

LENGTH-WEIGHT RELATIONSHIP, CONDITION, AND RELATIVE CONDITION FACTOR IN *MAYDELLIATHELPHUSA MASONIANA* AND *HIMALAYAPOTAMON EMPHYSETUM* INHABITING STREAMS OF JAMMU AND KASHMIR, INDIA

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ABSTRACT

Objective: The objective of this study was to determine the well-being, breeding activity and to authenticate the size at which maturity is attained by freshwater crabs species, namely *Maydelliatelphusa masoniana* and *Himalayapotamon emphysetum*.

Methods: Freshwater crab species were collected from streams and brought to the laboratory. Carapace width (CW) and weight were recorded monthly on different class size. Conditional factor and relative condition factor were determined.

Results: At present, 782 individuals of *M. masoniana* and 389 in *H. emphysetum* were analyzed for weight versus CW relationship. The mean CW of males was recorded to be 2.3±0.52 cm CW–6.3±0.63 cm CW and 2.2±0.32 cm CW–5.1±0.18 cm CW, whereas in females, it varied from 2.2±0.14 cm CW to 5.3±0.14 cm CW and 2.1±0.13 cm CW to 4.6±0.12 cm CW in case of *M. masoniana* and *H. emphysetum*, respectively. The mean weight of males recorded to be 16.4±4.2–142±6.3 g and 15.2±3.2–100.4±6.5 g while in females, it varied from 14.3±4.3 to 96.2±5.4 g and 14.2±6.3 to 80.6±7.2 g in case of *M. masoniana* and *H. emphysetum*, respectively. Males of both the species were, therefore, significantly heavier than females (p<0.05). Mean condition factor (K) in *M. masoniana* varied from 0.0370±0.0012 to 0.066±0.0026 in males and from 0.0368±0.0032 to 0.0583±0.0025 in females, whereas in *H. emphysetum*, the condition factor varied from 0.0324±0.0028 to 0.0602±0.0022 in males and between 0.0324±0.0018 and 0.0536±0.0023 in females. The relative condition factor (Kn) in *M. masoniana* varied from 0.78±0.10 to 1.08±0.20 in males and from 0.64±0.12 to 0.98±0.16 in females while in *H. emphysetum*, it varied from 0.62±0.14 to 1.02±0.14 in males and from 0.58±12 to 0.92±0.26 in females.

Conclusion: Male attains larger size than female in both the species. *M. masoniana* recorded to be biannual breeder while *H. emphysetum* a continuous breeder. Correlation between hepatosomatic index and gonadosomatic index observed to be inverse in *M. masoniana* while direct in *H. emphysetum*.

Keywords: Crabs, Carapace Width, Weight, Condition, Relative condition.

INTRODUCTION

Crabs constitute one of the important components of macrobenthic invertebrates fauna and act as link between the unavailable nutrients in detritus and useful protein materials in fish and shellfish. Crabs accelerate the breakdown of decaying organic matter into simpler inorganic forms such as phosphates and nitrates [1] and therefore act a major link in the food chain as most fishes, birds, and mammals depend directly or indirectly on them for their food supply [2]. Length-weight relationship is regarded as more suitable for assessing not only fish but also crustacean [3] and can be determined using the equation, $W=aL^b$, which was fitted in regression model. Where, “b” is constant of length-weight relationship, and has values between 2 and 5 [4], reported when (b=3) isometric growth take place, but when b value is below or above 3 allometry growth takes place. The relationships between carapace width/length and weight of the crabs have many uses. They are often used to calculate the standing stock biomass, condition indices, analysis of ontogenetic changes, and several other aspects of crustacean population dynamics [5]. In addition, they are used for the management of population.

Both condition factor and relative condition factor are primarily related to the reproductive status of a species, and therefore, can serve as reliable tool in understanding the reproductive behavior of the species and formulating the fishery management strategies to safeguard the broodstock population in nature. At present, therefore, an attempt has been made to assess length-weight relationship as well as the condition and relative condition factor in two species of crabs, namely *Maydelliatelphusa masoniana* and *Himalayapotamon emphysetum* so as to assess its standing biomass as well as a health status.

