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Fecundity and its relationship with different biometric parameters of *Maydelliathelphusa masoniana* and *Himalayapotamon emphysetum* inhabiting streams of Jammu (J&K), India

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Abstract
Mature females of *M. masoniana* were available only in June-July and December-January while in *H. emphysetum*, they appeared in collection throughout year. Maximum number of ovigerous females of *M. masoniana* were recorded in July (4 & 5) and January (3 & 4) while minimum in June (1 & 2) and December (1 & 1). In *H. emphysetum*, maximum ovigerous females were observed in March (5 & 4) and June (3 & 3) while minimum in May (0 &1) and October (1 & 1) during 2 years of investigation period. Fecundity was observed to vary from 430±36 eggs at 4.0 cm CW, 59 g weight and 3.8 cm Ab.W to 910±28 eggs at 5.7 cm CW, 97 g weight and 4.9 cm Ab.W with average fecundity 650±171 in *M. masoniana*. In *H. emphysetum* on other hand, fecundity was recorded to vary from 98±26 eggs at 3.4 cm CW, 33g weight and 2.9 cm Ab.W to 576±18 eggs at 4.9 cm CW, 89 g weight and 4 cm Ab.W. with average fecundity being 351±158 eggs. Correlation between fecundity vs CW, Ab.W as well as Weight of crab was recorded to be positive and significant in both the species.

Keywords: fecundity, biometric parameters, correlation

Introduction

Reproduction is the soul mechanism to maintain the proliferation of species as well as its continuity. In crabs, reproduction is extremely diversified which vary from production of maximum number of eggs with minimum parental care (marine crabs) to comparatively less number of egg production and maximum parental care (Yeo *et al*., 2008) [18]. Fecundity is an important parameter for species of commercial value as it is an index of reproductive potential of the species (Mantelatto and Fransozo, 1997) [10]. In crustaceans fecundity in general is determined by the number of eggs produced by female during a particular spawning season (Hines, 1989) [6]. Fecundity generally estimates the reproductive potential and stock size of species (Mantelatto and Fransozo, 1997) [10]. In crabs, studies on the relationship between the biometric features and fecundity are scanty (Matsuura *et al*., 1972 and Turra & Leite, 2001) [11, 17]. Since a considerable variation in fecundity as a function of female body size was evident therefore, an attempt has been made to investigate the fecundity and its relation to various biometric parameters such as carapace width, body weight & abdomen width in two species of freshwater crabs viz., *M. masoniana* and *H. emphysetum.*

Material and Methods

Present study has been carried out at Gho-manhasan and Jhajjar stream, both arising from river Chenab, a tributary of Indus river system traversing the maximum part of Jammu region of J&K state. Crabs were collected on monthly basis from both the streams during the study period (April, 2013-March, 2015) by using cast & drag net and brought to the laboratory where different biometric parameters were recorded viz., Carapace width (C.W.), Abdominal width (Ab.W) and Weight of crabs.

Estimation of Fecundity

Fecundity has been estimated on the basis of number of eggs carried externally by the female (Kumar *et al*., 2000) [8].

Results and Discussion

Mature females of *M. masoniana* were available only in June-July and December-January while in *H. emphysetum*, they appeared in collection throughout year. Maximum number of ovigerous females were recorded in July (4 & 5) and January (3 & 4) while minimum in June (1 & 2) and December (1 & 1) during 1st and 2nd years of investigation. Seemingly in *H. emphysetum*, maximum ovigerous females were observed in March (5 & 4) and June (3 & 3) while minimum in May (0 &1) and October (1 & 1) during 1st and 2nd years of investigation. Presently, fecundity was observed to vary from 430±36 eggs at 4.0 cm CW, 59 g Weight and 3.8 cm Ab.W to 910±28 eggs at 5.7 cm CW, 97 g weight and 4.9 cm Ab.W with average fecundity 650±171 eggs in *M. masoniana*. In *H. emphysetum* on other hand, fecundity was recorded to vary from 98±26 eggs at 3.4 cm CW, 33g W and 2.9 cm Ab.W to 576±18 eggs at 4.9 cm CW, 89 g weight and 4 cm Ab.W. with average fecundity being 351±158 eggs. Correlation between fecundity vs CW, Ab.W as well as weight of crab was observed to be positive and significant in both the species.

