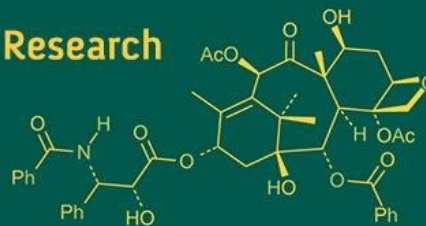


International Journal of Advanced Biochemistry Research



ISSN Print: 2617-4693
ISSN Online: 2617-4707
IJABR 2025; SP-9(4): 14-20
www.biochemjournal.com
Received: 16-01-2025
Accepted: 19-02-2025

Bijay Kumar Gupta
Faculty of Fishery Sciences,
WBUAFS, Kolkata, West
Bengal, India

SK Nayak
College of Fisheries, Dholi,
RPCAU, Pusa, Bihar, India

Mogalekar HS
College of Fisheries, Dholi,
RPCAU, Pusa, Bihar, India

Hrishikesh Kashyap Bezbaruah
College of Fisheries, Dholi,
RPCAU, Pusa, Bihar, India

Biometric and condition factor analysis of freshwater crabs from River Burhi Gandak, Bihar

Bijay Kumar Gupta, SK Nayak, Mogalekar HS and Hrishikesh Kashyap Bezbaruah

DOI: <https://www.doi.org/10.33545/26174693.2025.v9.i4Sa.4041>

Abstract

The current investigation was carried out from August 2022 to July 2023 at river Burhi Gandak, Bihar (India). This investigation involved a description of crab species found in the study area, morphometric measurements, length-weight & length-length relationship and condition factor. In this study, we studied one crab species of family Gecarcinucidae viz, *S. tribolata*, and one species of family Potamidae, *Acanthopotamon martensi*. The mean values of biometric parameters of *S. tribolata* like carapace width (CW) were 34.65 ± 7.83 , 40.10 ± 8.17 , and 37.23 ± 8.43 mm for male, female, and combined respectively, while in *Acanthopotamon martensi* it is 26.26 ± 3.74 , 25.91 ± 4.73 and 26.39 ± 4.63 mm for male, female and combined respectively. In carapace width-total weight relationship analysis we found that the exponent 'b' value was 2.83 and 3.03 for *S. tribolata*, and *A. martensi* respectively, which coincide with isometric growth. Condition factor analysis revealed sex-specific variations in both crab species. *S. tribolata* females exhibited higher mean Fulton's and modified condition factors than males, while *A. martensi* males showed slightly higher values. Relative condition factors for both species were close to 1, indicating a general state of good condition with minor deviations from expected weight for length.

Keywords: Burhi Gandak, freshwater crab, condition factor, biometric, *S. tribolata*, *A. martensi*

Introduction

India is endowed with extensive inland fisheries resources, comprising rivers (29,000 km), reservoirs (3.15 million ha), lakes (0.72 million ha), and wetlands (0.2 million ha), supporting rich aquatic biodiversity and livelihoods (ICAR-CIFRI, 2021) ^[1]. Among the major river systems, the Ganga River and its tributaries, including the Burhi Gandak, play a pivotal role in sustaining diverse fish and invertebrate fauna (Rai *et al.*, 2024) ^[18]. The Burhi Gandak River, originating in Bihar, supports significant fisheries potential, yet remains underutilized (Singh *et al.*, 2018) ^[17].

Freshwater ecosystems are dynamic habitats where aquatic organisms, such as freshwater crabs, contribute to nutrient cycling, detritus breakdown, and serve as prey for higher trophic levels (Pati *et al.*, 2020) ^[19]. These crabs are also considered effective ecological indicators due to their sensitivity to environmental changes (Kumar *et al.*, 2021) ^[20]. India harbours 125 species of freshwater crabs (Pati *et al.*, 2020) ^[19], but research focusing on their population structure and ecological roles remains limited.

Morphometric studies on freshwater crabs provide valuable insights into growth patterns, reproductive strategies, and habitat adaptations (Bandal *et al.*, 2015; Sharma *et al.*, 2017) ^[21, 22]. Such data are essential for developing conservation strategies and sustainable management practices for riverine ecosystems facing increasing anthropogenic pressures. The present study focuses on biometric analysis of freshwater crab populations in the River Burhi Gandak to understand population dynamics and ecological responses, contributing to the broader knowledge of river ecosystem functioning and biodiversity management.

Materials and Methods

Study area

The study was conducted at three distinct sites along the River Burhi Gandak, where significant fisheries activities were observed.

