regulation promulgated by local officials to manage the fishery in a sustainable manner.

Results of the study shed light on population parameters that described the biomass and exploitation rates. Information on its population dynamics is crucial for the conservation of A. pectinata. This would give policy makers and decision maker idea for the formulation of policy to avoid overexploitation of these resources. Population parameters provide some benchmark information that provides a concrete picture of the population of the pen shell. Most importantly it would document for its first time some notable parameters that yield data as basis for conservation of pen shell because it has export potentials in commercial form.

This study aimed to answer the following objectives: to determine the length and weight of the pen shell *Atrinapectinata*; to calculate the catch landing of hookah diver that collects pen shell in Brgy. Bunu-anan, Catbalogan City; to compute the condition index of pen shell and to estimate the population of pen shell using Virtual Population Analysis (VPA), fishing mortality (F), growth mortality (M) and exploitation rate (E).

Materials and Methods

The study was conducted in pre-selected barangay where the pen shell gatherers are located like in Brgy. Bunu-anan (see fig 1.) Gleaners were interviewed using simple ethno survey forms. Every sampling date catch landing was collected to determine its yield. Moreover, the length and weight of the pen shell was collected for the population parameters. Mathematical models were applied to estimates population parameters. A spread sheet and routines were the basic tools for computing the biological parameters.

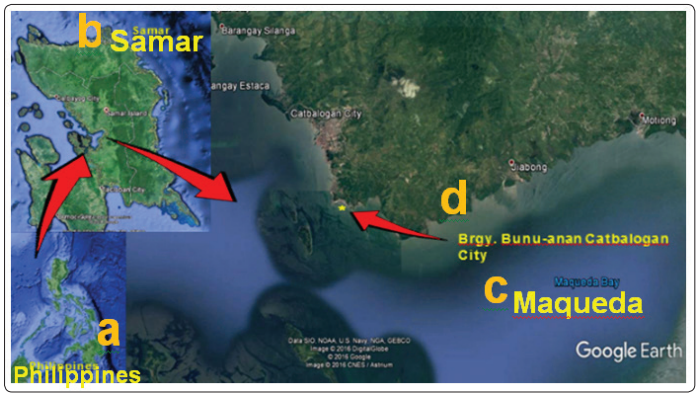

Figure 1: Study site

Sampling scheme

Data were collated in monthly basic from February 2017-January 2018 to get the seasonal trend, and peak of the harvest. On the other hand, every monthly sampling of at least 30 pcs of pen shells. Shell length and width thickness were determined using Vernier calliper at the nearest mm. and weight in grams using digital weighing scale (0.01g). In situ temperature sampling using Interface data logger (Science cube KDS E-A900-05-3048A connected to a laptop.

The dry weight of meat was subjected to condition index process to describe its growth performance and condition of the meat content by using oven set at 60ºC for 48 hours [8].

Figure 2: Standard Length and Weight Measurement of Pen Shell

Sampling for condition index (dry meat weight/dry shell weight) was also done and is expressed as: Condition Index:
dry meat weighting

$$CI = \frac{\text{Dry meat weighting}}{\text{Internal cavity volume in cm}^3} \times 100$$

Cavity volumes, previously measured chiefly as capacity by a water displacement method, may be determined by subtracting the weight in air of the intact mussels (both in g). This method is valid because the effective density of cavity contents is closed to 1g per cm^3 [9].

Statistical Tool

Basic routine like FiSAT by ICLARM was the software applied to calculate the length infinity and as well as the other parameters. Length of pen shell (in cm) and corresponding fresh weight (in gram) were recorded to establish the length-weight relationship for each particular species. The relationship is defined by the expression:

$$W = a\,L^b \text{ (Equation1)}$$

Where W is the weight of the pen shell (in gram), L is the fork length (in cm), a is the constant, and b is the coefficient. The exponential decay process was described by Bevert on and Holt (1957), in the following equation [10]:

$$N_t = N_0\, e^{-Zt} \text{ (Equation 2)}$$

Where N_t is the number of surviving pen shell in the population or cohort at time t, N_0 is the initial number of pen shell in the cohort or population at time t=0, Z is the instantaneous total mortality coefficient and t is the time interval (year) between N_0 and N_t. The functions describe the decrease of the number of individuals belonging to the same cohort overtime.

