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Fecundity and gonadosomatic index of *Macrobrachium australe* (Guérin-Méneville, 1838) in Dohinob Dacu River

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ABSTRACT

This study investigated the fecundity and gonadosomatic index (GSI) of *Macrobrachium australe* in relation to the physical characteristics of Dohinob Dacu River, Zamboanga del Norte, Philippines. Sampling was conducted in January 2024 across three sites. Water temperature, pH, depth, and phosphate concentration were measured alongside morphometric and reproductive traits of ovigerous females. Results showed that river conditions were generally suitable for prawn reproduction, with temperatures ranging from 25.1 to 27.6 °C, near-neutral pH (6.79–7.08), depth (35–49 cm), and phosphate levels below 0.4 mg/L. Total body length ranged from 77–95 mm and weight from 4.8–10.9 g. GSI values (0.39–0.74) reflected asynchronous gonad development. Fecundity varied widely (22–413 eggs) and correlated strongly with gonad weight (r^2 = 0.938), moderately with body weight (r^2 = 0.538), and weakly with body length (r^2 = 0.412). Findings highlight that reproductive capacity in *M. australe* is more dependent on gonadal development than somatic size, providing baseline information for biodiversity monitoring and management of freshwater prawn populations.

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INTRODUCTION

Freshwater prawns of the genus *Macrobrachium* play important ecological and economic roles in tropical river systems, providing subsistence and livelihood for local communities while contributing to aquatic biodiversity (Bono *et al.*, 2022). Among these, *Macrobrachium australe* is widely distributed in Southeast Asia and the Pacific but remains poorly studied compared to commercially important species such as *M. rosenbergii* and *M. lar* (Bradecina *et al.*, 2018; Castellini *et al.*, 2017). Existing research has mostly focused on growth and reproduction of aquaculture species, leaving gaps in the ecological and reproductive biology of wild populations of *M. australe*.

Reproductive traits such as fecundity and gonadosomatic index (GSI) are fundamental for understanding population dynamics, reproductive potential, and management strategies of freshwater prawns (Kant *et al.*, 2016; Hoarau *et al.*, 2019). Fecundity provides an estimate of reproductive output, while GSI reflects the relative investment in gonad development. Both are influenced by environmental factors, body size, and energy allocation strategies, making them essential indicators for stock assessment and conservation biology (Castellini *et al.*, 2017). Despite their importance, studies on fecundity and GSI of *M. australe* remain scarce, particularly in Philippine freshwater systems where the species occurs naturally.

Moreover, rivers in Mindanao, such as the Dohinob Dacu River, face increasing pressures from agriculture, fishing, and land use changes that may affect water quality and, consequently, reproductive biology of aquatic fauna. Previous studies emphasized that temperature, pH, depth, and nutrient availability can directly influence reproductive success in freshwater shrimps (Hoarau *et al.*, 2019; Bono *et al.*, 2022). Yet, no published study has systematically examined the physical profile of this river in relation to the biology of *M. australe*.

This study addresses these gaps by examining the physical characteristics of the Dohinob Dacu River alongside the morphology, fecundity, and gonadosomatic index of *M. australe*. Specifically, it evaluates (1) water temperature, pH, depth, and nutrient levels; (2) morphometric traits of ovigerous females; (3) fecundity and GSI; and (4) the relationships between fecundity and body parameters. Findings from this research will provide baseline information essential for local biodiversity monitoring and sustainable management of freshwater prawn resources.

MATERIALS AND METHODS

Research design and site

A quantitative–descriptive design was employed to describe environmental conditions and biological traits of *Macrobrachium australe*. Sampling was conducted in January 2024 at Dohinob Dacu River, Barangay Galokso, President Manuel A. Roxas, Zamboanga del Norte, approximately 12 km from Jose Rizal Memorial State University, Katipunan Campus (Fig. 1)

Fig. 1. Map of Barangay Galokso

Physical profile of the river

Water quality was assessed through three sampling events. Temperature was measured in situ using a digital thermometer (±0.1 °C), pH with a calibrated portable meter following APHA (2017) protocols, and depth with a calibrated line and weight. For nutrients, 500 ml water samples were collected in sterile bottles, preserved in ice, and analyzed for phosphate concentration at DOST IX using spectrophotometry. These methods are consistent with previous ecological assessments in tropical rivers (Hoarau *et al.*, 2019).

Morphological characteristics of *M. australe*

Ovigerous females were captured using baited traps and hand nets with smoked coconut meat as attractant, a technique also applied in Philippine shrimp studies (Bono *et al.*, 2022). Specimens were transported on ice to the laboratory. Total body length (rostrum tip to telson end) was measured with a digital caliper (mm), and total body weight was obtained using an analytical balance (±0.01 g).

