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RESEARCH ARTICLE

MORPHOMETRIC STUDIES OF FRESH WATER CRAB, *M. MASONIANA* FROM LOWER REACHES OF RIVER CHENAB (GHO-MANHASAN) JAMMU, J&K (NORTH INDIA)

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ABSTRACT

Present piece of work encompasses various morphometric parameters viz size, sexual maturity, allometric growth and length weight relationship of a fresh water crab *M. masoniana* from Gho-manhasan stream of Jammu region (J&K). Specimens were collected monthly for a period of two years (January 2012 to December 2013). A total of 592 crabs were obtained, 282 being males and 310 females. The maximum carapace width in female was 6.0 cm with abdominal width of 4.5 cm. Males exhibited maximum carapace width of 6.3 cm and chela length of 5.7 cm and chela depth of 3.5 cm. The mean body weight in males varied from a minimum of 16.674 g to a maximum of 90.186 g. Whereas in females, body weight ranged between 18,770 g being minimum & 64,850 g being maximum. Based on the relationship of carapace width (CW) with abdominal width (ABDW) and mean body weight (MBDwt) in females and relationship of carapace width (CW) with Chela length (CHL), Chela depth (CHD) and mean body weight (MBDwt) in males, the size of sexual maturity and allometric growth were assessed during the study period.

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INTRODUCTION

Freshwater crabs belong to the order decapoda, the crustacean group that also includes lobsters, prawns, crayfish and hermit crabs, which share the characteristic presence of five pairs of thoracic legs (pereopods). In freshwater crabs, the first pereopods are modified as pincers (chelipedes), and the remaining four pairs are relatively unspecialized walking legs. Decapod crustaceans generally show sexual dimorphism in their external morphology. The general body plan of fresh water crabs consist of a head, thorax and abdomen, with the head and thorax (cephalothorax) covered by a broad carapace and the abdomen reduced, flattened and flexed under the thoracic sternum. In adults, the male abdomen is slim and narrow, and is either triangular or T shaped, while the female abdomen is broad and round and covers nearly the entire thoracic sternum.

Sexual difference observed in the growth of several body parts relative to carapace size have often been used to examine the relationship between morphometric and sexual activity in addition to morphometric difference among populations or species (Aikens and Waddy 1989).

In crustaceans, as growth progress, certain dimensions of the animals body may grow much more than others, resulting in the phenomenon known as relative growth (Hartnoll, 1974). Studies of relative growth in crustaceans allow to define the type of allometry in the growth of different body parts, such as chelae, locomotor appendages, abdomen and pleopods, and to relate them to their specific functions. One probable factor responsible for these changes in the allometric growth is the sexual maturity (Gonzalez-Gurriaran & Freire, 1994). In population studies, morphometric analysis provide a powerful complement to genetic and environment stock identification approaches (Cadrin, 2000) and length weight relationship allow the conversion of growth in length equations to growth in weight for use in a stock assessment model (Moutopolos & Stergiou, 2002).

The mathematical length-weight relationship thus yields information regarding the general well-being of individuals, variation in growth according to sex, size at first maturity, gonadal development and breeding season. Such studies in aquatic animals have wide application in delimiting the growth patterns during their developmental pathways (Bagenal, 1978) and can be used to estimate the recovery of edible meat from crabs of various sizes (Lagler, 1968). The length width /weight relationship is regarded as more suitable for assessing not only

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fish but also crustacean (Sukumaran & Neelakantan 1997; Tabash 2001). These relationships are often used to calculate the standing stock biomass condition indices, analysis of ontogenic changes and several other aspects of crustacean population dynamics (Atar & Secer, 2003).

Knowledge of these distinguished character and size relationship in sexually mature individuals is of particular importance in the study of commercially valuable crustaceans. With these research inputs, the aim of this study is to provide baseline data on length weight relationship, morphometric & meristic analysis of fresh water crab *M.masoniana* widely distributed in the Gho-manhasan stream of Jammu region (J&K) North India.

The said species is consumed by socio-economically poor people to obtain their energy requirement. Information on morphometric analysis of the said species can be a necessary tool for the assessment of the fishery to ensure sustainability and also form the basis for their inclusion in a regional food security programme. Such knowledge can be useful for further studies on the life history of the species and in the development of its fishery, resource management and culture.

MATERIAL AND METHODS

The present study was conducted in their natural habitat viz Gho-manhasan stream fed by river Chenab in Jammu region (32°67' Latitude N: 74°79' East) J&K, North India. Crabs were randomly collected on monthly basis by hand picking or by using dragnet from the study area from Jan 2012 to Dec 2013.