The components of the instantaneous total mortality are shown in the following expression;

$$Z = M + F \text{ (Equation 3)}$$

Where, M is the instantaneous natural mortality coefficient or death caused by predation, old age, pollution, etc.; and F is the instantaneous fishing mortality coefficient or death caused by fishing. The annual extraction rate (F) or rate of fishing is expresses as a ratio between the total annual yield and standing biomass:

$$F = Y/B \text{ (Equation 4)}$$

Where Y and B are the annual yield standing biomass, respectively. The index of relative importance (IRI), as describe by Pink as [11],

was used since it combines the different measures of abundance, namely, number, weight and frequency of occurrence. This was defined by the following expression:

$$IRI_i = F_i (N_i = W_i) \text{ (Equation 5)}$$

Where IRI, is the index relative importance of the species I, F_i is the relative frequency of occurrence of species I, N_i is the percentage of number of species i, and W_i is the percentage of weight of species i;

Population parameters

Using the collected length frequency data growth parameters (L_∞, k) of the von Bertalanffy equation: total (Z), natural (M) and fishing (F) Mortality coefficients; exploitation ratio (E); and recruitment patterns of dominant and economically important species were estimated using the ELEFAN (Electronic Length Frequency Analysis) routines of the FiSAT (FAO ICLARM stock assessment tools) software package [12]. The parameter of the von Bertallanffy [13] growth equation is derived from the following expression:

$$I_t = L_\infty[^{1-e-k}(t - t_O)] \quad \text{(Equation 6)}$$

Where I is the length of the pen shell would grow if allowed to live and grow indefinitely, e is the base of Naperian logarithm, k is the growth coefficient, and t_0 is the hypothetical age the pen shell would be attained at length zero, if it has always grow in a manner as described by the von Bertallanffy equation.

M is estimated from Pauly's empirical formula:
$\log M = 0.654 \log k - 0.28 \log L_\infty + 0.4631 \log T$ (Equation 7)

Where L_∞ and k are the von Bertallanffy growth parameters and T is the average temperature of the fishing ground. These mortality components are also expressed in the form of an index to determine the rate of exploitation, i.e.

$$E = F / Z \text{(Equation 8)}$$

Where E is the exploitation rate, and F and Z are fishing and total mortality coefficients.

Results and Discussion

This chapter presents the result and discussion of the study based on the data obtained. Results are presented in tabular forms or graphs followed by textual explanations and statistical interpretations.

Length Weight Relationship

Table 1 presents the data on the mean, minimum and maximum length and weight of a total 379 samples of pen shell *Atrinapectinata* collected for every month and measured using the appropriate tools such as Vernier calliper and digital weighing scale. Collection and determination of length-weight of the samples were done every month started from February 6, 2017 up to January 10, 2018.

Table1: Monthly length and weight of samples

Mon	Lmean (cm)	Wmean (g)	Lmin	Lmax	Wmin	Wmax
Feb	19.1±0.2	157±5.1	16	21	103	215
Mar	18.4±0.3	143±4.5	16	22	115	207
Apr	26.4±0.3	266±6.1	24	30	208	339
May	29.8±0.4	363±14.8	21	33	153	518
Jun	18.8±0.3	104±6.3	17	22	61	169
Jul	15.4±0.1	47±1.61	14	17	33	69
Aug	18.9±0.5	130±4.93	16	22	82	189
Sep	22.7±1.0	219±31.8	13	31	59	515
Oct	20.3±0.3	108±4.03	18	25	62	151
Nov	18.3±0.2	118±2.92	17	20	80	151
Dec	21.5±0.2	148±4.7	20	24	87	220
Jan	20.3±0.3	166±5.2	17	23	112	226

Higher values of Lmean,Wmean, Lmin, Lmax, Wmin, and Wmax were recorded in the months of May, April, and September respectively. On the contrary, a lower value was observed during July.

