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Carapace Length-weight, Carapace Width-weight Relationships, Condition Factor and Sex Ratio of Freshwater Crab *Sartoriana spinigera* (Wood-Mason, 1971) from the River Burhi Gandak, North Bihar, India

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ABSTRACT

Background: The Burhi Gandak river origins in the Chautarwa Chaur region near Bisambharpur in the West Champaran district of Bihar and flows through the East Champaran, Muzafarpur, Samastipur and Begusarai districts. It falls into the river Ganga near Khagaria district. Its coordinates are 25°51′40″N latitudes and 85°48′36″E longitudes. The total area of catchment is 12500 sq. km in size overall, of which 9601 sq. km are in Bihar and the rest in Nepal. The study will be helpful for stock estimation, developing conservation and choosing appropriate species for aquaculture. The present data can be used to develop conservation plans while providing biological data needed for an effective management of this fishery.

Methods: The carapace length-weight, carapace width-weight relationship, condition factor and sex ratio of freshwater crab *Sartoriana spinigera* (n= 663) collected from River Burhi Gandak, North Bihar, between July 2020 to June 2021. In the present investigation, freshwater crabs were collected from different types of techniques, including hand-picking, digging, setting traps and taking them from their nest.

Result: Total of 663 specimens of *Sartoriana spinigera* (Wood-Mason, 1971) of both sexes (male and female) were collected in which 363 female and 300 male. The carapace length-weight of *Sartoriana spinigera* females were calculated as $W = 0.912^{2.521}$ with $R^2 = 0.875$, male $W = 0.4310^{2.505}$ with $R^2 = 0.853$ and length-weight of combined sex (male and female) were calculated as $W = 0.661^{2.701}$ with $R^2 = 0.954$. The carapace width-weight of female were calculated as $W = 0.554^{2.331}$ with $R^2 = 0.831$, male $W = 0.791^{2.421}$ with $R^2 = 0.802$ and carapace length-weight of combined sex (male and female) were calculated as $W = 0.1812^{2.601}$ with $R^2 = 0.900$. From this study showed it could be stated that crabs have allometric growth pattern. The Fulton's condition factor (Kn) value were calculated as 1.10 and sex ratio calculated was 1:1.49. This paper provides information.

Key words: Burhi gandak river, Carapace length-weight, Carapace width-weight, Condition factor (K), Freshwater crab.

INTRODUCTION

Freshwater ecosystems in the tropics support a variety of endemic wild lives including freshwater crabs, but due to some environmental factors like climate change, temperature, habitat loss and degradation, pollution and domestic waste, driven by human population growth and deforestation, many species are currently under the verge of extinction (Cumberlidge *et al*., 2009). In the tropical inland waters body around the world, freshwater crabs are among the most ecologically significant macro-invertebrate taxa (Dobson *et al*., 2007a). Freshwater crabs belong to the order Decapoda, infra-order: Brachyura, class Malacostraca and subphylum Crustacea (Rajesh *et al*., 2017). According to Cumberlidge (2016), freshwater crabs are one of the most diversified subgroups of brachyuran, with a range that is confined to the majority of tropical and subtropical waters. They are most frequently found in rivers, lakes, streams, swamps, ponds paddy fields, marshes and pits, in addition to semi-terrestrial or terrestrial environments (Ng and Yeo, 2007; Yeo *et al*., 2008). Freshwater crabs currently comprise 1564 species across five families. India is home to 125 species of these across two families (Gecarcinucidae and Potamidae) (Pati and Pradhan, 2020). Freshwater crabs

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are considered as an ecologically and commercially significant group due to play a vital role in the nitrogen cycle, water quality monitoring and small-scale fishing (Mahapatra *et al*., 2017).

Some species also contribute to the commerce in aquariums and small-scale fisheries. The freshwater crabs are an important and cheap source of animal protein for people, particularly for tribal and underprivileged populations living in rural settingss (Yeo *et al*., 2008; Cumberlidge *et al*., 2009). Along with having some medical significance, several crab species are commercially viable as aquarium or aquaculture species (Cumberlidge *et al*., 2009). They prefer to find cover in concealed places and are typically active at night and live or dead animals are preferred by freshwater crabs as foods (Yeo *et al*., 2008). Recently, these animals made it clear that they place a high premium on conservation (Pati and Pradhan, 2020).