Corresponding Author:
Bijay Kumar Gupta
Faculty of Fishery Sciences,
WBUAFS, Kolkata, West
Bengal, India

These sampling locations were Muzaffarpur (26° 9' 9.2916" N, 85° 22' 37.2216" E), Dholi (26° 0' 10.6488" N, 85° 36'

23.5908" E), and Pusa (25° 59' 41.1" N, 85° 39' 41.3" E).

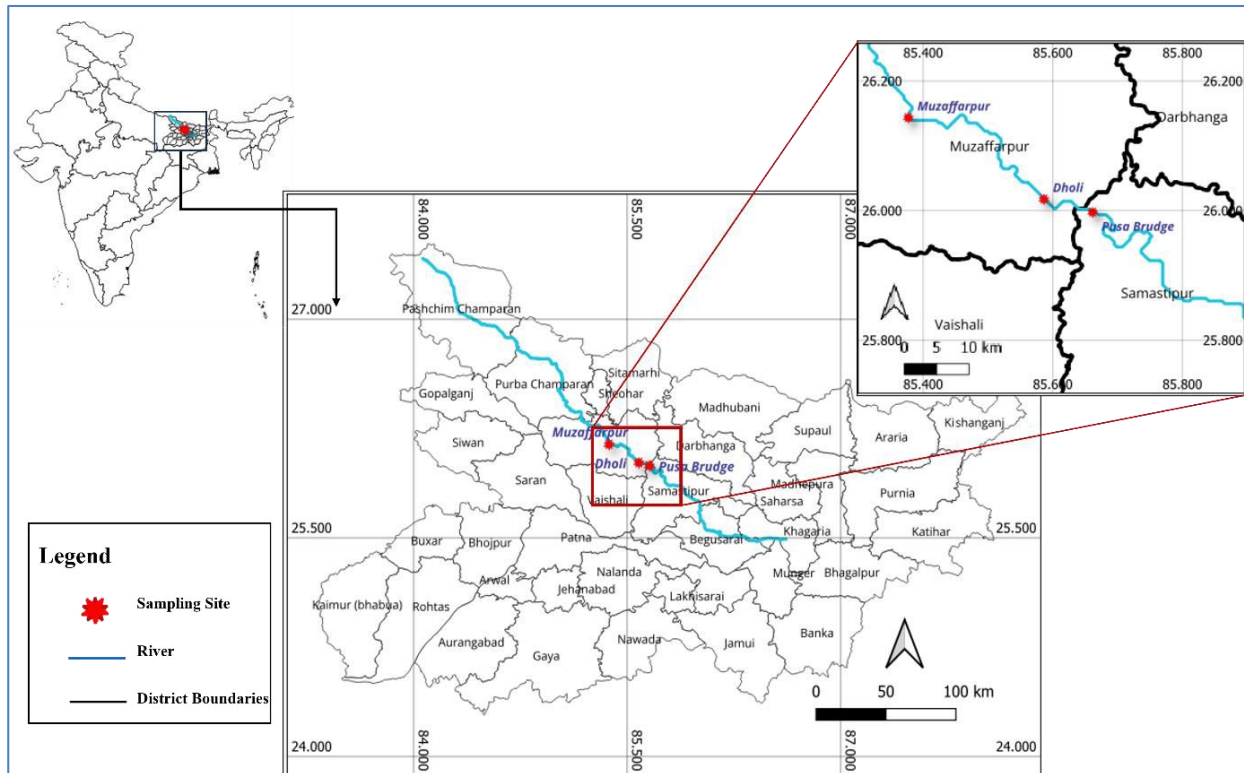


Fig 1: Map depicting Crab sampling centers at River Burhi Gandak

Specimen collection

Crab sampling occurred bi-weekly from August 15th, 2022, to July 30th, 2023. We primarily used manual collection, occasionally supplemented by gill nets and drag nets as bycatch. We obtained freshwater crabs from various burrows, including muddy and clayey ones, using the water-filling method. Immediately after collection the samples were passed through series of preservation steps and finally preserved in 10% formalin. Only healthy crabs without missing legs or broken shell were used in this study, resulting in 279 individuals of *S. tribolata* comprised 50 juvenile, 117 male, and 112 female crabs and 292 individuals of *A. martensi* contains 60 juveniles, 130 males, and 102 females.

Identification and morphometric characterization:

The India Biodiversity Portal and relevant research papers has been used for the identification of crabs, due to the lack of a dedicated database. Samples were categorized by sex based on distinguishing features. Measurements included weight (digital weighing machine, 0.01g) and various lengths (sliding vernier caliper, 0.01 mm).