Length-weight relationships are very useful for fisheries research based on the following: (a) allow the conversion of growth-in-length equation to growth-in-weight for use in stock assessment model; (b) allow the estimation of biomass from length observations; (c) allow an estimate of the condition of the fish; (d) useful for between-region comparison of life histories of certain species [14-16]. The data for establishing the length and weight relationship of the specimens is shown in the table below.The relationship is defined by the expression: $W = a L^b$

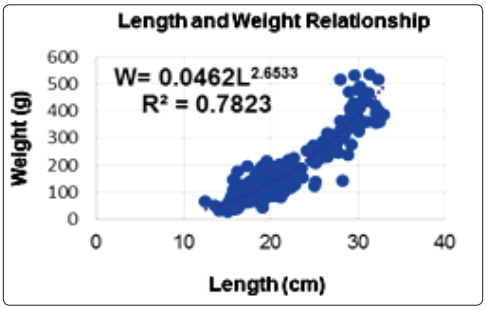

Figure 3: Length and Weight Relationship of pen shell *Atrinapectinate*

Length-weight relationship of pen shell showed "negative allometric growth; = $0.0462L^{2.6533}$ $R^2 = 0.7823$ N = 379; signifying pen shells growth was faster in length than on weight.

Length Frequency Distribution

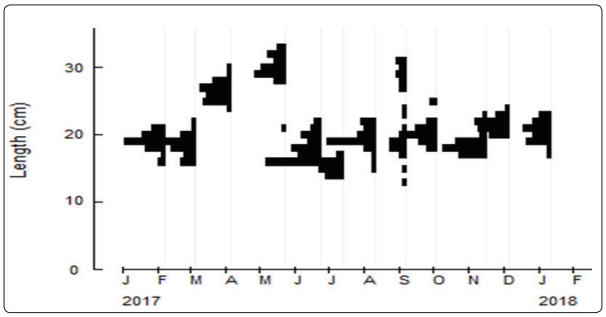

Figure 4: Length Frequency Distribution

Figure 4 shows that lenth13-16cm which is the lowest length-corresponds the highest frequency of 35 individuals in the month of July; whereas 32-34 cm which is the maximum length got the highest frequency of 7 individuals falls to the month of May.

Length Frequency Analysis

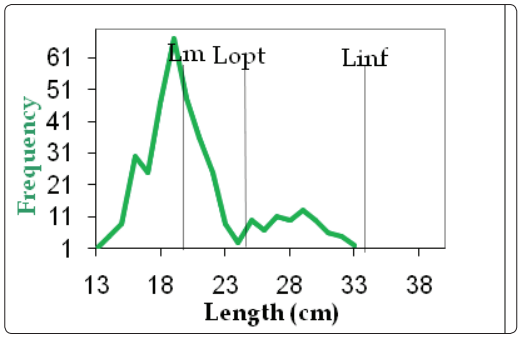

Figure 5: LF-Maturity Plot for 1 year

Figure 5 show that 19 cm length got the highest frequency of 51 while the lowest were 13, 23, and 33 cm of 1 frequency. Length at first maturity (L_m) is 20 cm for 1-year record (February 2017 - January, 2018). On the other hand, length optimum (L_{opt}) is 24cm based on the formula used by Froese 2004.The length infinity or asymptotic length (L_{inf}/L_{00}) resulted to 34. 65cm (see also table2).