METHODS

The present studies were conducted in Gho-manhasan stream and Jhajjar streams, both arising from river Chenab, a tributary of Indus river system traversing the maximum part of Jammu region of Jammu and Kashmir state. Crabs were collected using drag and cast net and brought to the laboratory. Crabs were segregated into males and females based on their well-marked sexually dimorphic characters [6].

Determination of condition and relative condition factors

1. Condition factor [4]:

$$K = \frac{100W}{L^b}$$

Where, “W” weight (g),

“L” is the carapace width (cm/mm)

“b” is the regression coefficient from the carapace width-weight relationship.

2. Relative condition factor [7]:

$$Kn = \frac{W}{aL^b}$$

RESULTS AND DISCUSSION

At present, 782 individuals of *M. masoniana* and 389 in *H. emphysetum* were analyzed for weight versus carapace width (CW) relationship. The mean CW of males was recorded to be 2.3±0.52 cm CW–6.3±0.63 cm CW

and 2.2 ± 0.32 cm CW– 5.1 ± 0.18 cm CW, whereas in females, it varied from 2.2 ± 0.14 cm CW to 5.3 ± 0.14 cm CW and 2.1 ± 0.13 cm CW to 4.6 ± 0.12 cm CW in case of *M. masoniana* and *H. emphysetum*, respectively. The mean weight of males recorded to be 16.4 ± 4.2 – 142 ± 6.3 g and 15.2 ± 3.2 – 100.4 ± 6.5 g while in females, it varied from 14.3 ± 4.3 to 96.2 ± 5.4 g and 14.2 ± 6.3 to 80.6 ± 7.2 g in case of *M. masoniana* and *H. emphysetum*, respectively. Males of both the species were, therefore, significantly heavier than females ($p < 0.05$). Males being larger and heavier than females have also been reported earlier by many workers [8-11]. The variation in weight between sexes may be attributed to the fact that males primarily invest energy for somatic growth so as to acquire larger size that helps to overcome intraspecific competition for territory as well as for breeding purpose [6]. On the other hand, females spend less energy for somatic growth but rather direct most of their energy budget to the egg production, thereby attain smaller size as compared to males. Thus, in presently studied crabs species, variation in somatic growth and reproductive behavior affects the overall weight and size in both the sexes. Pinheiro and Fransozo [12] held that in crabs differential growth rate, reproductive effort, and breeding behavior affect size as well as weight of crabs, thereby supporting present point of view.

The slopes and intercepts lines of CW versus weight of *M. masoniana* and *H. emphysetum* revealed that both the sexes exhibit allometric type of growth. In *M. masoniana*, the value of "b" (allometric value) was recorded to be 3.12 and 3.06 in males and females, respectively, while in *H. emphysetum*, the value of "b" was observed to be 3.08 and 3.02 for males and females, respectively. In contrast to the present findings, Baptista-Metri et al. [10] found an isometric growth while in Branco and Thives [13] found a negative pattern for the same relationship in *C. danae*. These differences may be a result of species or geographical variation between populations, due to fisheries exploitation [14], and/or differences in the abiotic factors such as pH, rainfall, DO, and especially temperature [15,16].

The mean condition factor (K) and mean relative condition factor (Kn) for both the sexes in the two species are presented in Table 1. Mean condition factor (K) in *M. masoniana* varied from 0.0370 ± 0.0012 to 0.066 ± 0.0026 in males and from 0.0368 ± 0.0032 to 0.0583 ± 0.0025 in