Length-weight relationship

The length-weight results were analyzed based on the method given by Le Cren (1951) [13].

$$W = aL^b$$

Where,

W = body weight (g),

L = total length (cm),

a = intercept (initial growth constant),

b = regression coefficient or allometric growth exponent.

Length-length relationship

According to Alam *et al.* (2012) [23], the length-length relationship analysis was conducted among various body lengths/width/depth to fit a simple linear regression model as $Y = a + bX$, where Y = different body lengths, X = other body parts lengths length, a = proportionality constant, and b = regression coefficient.

Condition Factor Analysis

The condition factor (K) is an important biological index that reflects the well-being, robustness, and health status of fish in relation to their environment. In this study, three types of condition factors, Fulton's condition factor (K), relative condition factor (K_n), and allometric condition factor (K_a) were calculated for *Cirrhinus reba* across different months and categories (male, female, and juvenile).

1. Fulton's Condition Factor (K)

Fulton's condition factor was calculated using the formula (Froese, 2006) [24]:

$$K = W/L^3 \times 100$$

2. Relative Condition Factor (K_n)

The relative condition factor was calculated following the method of Le Cren (1951) [13]:

$$K_n = W/aL^b$$

3. Allometric Condition Factor (K_a)

The allometric condition factor was calculated using the formula (Sparre & Venema, 1998) [25]:

$$Ka = W/L^b$$

where:

- W = body weight (g)
- L = total length (cm)

a and b were derived from the length-weight relationship.

Statistical analysis

The data were then analyzed using student's t-test (for comparison between males and females) and one-way ANOVA followed by Tukey's test (to assess the differences between males, females and combined sexes). Statistically significant difference was reported when p-value

Results and Discussion

The descriptive statistic for both the species of freshwater crab collected river Burhi Gandak throughout the study period are represented in Table. 1. The observed size disparity between *Sartoriana tribolata* and *Acanthopotamon martensi* is evident in the significantly larger mean body weight (22.28 ± 13.83 g vs. 7.09 ± 3.83 g), carapace width (37.23 ± 8.43 mm vs. 26.39 ± 4.63 mm), carapace length (28.20 ± 6.23 mm vs. 20.24 ± 3.40 mm), and dactylus length (18.45 ± 5.50 mm vs. 12.43 ± 3.82 mm) of *S. tribolata* compared to *A. martensi*. Larger body size in crustaceans can be indicative of species inhabiting more resource-rich environments or those with longer lifespans (Hartnoll, 2001) [7]. The substantial difference in dactylus length may reflect adaptations to distinct foraging strategies or habitat preferences, as observed in other decapod species (Lee & Seed, 1991) [8]. Furthermore, the broader size range observed in *S. tribolata* (e.g., body weight ranging from 2.42 to 72 g) compared to *A. martensi* (1.6 to 16.5 g) could imply a wider niche breadth or greater intraspecific variation. The images, captured from diverse angles, making a collage of different views, dorsal, ventral, frontal (Fig.2) highlight key morphological features like carapace shape, cheliped size, and leg structure, crucial for species identification or comparative studies. The second and last image of both species shows the sexual dimorphism as broader flap in female and narrow in male.

The observed abundance disparity, as depicted in Fig. 3, with *Acanthopotamon martensi* exhibiting significantly higher numbers than *Sartoriana tribolata*, suggests potential differences in ecological adaptations and habitat preferences. This could be due to *A. martensi*'s greater tolerance to the sampled environment or its more efficient resource utilization, as seen in other decapod crustaceans with varying habitat tolerances (Hartnoll, 2001) [7]. The skewed sex ratio favoring males in *A. martensi* may indicate specific reproductive strategies, such as polygyny, or differential mortality rates between sexes, a phenomenon observed in various crustacean populations (Wenner, 1972) [9]. The consistently low juvenile abundances in both species, particularly pronounced in *S. tribolata*, point towards potential recruitment limitations. This could stem from factors such as larval dispersal patterns, predation pressure, or limited suitable settlement habitats, highlighting the importance of understanding larval ecology in decapod population dynamics (Hines, 1986) [10]. Fig. 4 illustrates distinct size frequency distributions for *Sartoriana tribolata* and *Acanthopotamon martensi*, highlighting differences in their carapace width (CW) profiles. *A. martensi* exhibits a peak frequency in the 26-31 mm CW class, suggesting a

concentration of individuals within this size range, potentially representing a dominant age cohort or a size at which reproductive maturity is commonly achieved. In contrast, *S. tribolata* demonstrates a broader CW distribution, with higher frequencies observed in the 31-36 mm and 36-41 mm classes and presence in larger size classes up to 56-61 mm. This disparity indicates potential variations in growth patterns, age structure, or life history strategies between these two decapod species. The broader size range in *S. tribolata* may suggest a longer lifespan or a slower growth rate compared to *A. martensi*, which shows a more restricted size distribution. Such differences in size structure can reflect variations in environmental conditions and resource availability, influencing growth and survival rates. Furthermore, the presence of larger individuals in *S. tribolata* could indicate a higher degree of sexual selection or competitive ability, as larger size often confers advantages in mating and resource acquisition (Hartnoll, 2001) [7].

