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Population dynamics of the mangrove clam *Polymesoda erosa* (Bivalvia: Corbiculidae) in Iwahig, Palawan, Philippines

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Abstract
The mangrove clam *Polymesoda erosa* (Solander, 1786) is a principal mollusc resource collected by artisanal fishermen in the mangrove forest of Iwahig River, Palawan, Philippines. Between April 2013 and May 2014, measurements of shell lengths of *P. erosa* were undertaken to determine its population dynamics. The estimated L∞ and K of the von Bertalanffy Growth Formula (VBGF) were 107.1 mm and 1.0 yr^{-1} respectively. Total mortality (Z) was 3.74 yr^{-1}, natural mortality (M) was 1.41 yr^{-1} and fishing mortality (F) was 2.33 yr^{-1}. The exploitation rate (E = 0.62) which surpassed the maximum exploitation rate (E_{max} = 0.50) suggests the need to regulate harvesting. Exploring the aquaculture potentials of this species is suggested.

Keywords: *Polymesoda erosa,* Bivalvia, Corbiculidae, Philippines

1. Introduction

The aquatic resources in an extensive mangrove forest of Iwahig River in Palawan, Philippines, support the lives of many artisanal fishermen residing in Bucana Village. The most commonly collected species in the area are the mangrove clam *Polymesoda erosa,* also called “kibao” among the locals. People in the village collect the clams either for sustenance or source of additional income. Some collected *P. erosa* are displayed for sale in two stalls along the national highway near the village. Other collectors sell their catch in the public markets of the City of Puerto Princesa. Aside from its economic importance, *P. erosa* plays an important role in nutrient recycling and in the food web [1]. The species is also a subject for research because of its high antibacterial activity [2]. *Polymesoda erosa* inhabits the upper reaches of the mangrove forest that experience long period of dryness compared with the other areas in the mangrove ecosystems [1, 3]. These habitats when in proximate distance to human settlement are highly vulnerable to overexploitation and degradation.

Because of its economic importance, studies such as length-weight relationships [4], recruitment [3] and bioassay [5] were conducted. Aspects of biology of other species of the genus *Polymesoda* have also been studied. Argente and Ilano [6] explored the population dynamics of *Polymesoda expansa* in Bohol, Philippines, while the same study was conducted by Rueda and Urban [7] for *Polymesoda solida* in Colombia. In view of the ecological and commercial values of *P. erosa* including its potential for aquaculture, its population dynamics were investigated to generate relevant information essential in proposing management interventions.

2. Materials and Methods

2.1 The study site and sampling methods

The study was conducted at Iwahig River, Palawan, Philippines. Sampling was conducted between April 2013 and May 2014. Once a month (except during the months of July, August, November and December), the shell lengths of *P. erosa* displayed for sale in two vending stalls (9º44’25.48”N; 118º41’03.11E”) in Bucana Village were measured with callipers to the nearest millimetre.

2.2 Data analysis

The length data of 2,024 individuals were grouped into length classes by 5 mm. The data were then analyzed using the FiSAT software [8]. The asymptotic length (L∞) and growth coefficient

(K) of the von Bertalanffy Growth Formula (VBGF) were estimated by means of Powell – Wetherall Plot and ELEFAN 1 routine in the FiSAT Software. The estimates of L∞ and K were used to predict the sizes of *P. erosa* at various ages using the von Bertalanffy Growth Formula ($L_t = L_\infty [1 - e^{-k(t-to)}]$) and growth performance indices ($ø' = 2 \log_{10}L_\infty + \log_{10}K$). Total mortality (Z) was estimated using the length converted catch curve (LCCC) analysis. Longevity (t_{max}) of the clam was obtained using the formula $t_{max}=3/K$. The natural mortality (M) was obtained with the use of formula of Alverson and Carney [9]: $M = 3K/e^{tmax \cdot 0.38 \cdot K}-1$). Where: tmax or longevity =3/K (see Çolakoğlu 2014). Fishing (F) mortality was obtained by subtracting the natural mortality (M) from total mortality (Z). The exploitation rate (E) was obtained as the quotient of fishing mortality (F) and total mortality (Z). Exploitation level which result in a reduction of the unexploited biomass by 50% ($E_{0.5}$) and the level which maximizes yield per recruit (E_{max}) were obtained using Beverton and Holt Relative Yield per Recruit Analysis. The recruitment pattern was estimated from a time series of length-frequency data with the use of FiSAT software.