The crab *S. spinigera* (Wood-Mason, 1971) is a significant edible freshwater crab species under the family Gecarcinucidae. *S. spinigera* are globally found in the, India, Pakistan, Bangladesh and Myanmar *etc*. (Mahapatra *et al*., 2017). In India mainly found Bihar, Assam, Tripura, Uttar Pradesh, Uttarakhand, Rajasthan, Punjab, Orissa, Jharkhand, Assam and West Bengal. Freshwater crab systematics is severely neglected, particularly in the India and this is mostly because there had been few surveys conducted. The length-weight relationship is the most reliable method for estimating fish and crustacean populations (Sukumaran and Neelakantan, 1997; Cumberlidge *et al*., 2009). The relationship between length and weight provides taxonomic differences and significant events in life history of fishes and crustaceans (Jaiswar and Kulkarni, 2002). There has not been much study on the freshwater crab's carapace length-weight and width-weight relationships in India. This present study investigate the carapace length-weight relationship of the freshwater crab *S. spinigera*, aiming to inform conservation efforts and facilitate comparisons within and between populations of the same species. The study quantified the relationship between carapace length, weight, width and condition factor of *S. spinigera* from the Burhi Gandak river, North Bihar.

MATERIALS AND METHODS

Study area

The samples for the present study were collected from three selected sampling sites in the in the Burhi Gandak river of Bihar namely: Motihari, Muzaffarpur and Khagaria district (Fig 1).

The Burhi Gandak Basin is enclosed by the Himalayas to the North, the Ganges to the South, the Kosi Basin to the East and the Gandak Basin to the West. The Burhi Gandak river origin in the Chautarwa Chaur region near Bisambharpur in the West Champaran district of Bihar and flows through the East Champaran, Muzafarpur, Samastipur and Begusarai districts. It falls into the river Ganga near Khagaria district. Its coordinates are 25°51′40″N latitudes and 85°48′36″E longitudes and 300 mt elevations. The total length of Burhi Gandak river is 320 km and catchment area is 12500 sq km. In the present investigation, freshwater crabs were collected from different types of techniques, including hand-picking, digging, setting traps and taking them from their nest.

Data collection

The freshwater crab samples were collected from July 2020 and June 2021 from three selected sampling stations on the monthly basis. Crab body weight was taken using an electronic weighing balance (IGene Labserve Private Limited India) with an accuracy of 0.01 g and carapace length and width was measured by Vernier Calliper scale (India Tools and Instruments Co.) with an accuracy of 0.05 mm. The carapace length-weight and carapace width-weight relationship of *S. spinigera* were calculated from river Burhi Gandak, Bihar. A total of 663 specimens of *S. spinigera* were collected from selected three sampling stations of the river Burhi Gandak, Bihar.

Taxonimic identification

S. spinigera possess brownish yellow, orange, brown or dark brown carapace colour and orange to brown chillete colour. The carapace texture of the crab is very much oily. A large 'V'shaped patter with dark brown spot present on the carapace of the crab. The dorsal and ventral views of the male and female crab are shown in Fig 2.

Carapace length-weight and width-weight relationship of crab

The carapace length-weight and width-weight relationship data for the *S. spinigera* were estimated by using the power function of below formula:

$$W = aCW^b \text{ and } W = aCL^b$$

(Le Cren, 1951)

Where,
W= Weight in grams (g).
CL= Carapace length (mm).
CW= Carapace width.
A= intercept and b is the slope.

The log-transformed values of body weight, length and width of carapace were computed for linear regression analysis:

$$\text{Log } W = \text{Log } a + b \text{ Log } L$$

Fulton's condition factor and sex ratio

The Fulton's condition factor (Kn) were calculated by the formula:

$$K = \frac{100W}{L^3}$$

(Gayanilo *et al*., 1997)

Where,
K= Condition factor,
W = Mean weight of crab in g,

L = Mean carapace length of crab in mm.