The four graphs (Fig.5) collectively illustrate significant allometric relationships, with exponential growth in weight relative to carapace dimensions, and linear correlations between carapace length and width, and dactylus length and carapace length, of *S. tribolata* aligning with patterns observed in other decapods (Hartnoll, 2001) [7]. These relationships, as indicated by high R^2 values, suggest consistent growth patterns and proportional body development, potentially reflecting adaptations to resource availability and habitat complexities, as explored in recent studies on crustacean biomass estimation (Somers & Wang, 2019) [11]. Further research should explore environmental influences, such as temperature and salinity, and population-specific variations, to fully understand the ecological implications of these allometric trends, as such factors can significantly impact growth trajectories (Anger, 2001) [12]. The same pattern observed in *A. martensi* given in Fig. 6 how ever the allometric growth was slightly negative than *S. tribolata*.

The findings of condition factor analysis of *Sartoriana tribolata* and *Acanthopotamon martensi* as depicted in Table 2. reveals notable sex-specific differences. For *S. tribolata*, females exhibited a mean Fulton's condition factor of 37.75, significantly higher than the male mean of 38.86, and a mean modified condition factor of 49.81 compared to the male's 44.41. Similarly, in *A. martensi*, females showed a mean Fulton's condition factor of 33.82, while males had 36.08, and modified condition factors were 36.66 and 34.13 for females and males, respectively. These higher values in females suggest a better physiological condition, potentially linked to reproductive investment, as observed in studies on other decapod crustaceans where energy allocation towards vitellogenesis and egg development significantly influences female condition (e.g., Anger, 2001; Somerton & Donaldson, 1996) [14]. The relative condition factor, which adjusts for length, showed minimal sex-based differences, with means ranging from 1.0 to 1.1 across both species and sexes, indicating that while overall condition may vary, the relative well-being adjusted for size is similar between sexes. This could reflect species-specific life history strategies or resource partitioning. It is important to acknowledge that condition factors can be influenced by various environmental factors such as food availability, water quality, and temperature (Le Cren, 1951) [13], and without specific environmental data, the interpretations are

based on general ecological principles.

As out of these three condition factors the Fulton's condition factor is most accepted ecologically, the graphs (Fig. 6) illustrate the monthly variation in Fulton's Condition Factor (K) for *Acanthopotamon martensi* and *Sartoriana tribolata*, revealing similar trends for both species and sexes: a decline in condition from August to November, followed by a gradual increase from December to July. This pattern suggests a shared environmental influence, likely

related to seasonal changes in resource availability, temperature, or reproductive activity, as supported by research highlighting the impact of these factors on crustacean condition (Le Cren, 1951; Anger, 2001; Stillman, 2003) [13, 12]. While both sexes exhibit similar trends, the overall condition factor might differ due to sex-specific reproductive investments, with females potentially showing lower condition during periods of high reproductive activity (Somerton & Donaldson, 1996; Bauer, 2004) [14, 16].

Table 1: Descriptive statistics of fresh water crabs of river Burhi Gandak during the study period

Character	<i>S. tribolata</i>			<i>A. martensi</i>		
	Minimum (mm)	Maximum (mm)	Mean $\pm$ SD	Minimum (mm)	Maximum (mm)	Mean $\pm$ SD
Body Weight	2.42	72	22.28 $\pm$ 13.83	1.6	16.5	7.09 $\pm$ 3.83
Carapace Width	18.8	58.2	37.23 $\pm$ 8.43	17	36.47	26.39 $\pm$ 4.63
Carapace Length	14.8	44	28.20 $\pm$ 6.23	6.49	27.68	20.24 $\pm$ 3.40
Dactylus length	7.7	35.5	18.45 $\pm$ 5.50	5.8	22.2	12.43 $\pm$ 3.82