Studies of biometric parameters in crabs are important to understand its biology and population dynamics. Presently ovigerous females were recorded only during particular period of year i.e. June-July and December-January in *M. masoniana*, and almost throughout the year in *H. emphysetum* thereby indicating the former species to be a biannual breeder and later a continuous breeder (tables, 1-2). Fecundity was observed to vary from 430±36 eggs at 4.0 cm CW, 59 g Weight and 3.8 cm Ab. W to 910 eggs at 5.7 cm CW, 97 g weight and 4.9 cm Ab.W with average fecundity 650±171 eggs in *M. masonana*. In *H. emphysetum* on other hand, fecundity was recorded to vary from 98±26 eggs at 3.4 cm CW, 33g Weight and 2.9 cm Ab. W to 576±18 eggs at 4.9 cm CW, 89 g weight and 4 cm Ab.W. with average fecundity 351±158 eggs. (table 3)

A relatively low fecundity is therefore, evident in under studied crab species as compared to marine where number of eggs varied from 10000-15000. The present results are in agreement with the observations made by Dobson (2004) [2] and Rana *et al*., (2016) [14] who also held that unlike marine crabs, freshwater crabs produce far less number of eggs. In this context, Swetha *et al*., (2015) [15] while working on crab, *Oziothelphusa senex*, held that freshwater crabs though produce less number of eggs as compared to marine one yet the size of egg is always larger than marine crabs. They further added that difference in number and size of eggs could be explained in terms of development as well as survival rate of young ones. Marine crabs produce large number of eggs that hatch into larvae, therefore, production of large number of eggs enhance their chances of survival. Freshwater crabs on the other hand exhibit well marked parental care and the eggs hatch into young crablets rather than larvae.

Apart from marine crabs, present results when compared with earlier work (Micheli *et al*., 1990 and Liu & Li, 2000) [12, 9] on fecundity of freshwater crabs, considerable variations have been recorded. Micheli *et al*., (1990) [12] while working on *Potamon fluviatile* reported the number of eggs to vary from 55-157 eggs. On the other hand, Liu and Li (2000) [9] observed a wide range of egg number (9-117) in freshwater crab, *Candidopotamon rathunae*. Seemingly in both the under studied species, overall as well as within same carapace width fecundity was recorded to be higher in *M. masoniana* as compared to *H. emphysetum* (table 3). Variations in the fecundity of different freshwater crab species may be attributed to their species specific differences as well as to the different ecological condition they face. In this context, Hines (1982) [5] while working on two species of crab, *Geryon fenneri* and *Geryon quinquedens* held that fecundity varies with species, or even within species located at different areas due to different factors such as age, size, nourishment, ecological conditions of the water body, thereby supporting present view point.

Though the number of mature females recorded was quite high in *M. masoniana* (biannual breeder) as well as in *H. emphysetum* (continuous breeder), yet the number of ovigerous females were quite less in both the species. In contrast to present results, ovigerous females per unit catch have been reported to be quite high in marine crabs by some workers (Boolootein, 1959 and Mantelatto, & Fransozo 1997) [10, 1]. The said difference between marine and freshwater crabs may be due to the fact that freshwater crabs exhibited well marked parental care and thus females mostly remain hidden in burrows (as in case of *M. masoniana*) or beneath stones or rock cervices (*H. emphysetum*) for incubation of eggs as well as their protection till post hatching period on even beyond that and during this period females donot feed (Gupta, 2012) [3], thus reducing the chances of their catch. Marine crab, on the other hand, do not exhibit cryptic behaviour and therefore are subjected to easy catch.