In the laboratory, specimens were identified and sexed according to secondary sexual characters (abdomen morphology and number of pleopods). A total of 592 crabs were studied out of which 310 were females and 282 were males.

Determination of allometric growth/sexual maturity

The following variables were measured in the laboratory to the nearest 0.1 cm using a vernier calliper and total body weight was measured to the nearest 0.1g using a weighing balance

- Carapace width (CW)
- Chela length (CHL)
- Chela depth (CHD)
- Abdominal width (ABDW) in females.
- Mean body weight of both males and females. (MBDwt.)

The morphometric relationship CW/CHL, CW/CHD and CW/MBDwt. for males and CW/ABDW and CW/MBD wt for females were tested to estimate the size of maturity, based on changes of these structures and weight. The examined variables were subjected to a regression analysis.

In the allometric growth, the carapace width (CW) was used as the independent variable y, since it is the most representative dimension of the overall size of the animal (Hartnoll, 1982) ,

related to other body dimensions, the dependent variables being x in males , viz chela length (CHL & chela depth (CHD) and Abdomen width (ABDW) in females including mean body weight (MBDwt) in both the sexes.

Aiming to investigate the occurrence of allometry between the morphometric variables, specifically those related to secondary sexual characteristics, their values were logarithmized ($\log y = \log a + b \log x$) and the function $Y = a + x^b$, where x is the intercept (value of y when x=0), and b the slope of the regression line. The b value indicates the growth patterns of the analyzed variables, considering three possibilities: b = 1 (isometry) b<1(negative allometry), b>1 (positive allometry) (Hartnoll, 1982). The statistical significance of b was tested by student t-test.

RESULTS AND DISCUSSION

A look at the table 1 exhibits males of *M.masoniana* in the range of 2.0 to 6.3 cm with respect to carapace width (CW) . The chela length (CHL) range from 1.0 to 25.7 cm and Chela depth (CHD) ranged from 0.5 cm to 3.5 cm in the same species of male crabs. The mean body weight (MBDwt) of the male crabs ranged from 16.674 to 90.186 gms. In females of the same species, the carapace width (CW) ranged from 2.0 to 6.0 with abdominal width ranging from 1.0-4.5cm. The mean body weight (MBDwt) in females ranged from 18.7770-64.850gms.

Table 1 Morphometric Analysis of male and female crabs of *M. masoniana* during the study period (Jan 2012-Dec 2013)

Morphometric measurements/Analysis	Male (cm)		Female (cm)	
	Min	Max	Min	Max
Carapace Width (CW)	2.0	6.3	2.0	6.0
Chela Length (CHL)	1.0	5.7	1.0	5.3
Chela Depth (CHD)	0.5	3.5	0.5	2.5
Abdominal Width (ABDW)	-	-	1.0	4.5
Mean Body wt (MBDwt) in (gms)	16.674	90.186	18.770	64.850

Table 2 Showing relationship of carapace width with chela size and body wt. in male *M.masoniana* during study period (Jan 2012-Dec2013)

S.No	Mean Carapace width CW (Cms)	Mean Chela Length (CHL) Cm	Mean Chela Depth (CHD) Cm	Mean Body Weight (MBDwt) (Gms)	Colour Variation in Testis
1	2.5	1.5	0.7	16.674	Transparent
2	3.5	2.5	1.2	22.650	
3	4.5	4.2	2.5	36.245	Creamy White
4	5.5	5.6	3.2	50.120	
5	6.5	5.7	3.2	90.186	Milky White

Table 3 Showing relationship of carapace width CW (cm) with Abdominal width ABDwt. in female of *M.masoniana*.

S. No	Mean Carapace width CW (Cm)	Mean Abdominal Width ABDW (cm)	Mean Body Wt (MBDwt) (Gms)	Colour Variation in Ovaries
1	2.5	1.7	18.7770	Transparent to Yellowish
2	3.5	3.2	22.490	Orange Red
3	4.5	4.2	37.018	Coloration
4	5.5	4.2	46.741	Pale Yellow
5	6.5	-	64.850	Coloration

Table 4 Regression for body dimensions (CW: Carapace Width; CHL: Chela Length; CHD: Chela Depth; ABDW: Abdominal Width; MBDwt: Mean Body Weight, $t = t$ test for the slope b , r^2 = determination coefficient, allometry = positive (+).