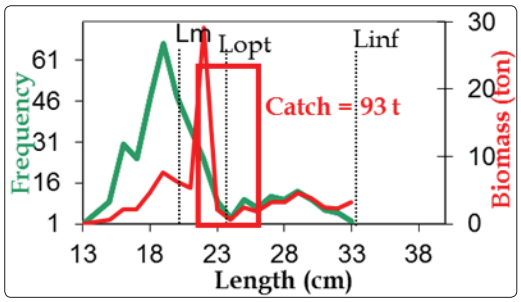

Figure 6: LF-Biomass Plot for 1 year

Figure 6 for the length frequency biomass for 1 year (February 2017-January, 2018) reveals that length 22cm got the highest biomass of 29 tons while 13cm got the lowest biomass of 0 tons. This length data is important because it allows life history and morphological comparison between species and between populations of the same species from different habitats and localities, and can be used the biomass of the stock [17].

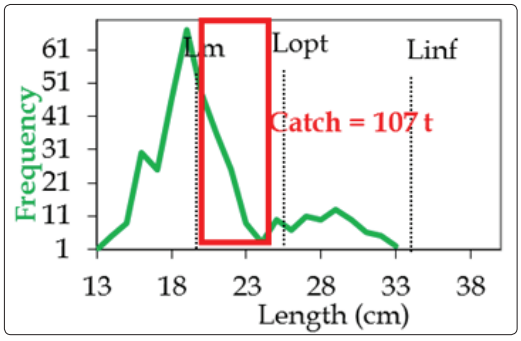

Figure 7: LF-Potential Biomass Plot for 1 year

Figure 7 plot display that the length frequency potential biomass for 1 year (February 2017 - January, 2018) of *Atrinapectinata* is 93 tons.

Condition Index Distribution

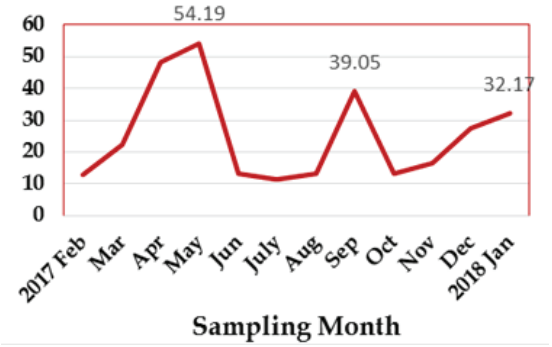

Figure 8: Agraphs showing the monthly average condition index of pen shell *Atrinapectinata*

Higher condition index was recorded from April to May, September and January, indicating the high quality of pen shell meat. The values can be correlated with gametogenesis and the development of gonads, when energy is stored in the form of proteins and lipids [18]. This can be clearly seen from the increasing values of condition index before spawning. The higher condition index was observed when pen shell was fully mature. There was a rapid decline in the condition index values during spawning, thus indicating the relationship between environmental parameters, chemical composition and physiological states during gonad development and reproductive phases. Periods; summer (April and May), September and January can therefore be considered as the best period for harvesting these pen shell due to the high quality of meat.

It is apparent that pen shell *Atrinapectinata* Spawning was all throughout the year from June to August and October to December.

Average Catch

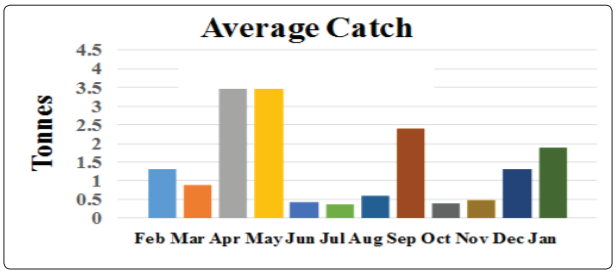

Figure 9: Average catch of hookah diver that collects pen shell

Figure 9 was based on every sampling date catch collected among the local gleaners. Summer, in particular April and May got the highest average catch throughout the year with 3.5 and 4.2 tons respectively; signifying as the peak season of the pen shell in the area. Moreover, the average catch/annually was 17.7 tons.