In crabs, the studies on relationship between morphological features and fecundity is quite scanty (Micheli *et al*., 1990 and Liu and Li, 2000) [12, 9], therefore, presently an attempt has been made to determine the correlation between fecundity vs CW, Weight and size of abdomen. Fecundity in crustaceans is generally evaluated as the number of eggs or weight of eggs produced by a female in a single egg batch and is observed to be positively correlated with carapace width, Abdominal width (Ab. W) and body Weight (tables 3). Presently, a significant ($P<0.01$) and positive linear relationship between carapace width and fecundity with high value ($R^2= 0.9852$) has been observed in *M. masoniana* whereas in *H. emphysetum* though the relationship was found to be positive but was insignificant i.e. $R^2 = 0.894$. The regression equation for fecundity and carapace width was $21.349x^{2.1409}$ & $0.7708x^{4.2899}$ with slope 2.14 & 4.28 and intercept 21.34 & 0.77 for *M. masoniana* and *H. emphysetum* respectively (figs. 1 & 4). Similar relationship has been reported by Koolkalya *et al*., (2006) [7] in case of crab, *Scylla olivacea* and Rana *et al*., (2016) [14] in *Potamon koolooense*. In contrast to the present studies, Tallack (2007) [16] while working on crab, *Cancer pagurus* and *Necora puber* reported a non-significant positive correlation between fecundity and carpace width.

Fecundity in presently studied crabs showed a significant positive linear relationship with abdominal width and could be expressed as $R^2= 0.9044$ & $R^2= 0.9276$ and linear equation $7.2508x^{2.9984}$ and $7.7984x^{3.0482}$ with slope 2.99 & 3.05 and intercept at 0.90 and 0.93 (figs. 2 & 5) for *M. masoniana* and *H. emphysetum*, thereby indicating that fecundity increase with increase in abdominal width. Further overall fecundity of *M. masoniana* was recorded to be higher than *H. emphysetum*, the variation may be attributed to the fact that overall size and thereby abdomen width of female *M. masoniana* was larger than *H. emphysetum* at a given class size. Larger the size of abdomen, higher is the capacity to hold and incubate the eggs. Present results are in agreement with the findings of Mantelatto & Fransozo (1997) [10] and Rana *et al*.(2016) [14] who while working on freshwater crabs held that abdominal width are related to the capacity of the female to incubate the egg mass, thereby supporting the present view point.

Correlation between total body weight and fecundity was also found positive and significant ($P<0.01$) and could be expressed as $R^2= 0.9563$ & $R^2= 0.9639$ and linear equation $0.373x^{1.7132}$ & $0.3456x^{1.6672}$ with slope 1.71 & 1.67 and intercept 7.25 and 0.35 (figs., 3 & 6) for *M. masoniana* and *H. emphysetum* respectively. Similar positive correlation between total body weight and fecundity with high R^2 value was reported by Haddon (1994) [4] in *Ovalipes catharus* and Raghunath *et al*., (2008) [13] in *Portunus pelagicus*.

Conclusion

Fecundity was recorded to be high in *M. masoniana* as compared to *H. emphysetum* and correlation between fecundity vs CW, Ab.W and Weight depicted that fecundity increases with increase of these biometric parameters. A comparative analysis of data further indicated that overall biometric values were higher in *M. masoniana* as compared to *H. emphysetum.*