Fecundity

Fecundity was estimated gravimetrically following Efendie (1979) and applied in recent freshwater prawn studies (Bradecina *et al.*, 2018). Eggs were carefully removed from pleopods, subsampled for count (Fs) and weight (w), and compared with the total egg mass weight (W). Fecundity (F) was calculated as:

$$F = Fs \cdot W/w$$

Gonadosomatic index

Gonads were dissected and weighed (GoW). The gonadosomatic index (GSI) was computed following Maddock and Burton (1998), a method still widely used in crustacean reproductive biology (Castellini *et al.*, 2017):

$$GSI = (GoW/GW)\ 100$$

where GW is gutted body weight.

Relationship between fecundity and morphometric traits

The relationships of fecundity with total length, body weight, and gonad weight were examined using regression and correlation analyses, consistent with approaches in freshwater shrimp studies (Kant *et al.*, 2016). Models followed:

$$Y = a+bX \quad \text{and} \quad Y = aXbY$$

where Y= fecundity, X= morphometric parameter, and a, b= constants.

Statistical analysis

Descriptive statistics (mean, SD) summarized environmental and morphometric data. Regression and correlation analyses were applied using the least squares method, with significance set at $p < 0.05$.

RESULTS AND DISCUSSION

Physical profile of the river

Temperature ranged 25.1–27.6 °C, consistent with favorable ranges for *Macrobrachium* reproduction (López-Uriarte *et al.*, 2020). pH values (6.79–7.08) were near neutral, within optimal levels for shrimp growth and reproduction (Dimero *et al.*, 2022). Depth ranged 35.6–48.8 cm, reflecting seasonal variation and potentially influencing prawn abundance (Dimero *et al.*, 2022). Phosphate levels (0.308–0.313 mg/L) were below the 0.4 mg/L threshold, suggesting balanced nutrient conditions (Mascareñas *et al.*, 2019) (Fig. 2-4) (Table 1).

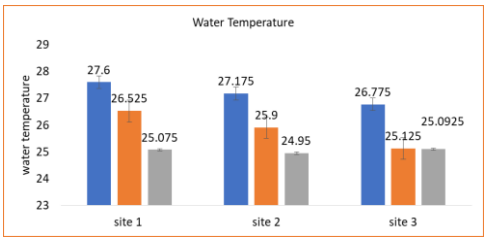

Fig. 2. Water temperature

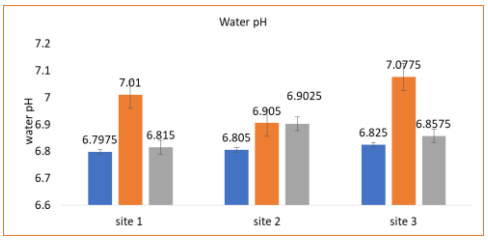

Fig. 3. Water pH

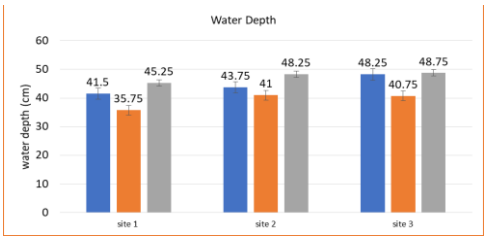

Fig. 4. Water depth

Morphological characteristics of *M. australe*

The length–weight relationship (LWR) describes how the body weight of an organism increases as its length increases (Fig. 5). In this study, the relationship for

Macrobrachium australe from Dohinob Dacu River was expressed as: W= 0.00018 L2.368 (R2= 0.412) where W is weight in grams and L is total length in millimeters. The slope of the equation, called "b", was 2.368. When b is equal to 3, the growth is called isometric, meaning the prawn gets heavier at the same rate it gets longer. In this case, b was less than 3, which indicates negative allometric growth. This means that as the prawns grew longer, their weight did not increase as quickly as their length. In simple terms, the prawns were becoming slender rather than stocky as they grew (Le Cren, 1951; Froese, 2006). It may reflect environmental limitations such as food availability, water quality, or energy being diverted to reproduction instead of body mass (Binohlan and Pauly, 2000; Froese, 2006). The moderate R^2 value (0.412) means that body length explains only about 41% of the variation in body weight. Ovigerous females often vary in gonad and egg mass, which affects weight even if their lengths are similar (Hossain *et al.*, 2021).