Table 2: Population parameters of *A. pectinata*

Population Parameters	A. pectinata
Asymptotic length (L_∞) in cm	34.65
Growth coefficient (K) year-1	0.77
Natural Mortality (M) year -1	1.01
Fishing Mortality (F) year-1	0.62

Total mortality (Z) year-1	1.36
Exploitation ratio (E)	0.46
Length range (cm)	13-33
Weight range (g)	33-518

The ELEFAN-I program estimated asymptotic length (L∞) and growth coefficient (K) of the von Bertalanffy Growth Formula (VBGF) for *A. pectinata* were 34.65 cm and 0.77 year^{-1}, respectively.

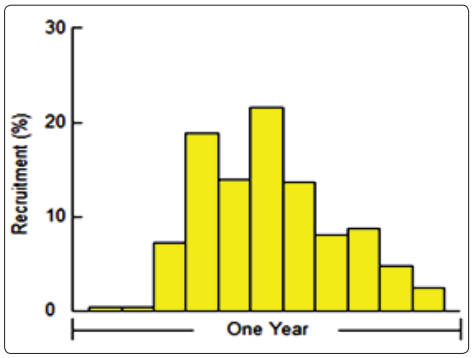

Figure 10: Recruitment pattern of *A. pectinata* onto a one year time scale

The recruitment pattern of *A. pectinata* was continuous throughout the year, with one major peak in July 21.60%.

Length Structured Virtual Population Analysis

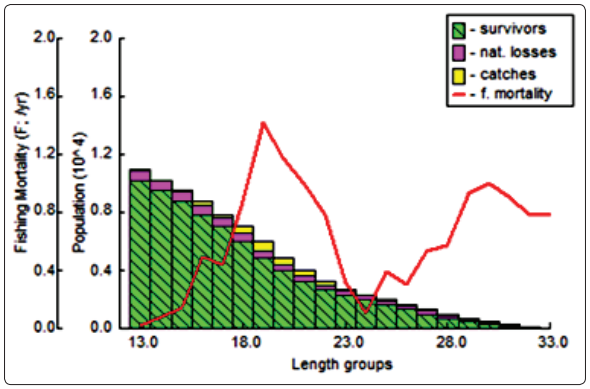

Figure 11: Parameters and VPA Plot

The figure showed the decreasing trend in the number of survivors as the length increases. The highest survivors was at length 13 cm with 1 x10^4 population while the lowest was 33 cm with 0.0x10^4 population. Whereas the highest fishing mortality was 19cm with 1.434, while the lowest was 13 cm with 0.0.Furthermore, the length with the highest catch is 19 cm with 670, substantially the total catches in numbers, and total population of pen shell were; 3772 and 84725.7 respectively.

Conclusion

Findings of this study revealed that summer (May) was the month where the pen shell exhibits its highest mean length (L_{mean}) and mean weight (W_{mean}) of 30cm and ±363g respectively. Lm or length at first maturity resulted to 20 cm whereas Lopt is 24 cm: the minimum harvestable size should be larger than the size at first maturity to guarantee that the individuals can reproduce at least once, thus ensuring a parental stock that is large enough to maintain the population hence the latter is recommended as the minimum limit size for harvesting the pen shell. In addition, length-weight relationship resulted to "negative allometric" $0.0462L^{2.6533}$ R2 = 0.7823; signifying pen shells growth was faster in length than on weight.

Results also showed that the summer: April and May bears the highest catch thus, noted as the peak season of the pen shell.

For a one-year time scale, the recruitment pattern was continuous throughout the year with one major peak in July and lowest percent recruitment recorded in February and March.

Three major peaks of condition index suggest as the best period for harvesting the pen shell due to the high quality of meat. On the other hand, June to August and October to December were the inclusive months of spawning period of the pen shell and can be recommended to policy maker to institute closed season to regulate the pens hell fishery in a sustainable manner. Further analysis, using the computed Asymptotic length (L∞), Fishing mortality (F) year-1, Natural Mortality (M) year-1, Total mortality (Z) year-1 and Exploitation rate (E) year-1of *A. pectinata*: 34.65,0.62, 1.01, 1.36, and 0.46 respectively, the population of the pen shell resulted to 84,725.7 which indicate that almost half of the population has been exploited due to lack of minimum limit size in harvesting the species

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