females, whereas in *H. emphysetum*, the condition factor varied from 0.0324 ± 0.0028 to 0.0602 ± 0.0022 in males and between 0.0324 ± 0.0018 and 0.0536 ± 0.0023 in females. The relative condition factor (Kn) in *M. masoniana* varied from 0.78 ± 0.10 to 1.08 ± 0.20 in males and from 0.64 ± 0.12 to 0.98 ± 0.16 in females while in *H. emphysetum*, it varied from 0.62 ± 0.14 to 1.02 ± 0.14 in males and from 0.58 ± 0.12 to 0.92 ± 0.26 in females. Perusal of data (Table 2) clearly indicates that overall condition factor and relative condition factor in males of both the species were slightly higher than that of females. The present observations are in tune with those recorded by Branco and Thives [13] and Pinheiro and Fransozo [16] who have also observed higher condition factor for male in *C. danae* and *A. cribrarius*. In contrast to present findings, however, higher value of condition factor for females has been reported in *C. sapidus* [5], *Dilocarcinus pagei* [17], and *Ucides cordatus* [11,17].

The condition factor and relative condition factor in both the sexes of *M. masoniana* were slightly higher than that of *H. emphysetum*, thereby indicating interspecific difference. At present, males of both the species exhibit a continuous increase of K and Kn values with increase in size; however, a sudden increase has been recorded at 4–5 cm CW. In females, on the other hand, K and Kn follow increasing trend up to 4–5 cm CW, and a sudden increase is evident at 3–4 cm CW. This sudden increase in values of K and Kn at 4–5 cm CW and 3–4 cm CW in males and females of both the species, respectively, correspond to the size at morphological maturity of understudied crabs species. Our findings, however, are in contrast to Mohapatra et al. [18], who, while working on marine crab *Scylla* species, reported their size at maturity to be 7–8 cm CW based on weight versus CW relationship. Although K and Kn values followed increasing trend with size in males as well as females of both the species, yet it exhibits fluctuating trend at size >4 cm CW in females prominently. Such a trend at this particular, i.e. >4 cm CW in females of both the species may be attributed to breeding activities/gonadal cycle of these crabs, as mature females are usually heavier than immature or spent as has also been held by many workers [19,20]. Observed seasonal variations in K and Kn, therefore, seem to be closely related to sexual cycle of the species. The condition factor as well as relative condition oscillated throughout the sampling year in both the species and were observed to be more prominent in females as compared to male

Table 1: Monthly variations of GSI and HSI in male and female crabs of *H. emphysetum* inhabiting Jhajjar stream, Jammu (2013–2015)

Months	GSI (2013–14)		GSI (2014–15)		HSI (2013–14)		HSI (2014–15)	
	Male	Female	Male	Female	Male	Female	Male	Female
April	0.34±0.12	0.70±12	0.38±0.11	0.74±0.	0.92±0.15	0.79±0.10	0.82±0.14	0.79±0.22
May	0.38±0.11	0.72±20	0.40±0.12	0.79±0.18	0.90±0.17	0.81±0.08	0.85±0.10	0.80±0.20
June	0.44±0.20	0.74±21	0.42±0.13	0.86±0.12	0.94±0.13	0.86±0.20	0.93±0.19	0.83±0.15
July	0.42±0.17	0.70±20	0.41±0.08	0.81±0.14	0.84±0.15	0.82±0.10	0.91±0.20	0.79±0.19
August	0.36±0.19	0.68±13	0.39±0.11	0.78±0.21	0.86±0.19	0.78±0.12	0.89±0.25	0.72±0.10
September	0.40±0.13	0.70±14	0.41±0.21	0.74±0.22	0.85±0.16	0.80±0.09	0.85±0.23	0.78±0.16
October	0.34±0.112	0.69±12	0.37±0.22	0.76±0.20	0.86±0.18	0.70±0.06	0.90±0.21	0.81±0.18
November	0.32±0.15	0.67±16	0.36±0.17	0.77±0.23	0.77±0.13	0.77±0.12	0.87±0.10	0.82±0.13
December	0.30±0.10	0.66±19	0.35±0.11	0.75±0.21	0.88±0.16	0.70±0.16	0.88±0.19	0.72±0.16
January	0.34±0.16	0.64±21	0.38±0.23	0.73±0.19	0.90±0.22	0.72±0.18	0.83±0.14	0.73±0.12
February	0.37±0.18	0.65±20	0.39±0.21	0.72±0.11	0.89±0.19	0.77±0.13	0.85±0.12	0.76±0.18
March	0.42±0.14	0.68±22	0.40±0.19	0.70±0.20	0.98±0.20	0.81±0.09	0.97±0.16	0.87±0.16