Relationship	SEX	Logy = loga +blogx	r ²	t(b=1)	Allometry
CW vs CHL	M	logCW= 1.3128logCHL+ 1.6643	0.919	7.49*	+
CW vs CHD	M	logCW= 0.825logCHD+ 1.2826	0.9487	3.09	+
CW vs (MBDwt)	M	logCW= 5E-05logMeanWt+ 2.3035	0.8877	4.97*	+
CW vs ABDW	F	logCW=-1E-05logABDW+ 5.3952	0.2764	3.55	+
CWvs (MBDwt)	F	logCW= -0.1842logMeanW TS + 4.9899	0.042	1.07	+

Significant at 5% level of significance.



Fig1 Male



Fig 2 Female

RESULT

A total of 592 crabs, 282 males and 310 females were analyzed in the present study. It was observed that there were more females than males. Sexual dimorphism was quite conspicuous. Sex differentiating characters were observed in morphometric and meristic features of both crabs. Male crabs have a depth (CHD) falling in the range of 1.0-5.7cm and 0.5-3.5 cm respectively (Table 1). The mean body weight (MBDwt) of The CW of females under study ranged from 2.0 to 6.0 cm with abdominal width falling in the range of 1.0 to 4.5 cm (Table 1). The mean body weight (MBDwt) of female *M. masoniana* under study was in the range of 18.7770 gms to The statistical analysis of the above data exhibited a positive allometry between CW and all dimensions analyzed viz chela length, chela depth, mean body weight in males; abdominal width and mean body weight in females. The allometric relations showed different levels of growth, that were observed for the different values of the coefficient b in each relation analyzed, but all the relations showed a positive allometric growth. In males, the allometric growth exhibited significantly positive allometry in relationship of CW V/s CHL and CW V/s Mean body weight (MBDwt) with values of 7.49 and 4.97 respectively whereas, in females, “slight positive allometry” was observed in relation of CW V/s ABDW & CW V/s Mean body weight (MBDwt) with values of 3.55 and 1.07 respectively. (Table: 4)

DISCUSSION

The present study identified the growth pattern of cheliped in case of males and abdomen in case of females and body weight

acting as the best indicators of morphological sexual maturity. The relationship between chela size and carapace width (CW) in the present study resulted in the morphological sexual maturity for males of *M. masoniana*. (Fig 1 & 2). The present observation, reports a positive allometry of cheliped in adult individuals of *M. masoniana* which is consistent with the predictions made by Hartnoll (1974), who compared the growth related to secondary sexual characteristic in Brachyurans. In crab a pubertal molt is often associated with an increase in cheliped size and allometric growth rate. Brachyuran males develop cheliped for combat, display and courtship (Hartnoll, 1982). The significance of heterochely in crab is unclear, but according to Daniels (2001) it may be related to sexual signaling and defence and in females may indicate reproductive vigour as well as the ability to take care off and protect their brood.

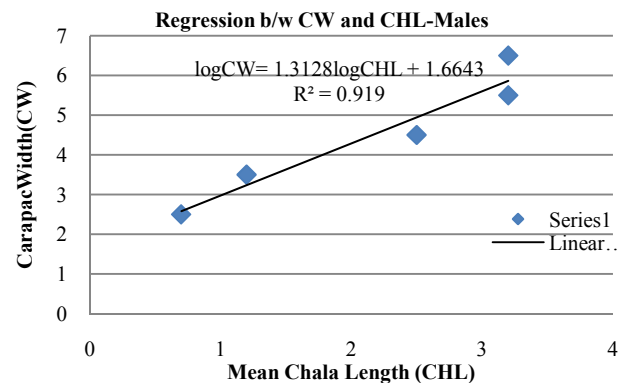


Fig 1 Regression between (CW) and chela length (CHL) males.

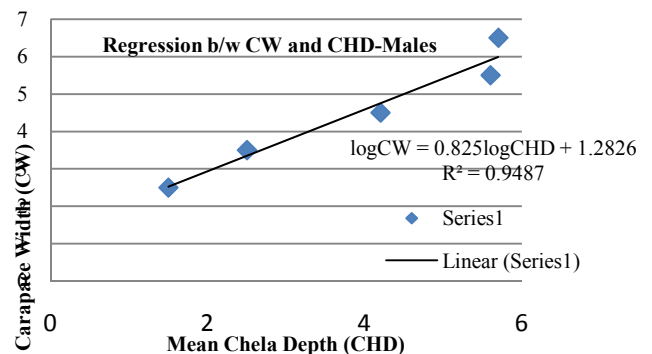


Fig : 2 Regression between (CW) and chela depth (CHD) males.