3. Results

3.1 Growth parameters

The observed extreme length was 102.0 mm and the predicted extreme length was 102.1 mm (Figure 1). At 95% confidence interval, the extreme length ranged between 94.85 and 109.3 mm. The estimated L∞ and K were 107.1 mm and 1.0 yr^{-1}. The growth performance index (ø') was 4.06. The growth curve superimposed on the restructured length-frequency data is presented in Figure 2. Another graph showing the predicted size at age and growth rate at each year obtained by substituting the L∞ and K values to the VBGF is reflected in Figure 3. Both graphs suggest a fast growth for *P. erosa*, reaching nearly 70 mm shell length in the first year. The growth gradually slowed down with age. Growth becomes very slow on the 3rd year where 95% of the L∞ is attained. In the 4th year, 98% of L∞ is attained. The estimated maximum life span (t_{max}) is 3 years.

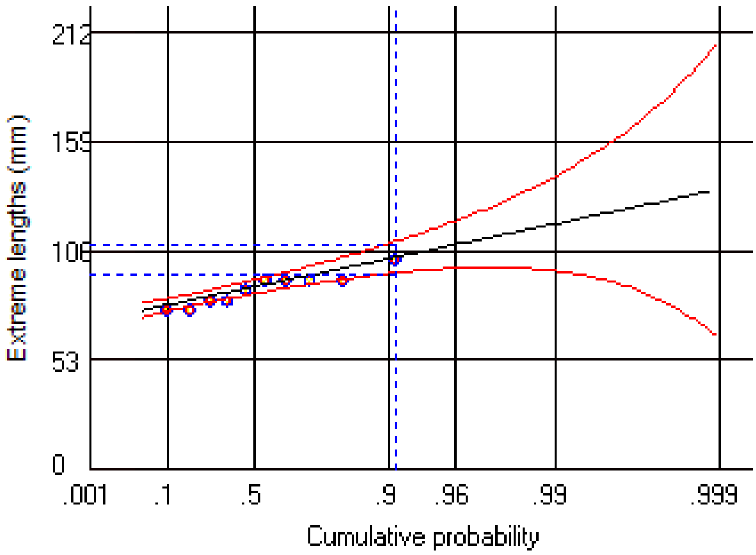

Fig 1: Predicted extreme length of *P. erosa* from Iwahig River, Palawan, Philippines.

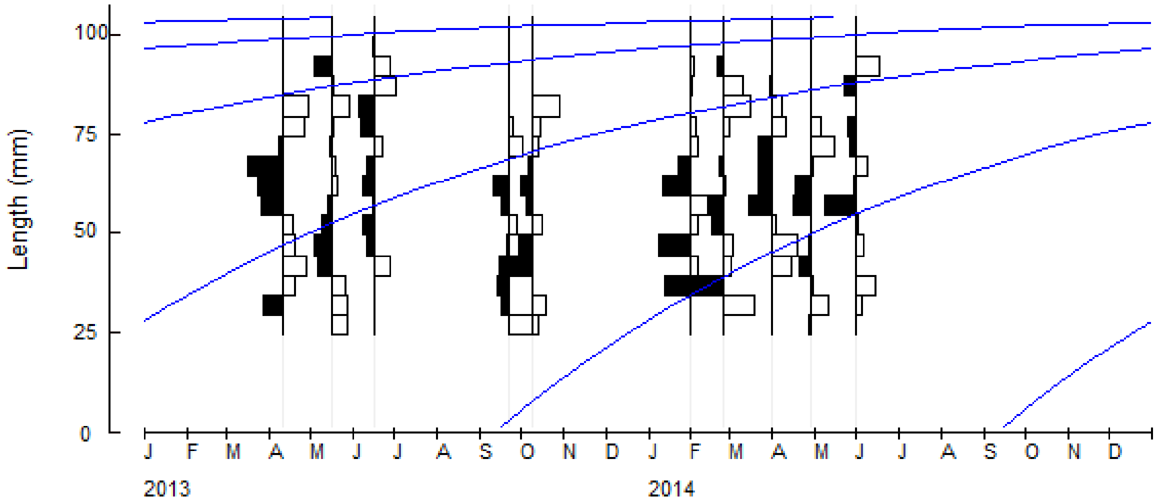

Fig 2: Restructured length-frequency distribution and the estimated growth curves for *P. erosa*, using ELEFAN I (L∞=107.1mm, K=1.0 yr^{-1}).