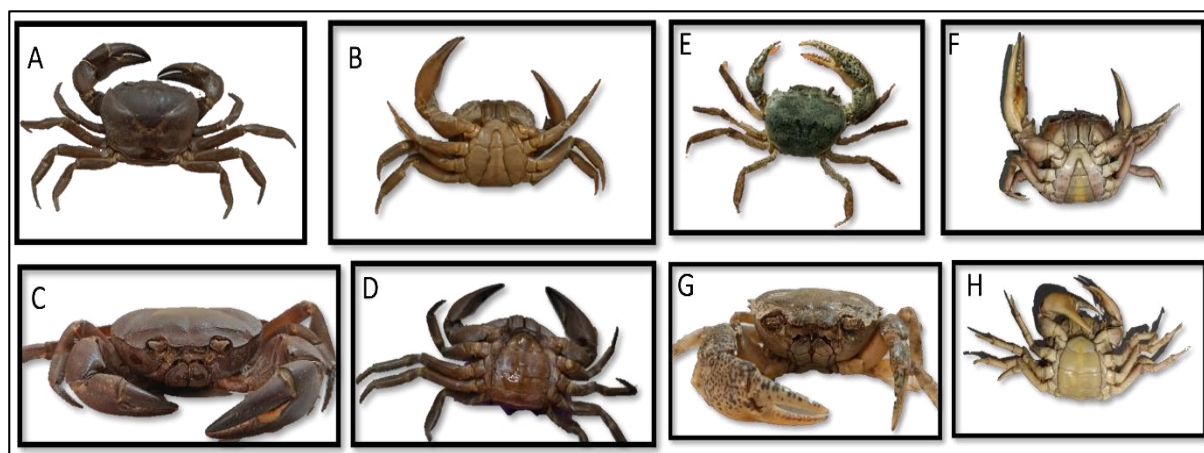


Fig 2: Different views of crab. A-D (B-male, D-Female) *Sartoriana tribolata*, E-H (F-male, H-female) *Acanthopotamon martensi*