The coefficient of determination (R^2) and slope value (b=3) is tested by student t-test (95%) at ($p<0.05$) level of significance. The sex ratio was determined by comparing the proportion of male and female samples. The significance of crab sex ratio was determined by Chi-square test (a=0.05).

RESULTS AND DISCUSSION

The carapace length of male were varied from 20 to 70 mm, total weight ranged from 3.0 to 25.97 g, while the carapace length of female varied from 25 to 76 mm and the weight ranged from 5.0 to 30.34 g. The carapace width of male varied from 24 to 77 mm and female ranged from 28 to 80 mm.

The sample size, carapace length, carapace width and body weight range, carapace length to weight and width to weight variable, a and b value of length–weight, width weight relationship frequency and 95% confidence intervals and the coefficient of determination value are give in Table 1.

Carapace length-weight and carapace width-weight relationship

The carapace length-weight of females were calculated as $W = 0.912^{2.521}$ ($R^2 = 0.875$) and the carapace length-weight of male were calculated as $W = 0.4310^{2.505}$ ($R^2 = 0.853$). While the carapace length-weight of combined sex (male and female) were calculated as $W = 0.661^{2.701}$ ($R^2 = 0.954$). The carapace length-weight of male, female and combined sex showed in Fig 3, 4 and 5. The carapace width-weight of female were calculated as $W = 0.554^{2.331}$ ($R^2 = 0.831$) (Fig 6) and male carapace width-weight were calculated as $W = 0.791^{2.421}$ ($R^2 = 0.802$) (Fig 7) respectively. While the carapace width-weight relationship of combined sex were calculated as $W = 0.1812^{2.601}$ ($R^2 = 0.900$) (Fig 8).

Fulton's condition factor and sex ratio

The condition factors of *S. spinigera* were estimated was 1.10. The variation in condition factors between the sexes was not significant for either equation ($p<0.05$). There is no significance difference, variation in the condition factor of between sexes. The sex ratio of Male: Female freshwater

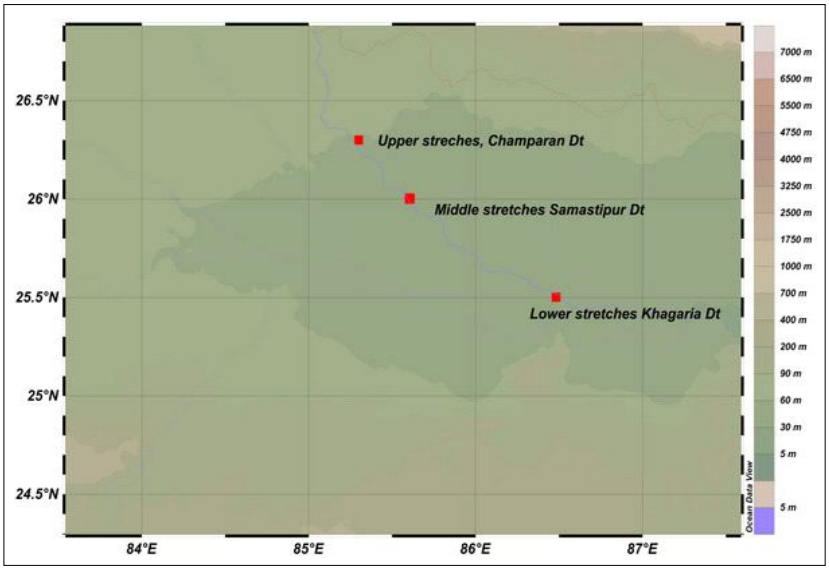

Fig 1: Showing the sampling sites location area.