Table 1. Water nutrients

Water sample no.	Result (mg/L)	Test method
1	0.313 Within MDL & MQL MDL² = 0.1 mg/L MQL³ = 0.5 mg/L	Vanadomolybdo-phosphoric Acid Colorimetric Method, SMEWW 4500-P C., 23rd Ed., 2017
2	0.308 Within MDL & MQL MDL² = 0.1 mg/L MQL³ = 0.5 mg/L	
3	0.311 Within MDL & MQL MDL² = 0.1 mg/L MQL³ = 0.5 mg/L	

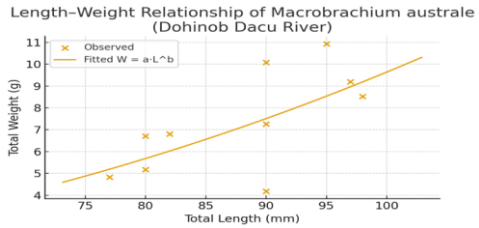

Fig. 5. Length-weight relationship of *Macrobrachium australe*

Fecundity and gonadosomatic index of *Macrobrachium australe*

Fecundity is the number of eggs a female prawn carries, and it is a key measure of reproductive capacity. In this study, *M. australe* showed a wide range of fecundity values (Table 2).

Table 2. Fecundity and gonadosomatic index of *Macrobrachium austral*

Specimen no.	Fecundity	GSI
1	38.4	.469
2	80.26	.393
3	21.67	.414
4	149.60	.506
5	412.5	.743
6	35.6	.469
7	24.8	.395
8	152.30	.489
9	75.60	.375
10	25.20	.350

Such variation is normal in crustaceans and can be influenced by factors like body size, age, nutrition, and reproductive stage (Hossain *et al.*, 2021). Larger or healthier females often produce more eggs because they have more energy and body resources to invest in reproduction (Sharma and Subba, 2005). The findings here support what other studies on freshwater prawns have also observed that fecundity is not fixed but depends strongly on the condition and size of the individual female (Bradecina *et al.*, 2018). High-fecundity individuals contribute more to population growth, but the presence of lower-fecundity individuals shows that reproduction is uneven, which can be important for population management and conservation.

On the other hand, the Gonado-somatic Index (GSI) measures the proportion of gonad weight relative to the body weight of an organism. In simple terms, it shows how much energy a prawn invests in reproduction at a given time. Higher GSI values mean the ovaries are more developed and take up a larger share of the body, which usually indicates the female is closer to spawning (Fatihah *et al.*, 2022). In this study, the GSI of ovigerous *M. australe* ranged from 0.350 to 0.743. The lower values suggest individuals in the early or mid-stages of gonad development, while higher values reflect prawns with mature ovaries ready for reproduction. The variation among specimens shows that not all females were at the same reproductive stage, even though they were all

ovigerous. This is common in *Macrobrachium* species, which often exhibit asynchronous gonad development, which means that different individuals, or even different parts of the same ovary, may develop at different rates (Chang and Shih, 2011; Fatihah *et al.*, 2022). This diversity in reproductive stages is important for the survival of the population because it helps spread out the timing of reproduction, increasing the chances that at least some offspring survive under varying environmental conditions (Sampaio *et al.*, 2007). Overall, the GSI results confirm that *M. australe* in Dohinob Dacu River is actively reproducing and that the population contains individuals at different stages of maturity. This is a healthy sign for the species in this environment.

Relationship between fecundity and body parameters

Fecundity and body parameters

The relationship between fecundity and body length (r^2= 0.412) showed a weak correlation which suggests that while larger individuals tend to produce more eggs, length alone is not a strong predictor of fecundity. This may be because individuals of similar lengths can differ substantially in body condition, maturity, and reproductive investment.

Body weight (r^2= 0.538) showed a moderate correlation with fecundity. This indicates that overall body mass explains more variation in reproductive output than length. Weight reflects not only skeletal size but also body reserves and condition, making it a better indicator of reproductive potential than length.

Gonad weight (r^2= 0.938) exhibited the strongest relationship with fecundity. This result aligns with expectations, as gonadal tissue directly represents reproductive investment. Larger gonads generally mean more oocytes, and thus higher fecundity. The very high r^2 shows that gonad development is the most reliable morphometric predictor of reproductive capacity (Wiratama *et al.*, 2019; Kumar *et al.*, 2019).

CONCLUSION

The Dohinob Dacu River supports *Machrobrachium australe* populations under favorable physical conditions. Morphometric traits varied, GSI values confirmed asynchronous gonad development, and fecundity showed high variability. Strong correlation with gonad weight highlights the importance of gonadal condition over somatic size as a determinant of reproductive capacity. These results provide baseline information on the reproductive biology of *M. australe* in Philippine rivers.

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