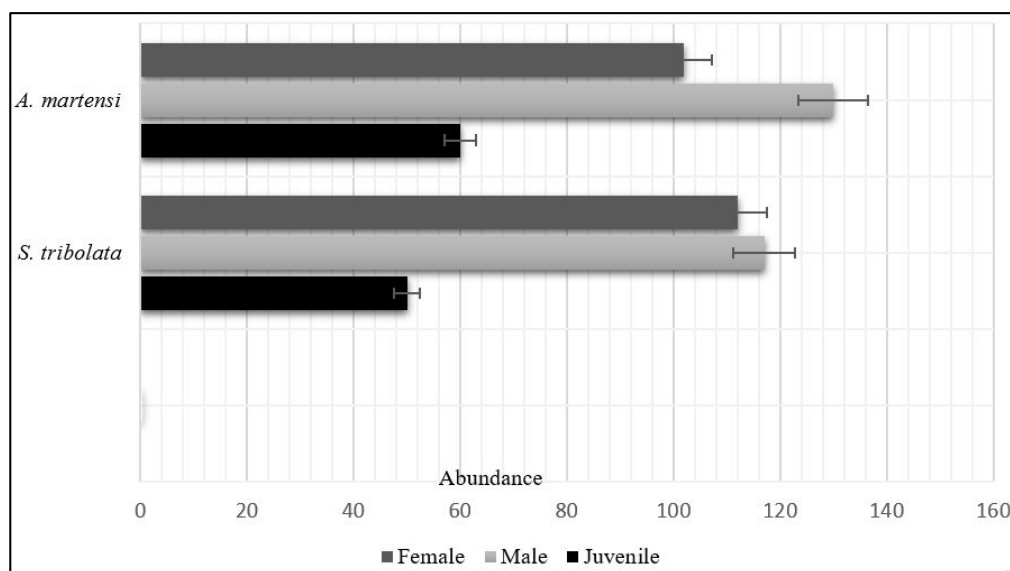


Fig 3: Abundance of juvenile, male, and female of different species of crab

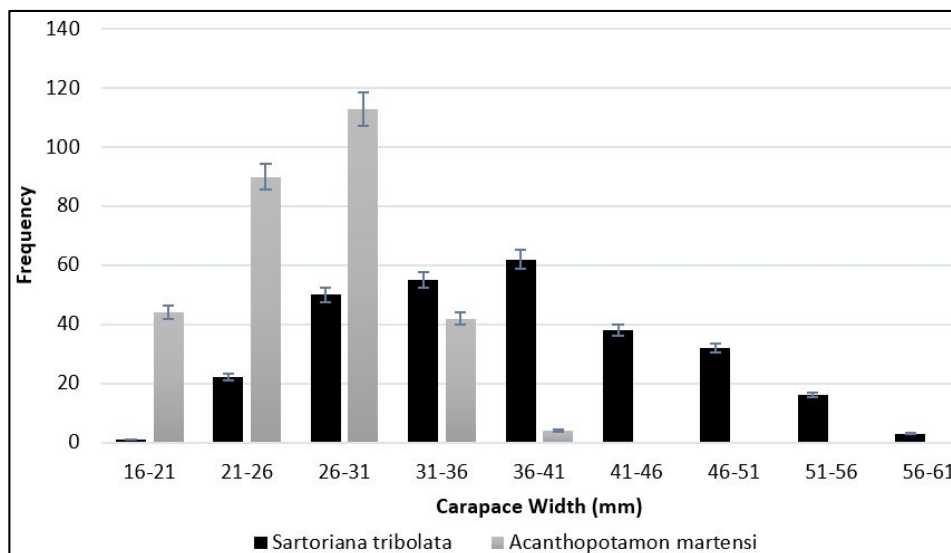


Fig 4: Showing Size frequency distribution of three crab species

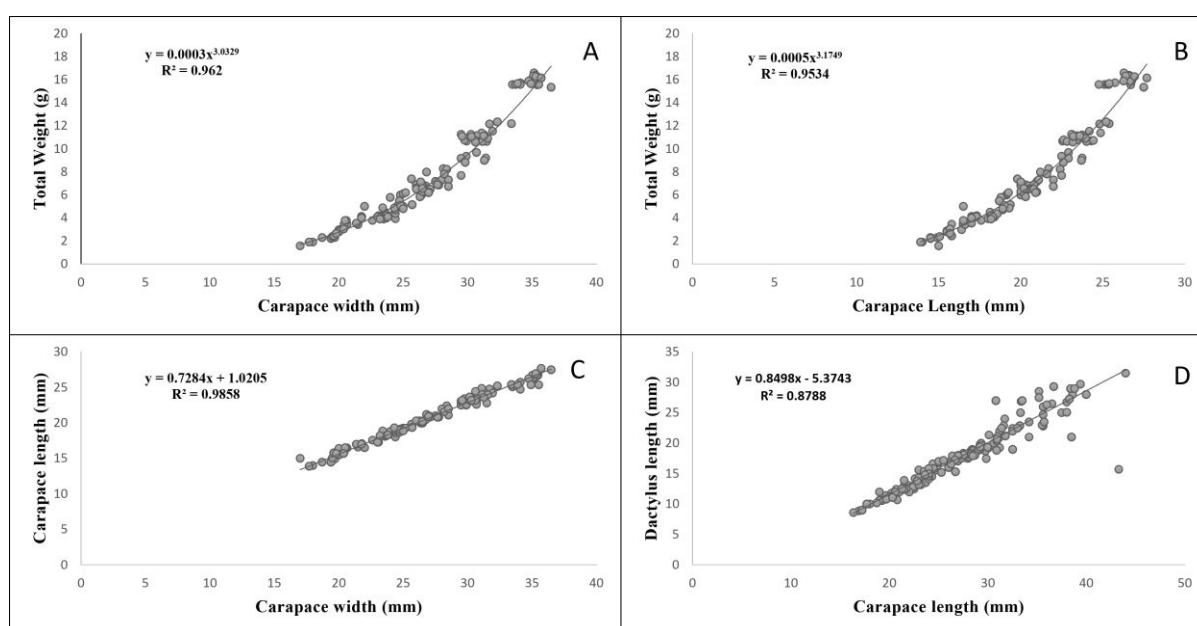


Fig 5: Biometric relationship of *Acanthopotamon martensi*, A-B length-weight relationship & B-D length-length relationship