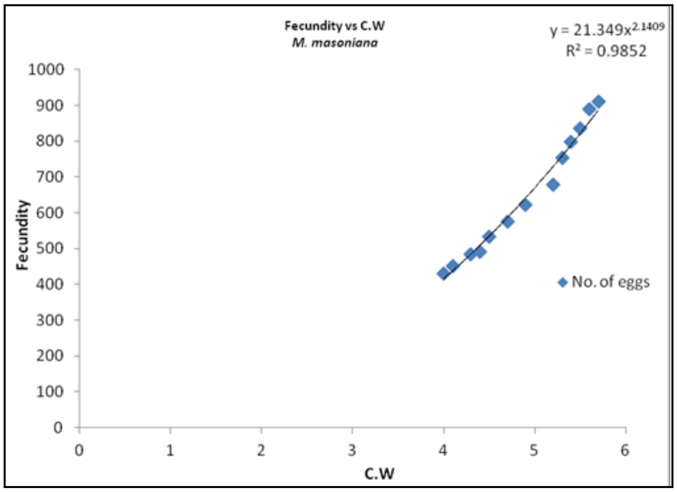

Fig 1: regression analysis between fecundity and carapace width

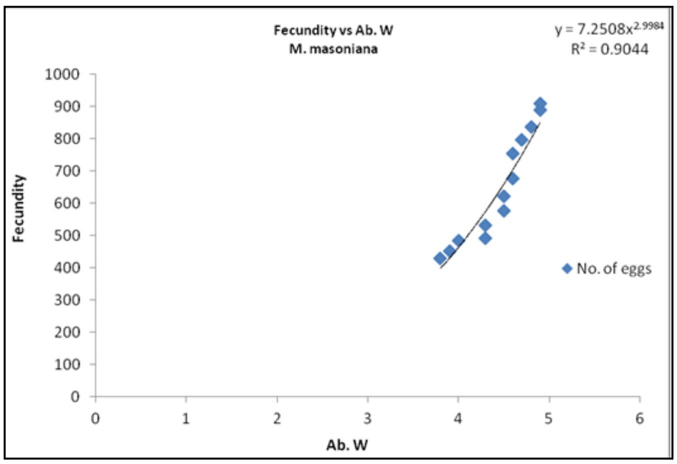

Fig 2: regression analysis beween fecundity and abdominal width

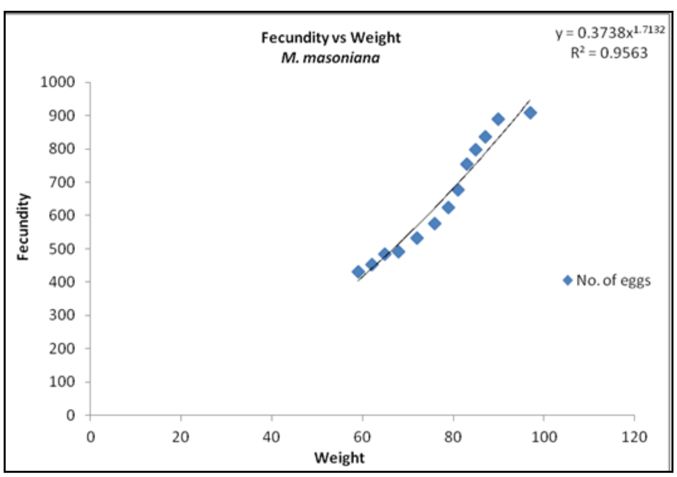

Fig 3: regression analysis between fecundity and weight

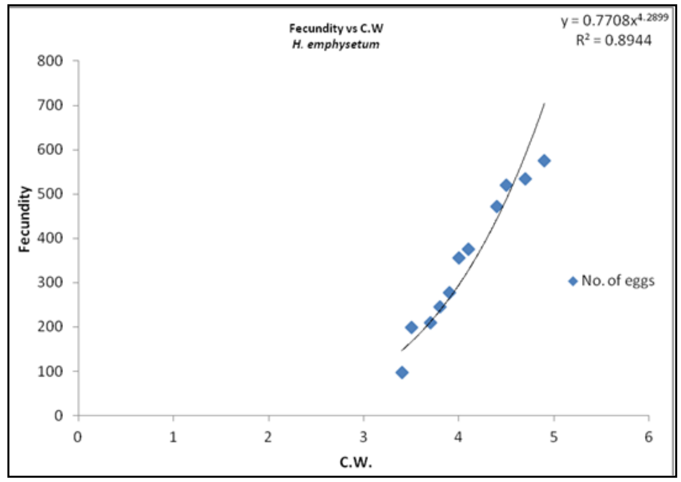

Fig 4: regression analysis between fecundity and carapace width

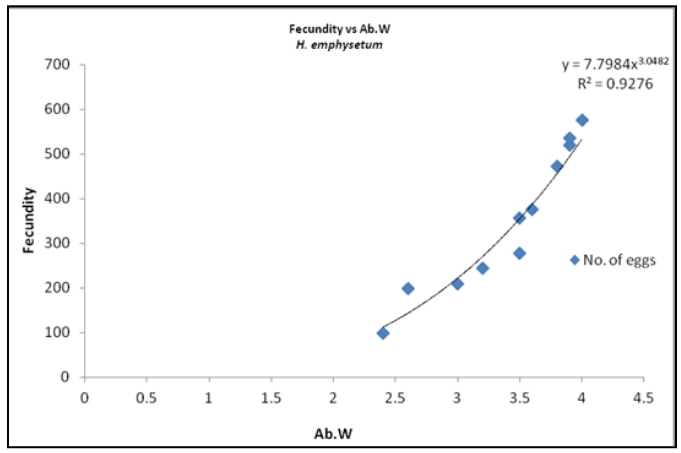

Fig 5: regression analysis between fecundity and abdominal width

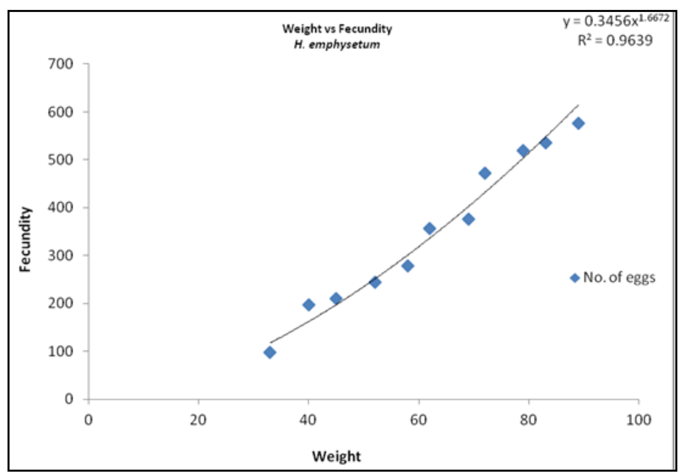

Fig 6: regression analysis between fecundity and weight of crab

Table 1: Monthly collection of ovigerous female of *M. masoniana* inhabiting Gho-manhasan stream, Jammu (2013-15)

Months	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
M. masoniana	0	0	1	4	0	0	0	0	1	3	0	0
M. masoniana	0	0	2	5	0	0	0	0	1	4	0	0

Table 2: Monthly collection of ovigerous female of *H. emphysetum* inhabiting Jhajjar stream, Jammu (2013-15)