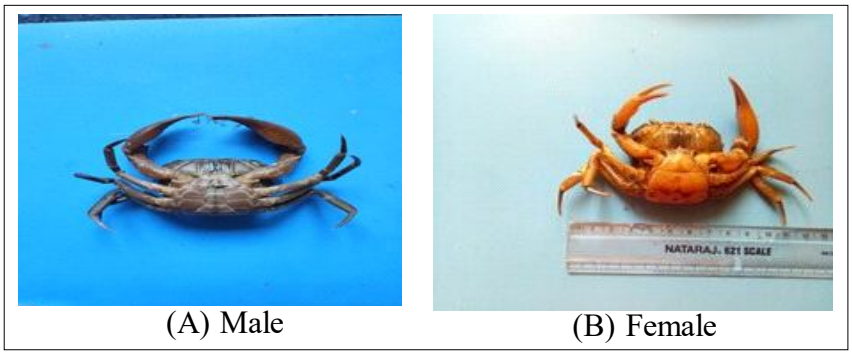

Fig 2: The dorsal and ventral views of the male and female crab.

Table 1: Length-weight, width-weight and height-weight relationships of *Sartoriana spinigera*.

Allometric relation	Sex	Sample size (N)	TL range (mm)		TW range (g)		Regression parameters				GCS (Global conservation status) IUCN/CITES
			Min	Max	Min	Max	R^2	95% CL a	b	95% CL b	
Sartoriana spinigera											LC
Length-weight	Male	300	20	70	3.0	25.97	0.853	1.776-1.960	2.505	1.588-1.888	
	Female	363	25	76	5.0	30.34	0.875	0.918-1.359	2.521	1.519-2.378	
	Pooled	663					0.954	1.115-1.314	2.701	1.628-1.976	
Width-weight	Male	300	24	77			0.832	0.101-1.374	2.421	1.401-1.613	
	Female	363	28	80			0.801	0.731-1.215	2.331	1.426-1.638	
	Pooled	663					0.900	1.210-1.380	2.601	1.430-1.831	

n= Sample size; TL= Total length; TW= Total weight; a= Intercept; b= Slope; CL= Confidence limits; R^2= Coefficient of determination; LC= Least concern.

crab was = 1: 1.49. The sex ratio and the percentage occurrence of male and female crabs indicated that there is a dominance of female crabs over male crabs in the study site.

In the present study, the 'b' value were estimated as =2.70 for combined sex populations of crabs. However, for the male the 'b' value were estimated at 2.50 and 2.52 for females. All of these value are show negative allometrically, however female are heavier than male. Okon and Sikoki (2014) recorded the b values of the length-weight

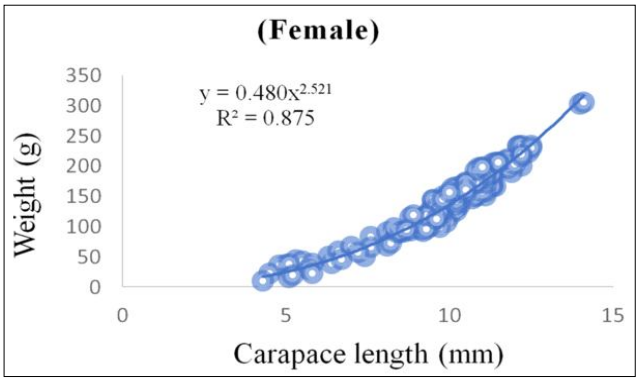

Fig 3: Carapace length-weight relationship of female *Sartoriana spinigera*.

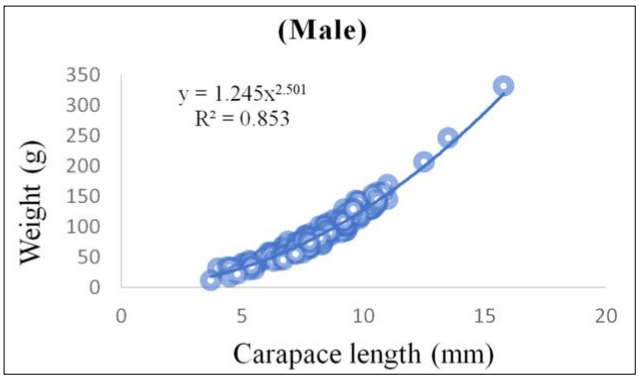

Fig 4: Carapace length-weight relationship of male *Sartoriana spinigera*.