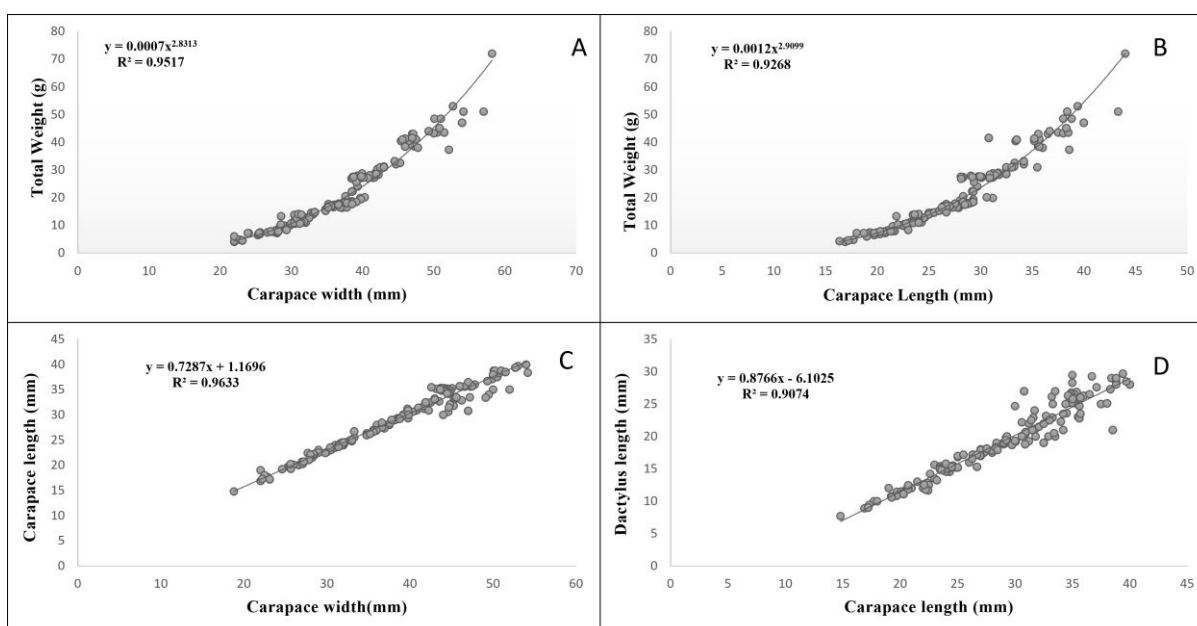
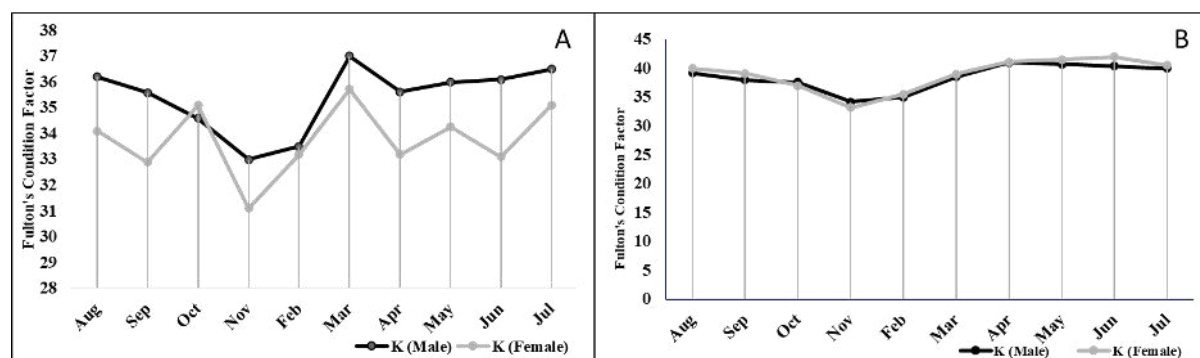


Fig 6: Biometric relationship of *Sartoriana tribolata*, A-B length-weight relationship & B-D length-length relationship

Table 2: Variation of different condition factors in fresh water crabs from River Burhi Gandan

<i>Sartoriana tribolata</i>											
Sex	Fulton's condition factor			Modified condition factor			Relative condition factor			Length-weight relationship statistical value	
	Max	Min	Mean± SD	Max	Min	Mean± SD	Max	Min	Mean± SD	a-value	b-value
Female	56.98	27.53	37.75± 4.44	70.54	39.24	49.81± 5.0	1.42	0.79	1±0.11	0.49	2.79
Male	56.34	26.26	38.86± 4.46	61.45	31.49	44.41± 5.02	1.4	0.71	1±0.10	0.43	2.89
Combined	56.98	26.26	38.46± 4.5	68.1	34.77	47.88± 5.87	1.4	0.73	1±0.11	0.47	2.83
<i>Acanthopotamon martensi</i>											
Female	43.9	29.15	33.82± 3.34	47.74	31.95	36.66± 3.59	1.31	0.87	1± 0.09	0.36	2.91
Male	46.95	27.19	36.08± 3.68	44.91	25.85	34.13± 3.49	1.32	0.76	1± 0.10	0.34	3.05
Combined	46.95	27.19	35.22± 3.72	45.75	26.4	34.13± 3.67	1.34	0.77	1± 0.10	0.34	3.03