The present observation exhibited males with greater chela depth than of the females indicating larger cheliped in males as compare to females (Table1). In accordance to our findings, Akin Oriole et.al (2005) to have reported that the right chelae diameter of males were significantly bigger ($P \leq 0.05$) than that of females in *C. armatum*. On the similar lines other relevant parameters like body weight, chelae diameter condition factor of male *C. Pallidus* were higher than those of females.

According to Mansur et.al (2005) in *Dilocarcinus, pagei* the positive allometry found for the male cheliped propodus in the adult stage indicated the possibility of a greater energy investment in the development of the structure after the prepubertal stage.

In the present study, carpace width (CW) was taken as independent variable for studying the relationships between

morphometrics and sexual activity. This is in accordance with the findings of Aiken & Wady (1989) who observed sexual difference in the growth of several body parts relative to carapace size in lobsters. According to Antekhai *et.al.*, (1994) carapace width is more appropriate index of body weight and an ideal parameter for weight estimation. Present observation based on carapace width (CW) as an independent variable is also in accordance with findings of Castiglioni and Negreiros-Franzozo (2004) who reported that carapace width is the body dimension most frequently used as an independent variable in the analysis of relative growth of crabs, because it fully represent the physiological changes that occur through their life history.

During the present investigation it was found that the females reached morphological sexual maturity at smaller size than the males. A look at the table 3 revealed that females of carapace width 2.5 cm showed isometric growth, whereas, females of carapace width ranging from 3.5 to 4.5 cm showed positive allometric growth and there after again isometric growth was exhibited at 5.5 cm carapace width in females. Thus indicating 3.5 cm (CW) to be the size of morphological sexual maturity. Males exhibited allometric growth at 4.5 cm indicating size of sexual maturity as after this size cheliped showed isometric growth with respect to length and depth measurements. The difference in the size at morphological sexual maturity between males and females is consistent with the pattern proposed by Shine (1988) for brachyurans. According to which, this pattern explained the requirement for reproduction in two sexes. When females allocate their energy for reproductive purpose, such as spawning and egg incubation, they tend to mature at smaller size than males, who invest their resources in somatic growth and reach maturity at greater size. Our findings are also in tune with the observations of Carsen *et.al* (1996) who reported that sexual maturity occurred at 4.0 and 5.0 cm carapace width in males *Platyxanthus patogonicus* and ovigerous females of same species who reach sexual maturity between 42.7 and 72.0 mm of carapace width.

On similar pattern Silva and Chacur (2002) reported a morphological sexual maturity of 13.3 mm carapace width for females and 14.4 carapace width for males for *S. rectum*. Later Silva *et al* (2007) however, reported sexual maturity in *S. Rectum* with carapace width of 17.4 mm for females and 18.5 mm carapace width for males. Recently Castiglioni *et al* (2011) reported morphological sexual maturity of 16.71 mm carapace width for females and 15.73 mm carapace width for males in same species. In the present study the positive allometric growth during the adult stage correspond to the increase in the reproductive potential of the females in *M. masoniana*. The characteristic of the adult stage has also been verified in other brachyuran species (Pinheiro & Fransozo, 1993; Mantelatto & Fransozo, 1994; Negreiros-Franzozo *et.al*, 2003). The abdomen of females present an important reproductive function for most freshwater crabs as they form a 'chamber incubatory' with function of retaining the eggs and newly hatched juveniles, as reported by Hines (1982). On similar lines our observation on present study gets further authenticated, with respect to abdominal growth as indicator of morphological sexual maturity. (Fig :3)

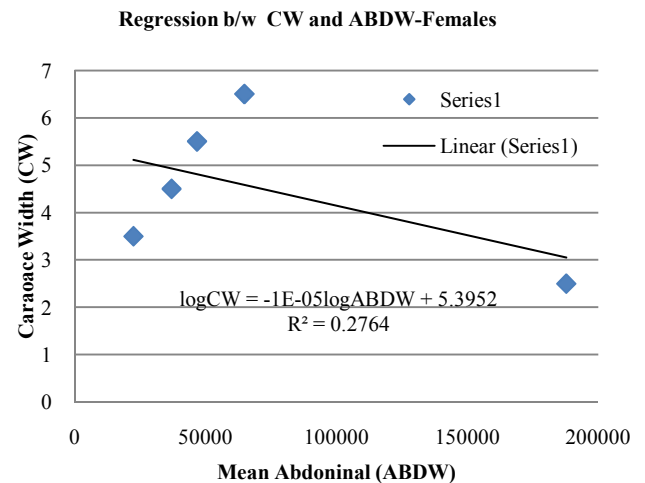


Fig: 3 Regression between (CW) and ABDW in females.