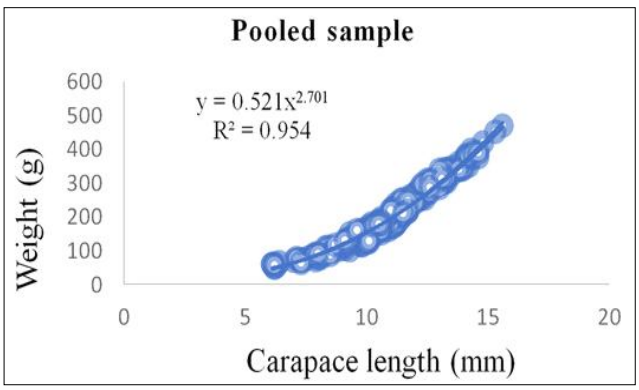

Fig 5: Carapace length-weight relationship of combine sexes (male+female) of *Sartoriana spinigera*.

relationships of West African Fiddler crab (*Ucatangeri*) to be 1.642 this is lower than the value observed in the current investigation. The current 'b' value of *S. spinigera in length-weight* (female 2.521, male 2.501, combined 2.701) and width-weight (female 2.331, male 2.401, combined 2.601), was lower those of *Barytelphusa gurini*, Kham River, Aurangabad (Patil and Patil, 2012). According to Afzaal *et al.* (2018), *Portunus pelagicus* collected from the Pakistan water

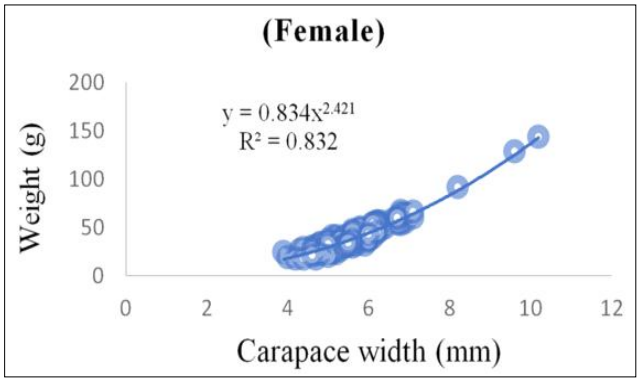

Fig 6: Carapace width-weight relationship of female *Sartoriana spinigera*.

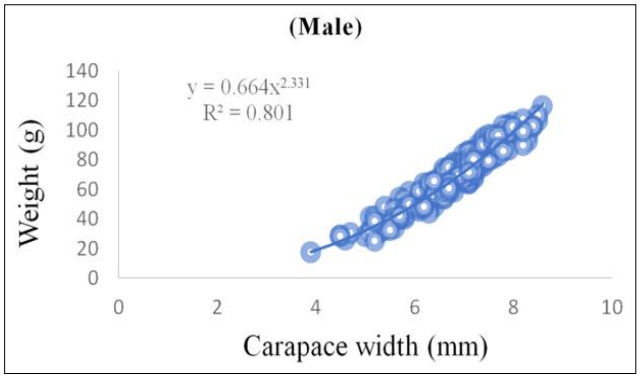

Fig 7: Carapace width-weight relationship of male *Sartoriana spinigera*.

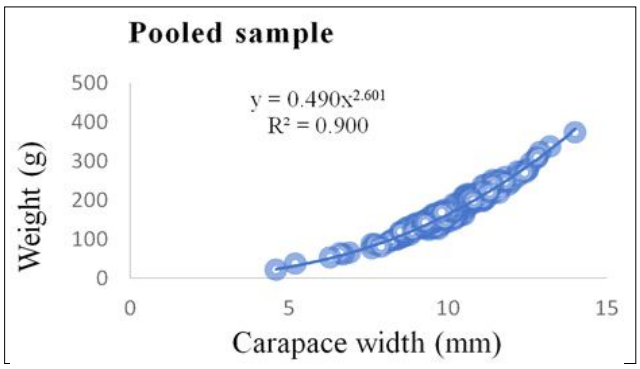

Fig 8: Carapace width-weight relationship of combine sexes (male+female) of *Sartoriana spinigera*.

in northern Arabian Sea had a negative allometric growth trend, which is consistent with the findings of our study.