HSI: Hepatosomatic index, GSI: Gonadosomatic index, *H. emphysetum*: *Himalayapotamon emphysetum*

Table 2: Condition factor (K) and relative condition factor (Kn) of *M. masoniana* and *H. emphysetum* from April 2013 to March 2015

Class size (CW) cm	K values in <i>M. masoniana</i>		K values in <i>H. emphysetum</i>		Kn values in <i>M. masoniana</i>		Kn values in <i>H. emphysetum</i>	
	Male	Female	Males	Females	Males	Females	Males	Females
2–3	0.0370±0.0012	0.0360±0.0032	0.0324±0.0028	0.0314±0.0018	0.78±0.10	0.64±0.12	0.62±0.14	0.58±0.12
3–4	0.042±0.0016	0.048±0.0020	0.040±0.0018	0.0402±0.0012	0.82±0.12	0.78±0.013	0.68±0.22	0.72±0.17
4–5	0.056±0.018	0.050±0.022	0.0540±0.0020	0.044±0.0016	0.98±0.16	0.84±0.012	0.88±0.20	0.78±0.21
5–6	0.058±0.0020	0.054±0.018	0.0562±0.0022	0.048±0.0022	1.04±0.22	0.90±0.016	0.95±0.23	0.85±0.19
6–7	0.066±0.0026	0.0583±0.0025	0.0602±0.0022	0.0536±0.0023	1.08±0.20	0.98±0.016	1.02±0.14	0.92±0.26

M. masoniana: *Maydellithelphusa masoniana*, *H. emphysetum*: *Himalayapotamon emphysetum*, CW: Carapace width

counterpart. Analysis of Table 2 further revealed that in females of *M. masoniana*, the K and Kn values were high in June (0.0583 ± 0.0025 and 0.98 ± 0.016) which thereafter marked a decline, attaining its least value in August (0.0368 ± 0.0032 and 0.84 ± 0.022), which it again followed an increasing trend exhibiting its peak in December (0.0542 ± 0.0024 and 0.92 ± 0.25) followed by least value in February (0.0364 ± 0.0018 and 0.81 ± 0.23), it again following increasing trend attained its maximum value in June. In females of *H. emphysetum*, though fluctuations in K and Kn values are not as prominent as in *M. masoniana*, yet still maximum values were evident in March, June, and August while least in July and September. Thus, more or less K and Kn values round the year except for March, June, and August gives an indication of year-round availability of mature crabs. Pinheiro and Taddei [17], while working on *Ucides cordatus*, held that the months having peak values of K and Kn represent the breeding season of crabs while least value indicates that spawning has taken place and gonads are fully flaccid now. Based on this, it can further be emphatically held that *M. masoniana* is a seasonal breeder that breeds twice a year, i.e. during June–July and December– January, while *H. emphysetum* is a continuous breeder that exhibits intense breeding activities in March, June, and August.

Besides, gonadal cycle, differential growth rates, nutritional aspects, stage of maturity, time of recruitment, and selective fisheries might also affect sexual differences of the condition factor or even a small difference in the regression coefficient between sexes could generate great differences in the condition factor [21].

CONCLUSION

Male crab in both the species attains morphological maturity at larger size (4–5 cm CW) compare to female counterpart (3–4 cm CW). *M. masoniana* recorded to be biannual species that breed during June–July and December–January, whereas *H. emphysetum*, a continuous breeder with peak season in March, June, and August. The present work will be helpful for studying the life cycle of these crab species and will set a venture for aquaculture point of view.

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