Our observation further gets strengthened by the findings of Hartnoll (1974) who reported that changes in allometric growth of female abdomen occur at the beginning of sexual maturity. The inflection of the straight line in graphic analysis of ABDW/carapace width clearly demonstrated the point at which sexual maturity is attained by female of *M. masoniana* (Fig 3) indicating that the morphometric maturity was reached at 3.5 cm carapace width exhibiting positive allometry. Finney and Abele (1981) in *Trapezia ferruginea* reported that abdomen growth rate decreases slightly as a result of the sexual maturity with the fact that high positive allometric growth occurred in juvenile females and isometric in adult females.

The present study also indicated positive allometry for relationship between carapace width (CW) and mean body weight (MBDwt) in case of male and female *M. masoniana*. A look at table 2 and 3 revealed that upto 4.5cm of carapace width females were marginally heavier than males and thereafter males were heavier than females. A significant positive allometry was indicated in males with values of 4.97 in males and slight positive allometry with value of 1.07 in females (Table 4). (Fig: 4 & 5). Our findings are in accordance with the findings of Sukumaran and Neelkantan (1997) who reported weight increase to be evident above a carapace width of 115 mm in *P. pelagicus* one of the characteristic feature of

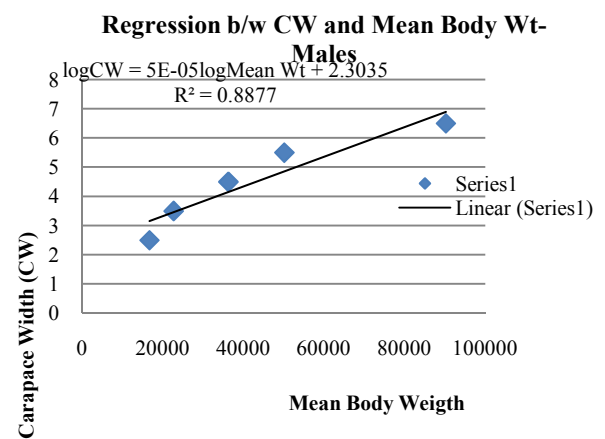


Fig: 4 Regression between (CW) and MBDwt in males.

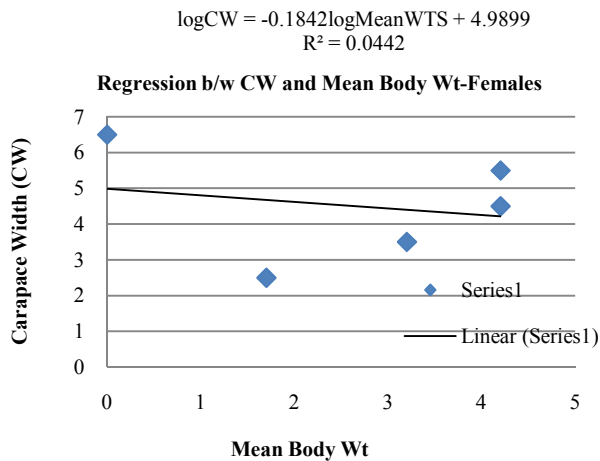


Fig: 5 Regression between (CW) and MBDwt in females.

present findings is the tendency of males to be heavier than females and this observation matches well with those made by Potter *et al* (1983) in *P. pelagicus* and Prasad *et al* (1989) in *Scylla serrata*. The results of length weight relationship analysis in *P. pelagicus* indicated that in juveniles and pre-adult crabs, weight gain is almost uniform, females being slightly heavier than males until they attain 120-125 mm carapace width, thereafter males becoming heavier than females at any given length (Jose Josileen, 2011). In contrast to the present findings, Dhawan *et al* (1976) found the females of *P. pelagicus* to be heavier than males at a given carapace width.

Summary

Based on the data obtained from morphometric analysis in male and female of *M. masoniana* the size at sexual maturity happened to be 3.5 cm carapace width in females and 4.5 cm carapace width in males. The carapace width/weight relationship will enable crab biologists to derive length weight estimates for *M. masoniana* that are weighed and measured. The data provides the information to determine the minimum size of males and females of *M. masoniana* below which harvesting should not be practiced because it will enable the population to reproduce and maintain juveniles and adult in the optimum proportions. Hence the results of present study can serve as useful tool for the effective management and utilization of this resource in the area where *M. masoniana* can make a good fishery possible.

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