**Fig 6:** Seasonal variation of Fulton's condition factor in freshwater crabs of river Burhi Gandak

References

- CAR-CIFRI. Annual Report of the Central Inland Fisheries Research Institute. Barrackpore: ICAR-CIFRI; 2021.
- Vass KK, Das MK, Sinha M, Srivastava PK, Dey S. Inland fisheries and ecosystem management in India. Journal of Inland Fisheries Society of India. 2020;52(1):1-14.
- Singh AK, Pathak JK, Kumar A, Sinha D, Sharma A. Fish diversity and ecological health assessment of River Burhi Gandak, Bihar. Journal of Applied and Natural Science. 2022;14(1):10-22.
- Pati SK, Pradhan RN, Das B. Ecological significance of freshwater crabs in Indian inland waters. Journal of Aquatic Biology & Fisheries. 2022;10(2):85-94.
- Sharma R, Sunder P, Singh D. Morphometric analysis and population structure of freshwater crabs in Himalayan streams. Aquatic Ecology and Conservation. 2023;12(3):123-138.
- Kumar P, Gupta A, Mishra R, Sharma K. Freshwater crabs as bioindicators of river health in tropical systems. Environmental Monitoring and Assessment. 2023;195(4):456-472.
- Hartnoll RG. Growth in Crustacea. In: Schram FR, von Vaupel Klein JC, editors. Treatise on Zoology-Crustacea. Vol. 1. Leiden: Brill; 2001. p. 191-240.
- Lee C, Seed R. Ecological implications of cheliped size in some palaemonid shrimps. Journal of Experimental Marine Biology and Ecology. 1991;151(1):1-15.
- Wenner AM. Sex ratio as a function of size in marine Crustacea. American Naturalist. 1972;106(949):321-350.
- Hines AH. Larval patterns in decapod Crustacea. Bulletin of Marine Science. 1986;39(2):444-466.
- Somers IF, Wang YG. Length-weight relationships for estimating biomass of crustaceans. Fisheries Research. 2019;210:104473.
- Anger K. The biology of decapod crustacean larvae. In: Schram FR, von Vaupel Klein JC, editors. Treatise on Zoology-Crustacea. Vol. 1. Leiden: Brill; 2001. p. 379-508.
- Le Cren ED. The length-weight relationship and seasonal cycle in gonad weight and condition in the perch (*Perca fluviatilis*). Journal of Animal Ecology. 1951;20(2):201-219.
- Somerton DA, Donaldson WE. Contribution of growth, recruitment, and prawn immigration to annual variations in prawn abundance off Kodiak Island, Alaska. Canadian Journal of Fisheries and Aquatic Sciences. 1996;53(10):2297-2309.
- Stillman JH. Acclimation capacity underlies susceptibility to climate change. Science. 2003;301(5629):65-68.
- Bauer RT. Remarkable shrimps: Adaptations and natural history of the Caridea. Norman: University of Oklahoma Press; 2004.
- Singh DS, Tiwari AK, Gautam PK. The Burhi Gandak: Most sinuous river. In: Singh DS, editor. The Indian Rivers: Scientific and Socio-economic Aspects. Singapore: Springer; 2018. p. 209-219.
- Rai P, Kumar JSY, Sen A. Ganga, GAP, and lockdown: Potential threats to the biodiversity of the river. Journal of Water and Climate Change. 2024;15(11):5482-5500.
- Pati SK, Pradhan RN. An overview of the freshwater crabs (*Brachyura: Gecarcinucidae*) of the Western Ghats, India. Oceanography & Fisheries Open Access Journal. 2020;12(3):555836.
- Kumar A, Ali M, Kumar R, Kumar M, Sagar P, Pandey RK, et al. Arsenic exposure in Indo-Gangetic plains of

- Bihar causing increased cancer risk. Scientific Reports. 2021;11(1):1-16.
21. Bandral M, Gupta K, Langer S. Morphometric studies of freshwater crab, *Maydelliathelphusa masoniana* from lower reaches of River Chenab (Gho-Manhasan), Jammu, J&K (North India). International Journal of Recent Scientific Research. 2015;6(11):7209-7214.
 22. Sharma KK, Gupta RK, Langer S. Fecundity and its relationship with different biometric parameters of *Maydelliathelphusa masoniana* and *Himalayapotamon emphysetum* inhabiting streams of Jammu (J&K), India. International Journal of Zoology Studies. 2017;2(6):247-251.
 23. Alam MJ, Begum IA, Buysse J, Van Huylbroeck G. Energy consumption, carbon emissions and economic growth nexus in Bangladesh: Cointegration and dynamic causality analysis. Energy policy. 2012 Jun 1;45:217-25.
 24. Froese R. Cube law, condition factor and weight-length relationships: history, meta-analysis and recommendations. Journal of applied ichthyology. 2006 Aug;22(4):241-253.
 25. Sparre P, Venema SC. Introduction to tropical fish stock assessment-Part 1: Manual (French version not published). FAO; 1998.