The range of 'b' value ranges from 2.5 and 3.5 (Froese, 2006). If the measured b value is equal to 3, it indicates that both length and weight increase in isometric increments; however, if it is the 'b' values greater than 3 it is an that the fish or crustaceans are plumper with the length and if the 'b' values is less than 3, it indicates that species have slimmer bodies as length tends to increase (Atar and Seçer, 2003). Variation in the relative growth coefficient 'b' recorded for different regions shows interregional differences in the length-weight relationship (Jaiswar *et al*., 2004); and results in allometric growth (Dubey *et al*., 2014; Mehanna *et al*., 2013; Oluwatoyin *et al*., 2013). The ratio of carapace length to body weight has been commonly used to categorize species development and evaluate species decrease in a certain geographic area. Temperature, food quality and food quantity are the key environmental factors that can affect crustacean growth. The exponent (b) values in the present investigation remained below 3 and the estimated width/ length-weight equation was allometric.

There are various uses for the relationships between carapace width-weight as well as between carapace length-weight. The recovery of edible meat from crabs of different sizes is estimated using these indications of condition, which are also used to determine biomass (Cumberlidge, 2009). Since they enable the conversion of length data into weight data and vice versa, they also have a practical value. However, while studying crustaceans, the most commonly used measures are total length, width and body weight. The 'b' values for *Callinectes pallidus* ranged from 2.04 to 3.24 and these values shows the similarities with the present study (Oluwatoyin *et al*., 2013). Even though the change in 'b' values is primarily depends on the shape and fatness of species, other various other factors, such as temperature, food, season, sex and maturity stages, may also play a role in the variations in the length-weight/width-weight relationship parameters between seasons and years (Cumberlidge, 2009; Jose Josileen, 2011). The values of slope b may differ depending on the type of fishing methods, the time of the sampling, chemical and physical parameters conditions, the level of nutrient availability in the water body and other environmental factors that have an impact on the length-weight and width-weight relationship parameter of the crabs (Atar and Sector, 2003; Cumberlidge, 2009).

Condition factor (K) is one of the most important biological parameters that show if a specific body of water is suitable for the growth of fish (LeCren, 1951). The condition factor's variation provides information about the physiological status of crab. The condition factor showed (1.10) that the crabs in Bihar region were in good physiological condition, as seen by their healthy growth and favorable length-weight relationship. The condition factor (K) revealed variation in the relationship between carapace length-weight and carapace width-weight, which may be impacted by

seasonally changes of the gonad, intensity of feeding, habitat and environmental factors Dubey *et al*. (2014). The current sex ratio was 1:1.49. The sex ratio and percentage occurrence of male and female crabs revealed that there were the female crabs is more than the males crabs in the population.

CONCLUSION

The results of this study will be beneficial for the preservation and prudent use of *S. spinigera* because it provides insight into the length-weight relationship and the condition factor of during a particular period of time. It can serve as an outline for future research by fisheries biologists. Also, present study offers estimates of the carapace length, weight and width based on body weight that crab fishery biologists may find valuable. The current study suggests that crab fishery managers implement certain management measures that avoid the catch of small size crab at landing sites. The length-weight relationship with age determination study may also be recommended for future study from North Bihar, India. This present study provides a baseline data for future crab fishery management in the Burhi Gandak river, Bihar.

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Conflict of Interest

The authors have declared no conflict of interest.

Ethical statement

No live specimens here used in the present study.

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Author contributions

Sanjay Chandravanshi: Sample collection, species identification and preparing the first version of manuscript. H.S. Mogalekar: Critical reviewing of the research work and reviewing drafts of the manuscript for final approval.Data analysis and curation: Adyasha Sahu, Narsingh Kashyap, Domendra Dhurve, Swapnil Narsale, Rishikesh Kadam and Sourabh Debbarma.

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