Months	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
H. emphysetum	1	0	3	1	1	2	1	1	1	1	1	5
H. emphysetum	1	1	3	1	1	2	0	1	1	1	1	4

Table 3: Fecundity vs different biometric parameters (C.W, Ab.W and Weight) of *M. masoniana* and *H. emphysetum* (2013-15)

M. masoniana				***H. emphysetum***			
C.W (cms)	**Ab. W (cms)**	**Weight (g)**	**No. of eggs**	**C.W (cms)**	**Ab.W (cms)**	**Weight (g)**	**No. of eggs**
4	3.8	59	430±36	3.4	2.4	33	98±26
4.1	3.9	62	452±42	3.5	2.6	40	198±42
4.3	4	65	485±54	3.7	3	45	210±55
4.4	4.3	68	492±38	3.8	3.2	52	245±36
4.5	4.3	72	532±46	3.9	3.5	58	278±48
4.7	4.5	76	576±30	4	3.5	62	356±44
4.9	4.5	79	623±58	4.1	3.6	69	376±28
5.2	4.6	81	678±32	4.4	3.8	72	472±54
5.3	4.6	83	754±42	4.5	3.9	79	520±32
5.4	4.7	85	798±36	4.7	3.9	83	535±26
5.5	4.8	87	836±32	4.9	4	89	576±18
5.6	4.9	90	890±44				
5.7	4.9	97	910±28				

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