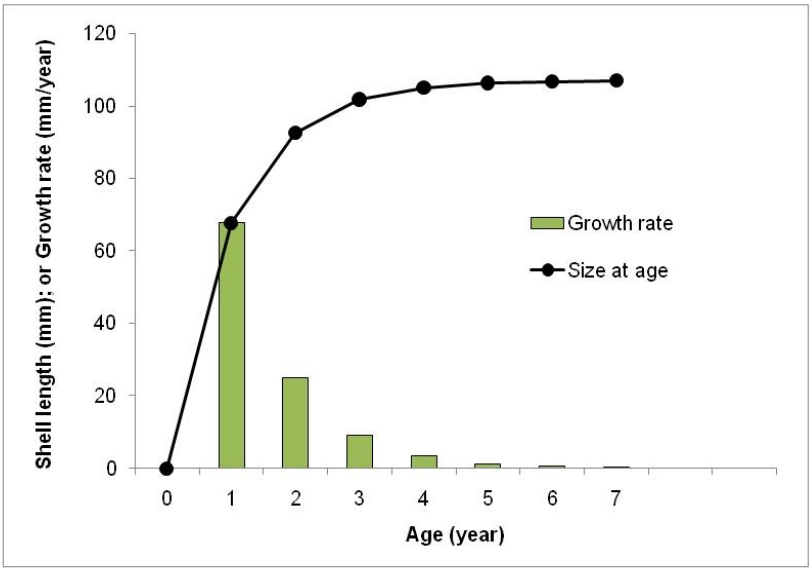

Fig 3: Another representation of the predicted size at age and growth rate per year of *P. erosa* after substituting $L\infty$=107.1 mm and K =1.0 yr^{-1} into the VBGF.

3.2 Mortalities

The length-converted catch curve (LCCC) analysis revealed a 3.74 total mortality (Z) for *P. erosa* (Figure 4). Natural (M) and fishing (F) mortalities were 1.41 and 2.33 yr^{-1} respectively. The exploitation rate (E= 0.62) exceeded the maximum allowable limit of exploitation (E_{max} = 0.50).

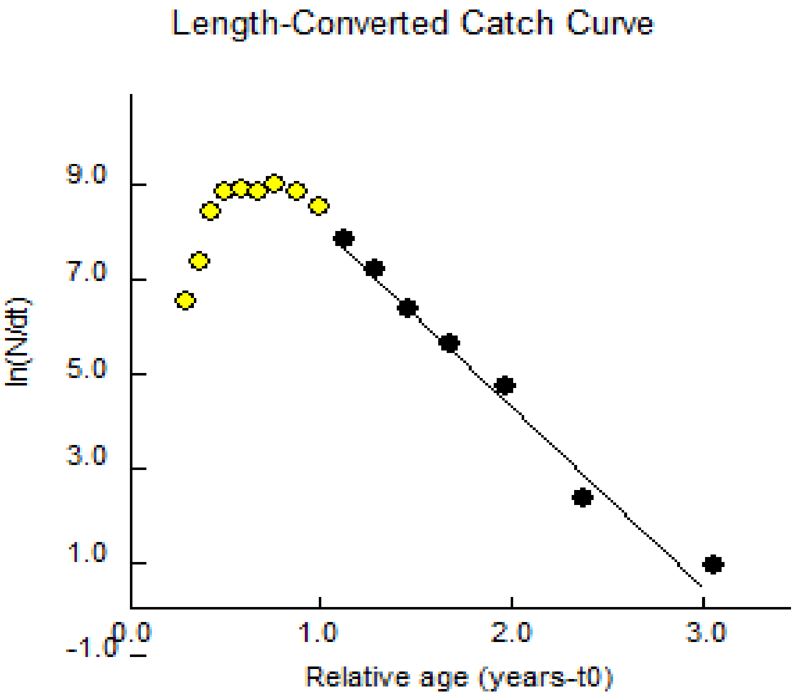

Fig 4: Length converted catch curve of *P. erosa* in Iwahig, Palawan, Philippines.

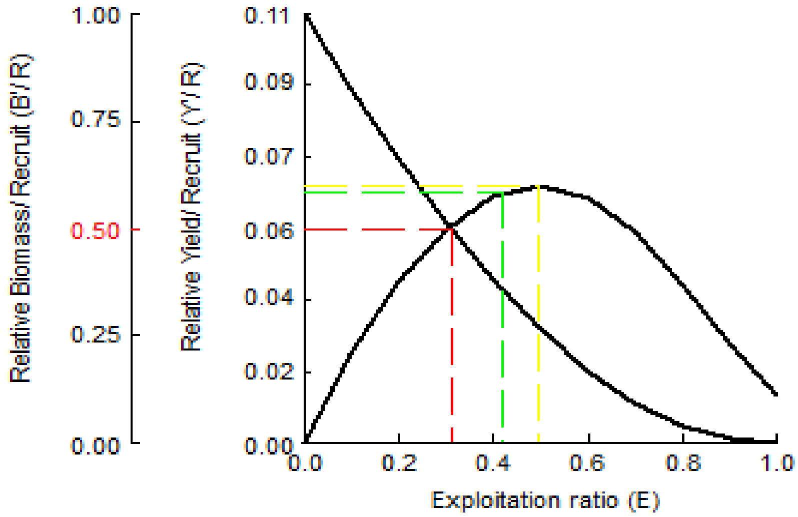

Fig 5: Relative yield per recruit of *P. erosa* from Iwahig River, Palawan, Philippines (yellow line - E_{max}; green line – E_{10}; red line – E_{50}).

3.3 Recruitment pattern

The recruitment pattern for *P. erosa* occurred year round with more or less similar percentage of recruit between March and October. The highest percentage of recruit could happen in April (14.41 %) and September (12.18%).

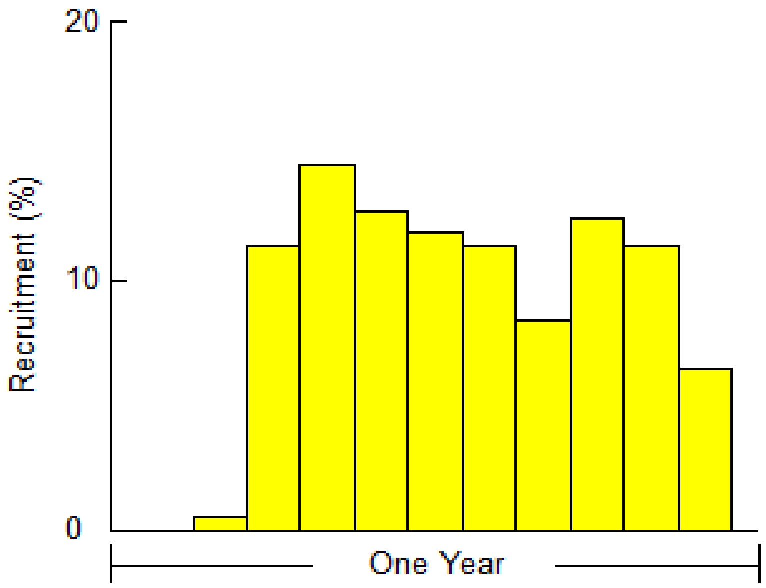

Fig 6: Recruitment pattern of *P. erosa* in Iwahig, Palawan, Philippines.

4. Discussion

The observed extreme length (102.0 mm) for *P. erosa* in this study is similar to the reported maximum length of the same species in Goa, India [3] but a little smaller than the largest recorded size (105 mm) in its distribution range [10]. Clemente [1] however reported a much higher maximum shell length (120 mm) for *P. erosa*. The variation in size could be geographical and exploitation related. When collection is unregulated, large sized individuals could be the first to exterminate which in turn may influence the largest size of clam available in the area.

The growth of *P. erosa* in Iwahig River is quite fast compared with *P. expansa* [6]. *Polymesoda erosa* becomes sexually mature upon reaching 40 - 46 mm shell lengths [1, 11] which is attainable within six months. The graph on projected size at age (Figure 3) suggests 98% of the $L\infty$ can be attained in about four years, despite the estimated longevity of the clam based on the formula t_{max}=3/K, is only three years. Other studies suggested a 4-year life span for the clam [1, 3] which coincide with the results in this study (see Figure 3).

Population parameters for *P. erosa* can vary between regions and even between patches of mangroves as maybe influenced by environmental conditions and harvesting. Nash [12] reported how various parameters can affect the growth of the reef gastropod *Trochus niloticus*. The growth parameters for other bivalve species are presented in Table 1.

Table 1: Growth and other related parameters of *P. erosa* and of other bivalve species as reported in other studies.

Location	Species	L ∞ (mm)	K yr^{-1}	F yr^{-1}	E	Source
Palawan, Philippines	*Polymesoda erosa*	107.10	1.0	2.33	0.62	This study
Bohol, Philippines	*Polymesoda expansa*	91.53	0.51	0.19	0.20	[6]
Colombia	*Polymesoda solida*	47.30	0.20	0.54	0.72	[7]
Bangladesh	*Meretrix meretrix*	81.40	0.97	0.02	0.01	[13]
India	*Meretrix casta*	24.24	1.81	2.12	0.54	[14]
India	*Meretrix casta*	26.50	2.00	0.98	0.33	[14]

The higher fishing mortality (F=2.33) for *P. erosa* in Iwahig River compared with its natural mortality (M=1.41) rate is suggesting that fishing is the major cause of death among clams. This data is supported by an exploitation rate (E=0.62) which is higher than the maximum exploitation rate (E_{max}=0.50). If this trend continues, there is a high probability for *P. erosa* population to collapse. In fact, people residing in Bucana have noted the scarcity of clams close to the village and they now tend to explore areas far from the area just to get a good catch.

To promote the sustainable utilization of *P. erosa*, there is a need to regulate its exploitation. About 20% of the measured samples fall below 44 mm (assumed juveniles). It is expected that such percentage of juveniles in the catch may increase with time as large individuals are becoming scarce. Exploitation of juveniles is detrimental to population growth as it does not allow the stock to propagate at least once in its lifetime. *Polymesoda erosa* are fast growing and with available methods in collecting settling juveniles [3] aquasilviculture trials may be tested.

5. Acknowledgments

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