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Original Article

Morphometric Study of Horseshoe Crab (*Carcinoscorpius rotundicauda*) in Odisha

Saswati Panda[1], Pradeep K Naik[2]

[1]Student, Department of Life Sciences, Sambalpur University, Sambalpur, Odisha, India, [2]Professor, Department of Life Sciences, Sambalpur University, Sambalpur, Odisha, India

Abstract

Introduction: Morphometric analysis is commonly performed on organisms and is useful in analyzing their fossil record, impact of mutations on shape, developmental change in form, covariance between ecological factors and shape, as well for estimating quantitative-genetic parameters of shape.

Materials and Methods: A total number of 61 specimens (30 males and 31 females) of *Carcinoscorpius rotundicauda* were examined for various morphological characteristics.

Results: Opisthosomal length versus total length relationship was linear, with a high degree of correlation for male (r = 0.79) and for female (r = 0.77), indicating that the opisthosomal length increases proportionately with the gradual increase of total length. Carapace length (CL) versus total length relationship was linear, with a high degree of correlation for male (r = 0.78) and for female (r = 0.76), indicating that the CL increases proportionately with the gradual increase of total length. Telson length (TEL) versus total length relationship highlighted a proportionate increase in TEL to the total length. The relationship between prosomal length and total body length was linear, with a very high degree of correlation for male (r = 0.71) and for female (r = 0.74), indicating that the increase in carapace width (CW) to CL was proportionate. TEL versus total length relationship indicated a linear relationship and found proportionately increasing, thus suggesting uniform growth pattern of body dimensions with the advancement of growth. The increase in the soft body parts could probably be due to increased feeding efficiency and food availability to horseshoe crabs. CW and CL relationship also showed a proportionate increment in these parameters.

Conclusion: The changes in body dimensions of the *C. rotundicauda* population indicate that the relationship could indirectly be influenced by population density, feeding efficiency, food availability, and local environmental conditions. It is also important to study the modification of body parts which helps adjust in the changing environment for this morphometric evaluation is needed.

Keywords: *Carcinoscorpius rotundicauda*, Morphometric variation, Opisthosomal length, Prosomal length, Telson length, Total body length

INTRODUCTION

The term morphometrics comes from two Greek words, i.e., "morphe" meaning shape and "metria" meaning measurement. Hence, morphometry refers to the quantitative analysis of form, which is concerned with shape and size.[1-4] Morphometric analysis is commonly performed on organisms and is useful in analyzing their fossil record, impact of mutations on shape, developmental change in form, covariance between ecological factors and shape, as well for estimating quantitative-genetic parameters of shape. Morphometry can be used to quantify a trait of evolutionary significance, detect the changes in shape, and deduce something of their developmental history, function, or evolutionary relationships. A major objective of morphometrics is to statistically test hypothesis about the factors that affect shape. Morphometric analysis is widely used in ecology and evolutionary biology to study plasticity and evolutionary changes in shape and in developmental biology to study the development of shape (Zelditch and Swiderski, 2012). In horseshoe crab, the morphometric analysis is generally done by taking the ratio among their prosomal length with prosomal width (PW), opisthosomal

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Corresponding Author: Sawati Panda, Department of Life Sciences, Sambalpur University, Sambalpur - 768 019, Odisha, India. Phone: +91-9937647365. E-mail: saswati.panda1991@gmail.com

length with opisthosomal width, tail length with tail width, distance between the two eyes with prosomal length, etc. This comparison gives idea about their evolutionary history, i.e., how different parts of their body become developed and the entire relationship between them. This also helps study the pattern of organogenesis and how the genetic factor and environmental factor affect the morphology of horseshoe crab.[5-10]

MATERIALS AND METHODS

Specimen of the horseshoe crab *Carcinoscorpius rotundicauda* (*Arthropoda: Merostomata*) was collected from Bhitarkanika National Park, Odisha (latitude 20.714820′N, longitude 86.8659′E), in June 2016. A total number of 61 specimens (30 males and 31 females) were examined for various morphological characters for the study. The different morphometric parameters were measured and noted down. Specimens were measured with the help of a Vernier caliper to 0.1 mm accuracy, for length of prosoma (a), length of opisthosoma (b), length of Telson (TEL) (c), and PW (d). The allometric and morphometric analysis was followed as described by Chatterji *et al*., 1988. Collected horseshoe crabs were measured to the nearest 0.1 cm using the Vernier caliper for their PW, the widest part of the prosoma; carapace length (CL), the length from the tip of prosoma to the anus; TEL, the length from the tip of prosoma to the end of Telson and intraocular distance, the distance between two compound eyes, etc (Figure 1).

A total of 16 parameters were taken for morphometric analysis, which include prosomal length, PW, PW from right transverse auricular groove (TAG) to left TAG, opisthosomal length, length of TAG to anus, width of anal region, tail length, tail width at tip, tail width near anus, length of prosoma through lateral compound eye, length of hinge, length of TAG, distance between right side of TAG to anal spine, width of opisthosoma, length of opisthosoma, total length of body, distance between lateral eye. Moreover, different ratios were taken such as between prosomal length and PW, opisthosomal length and opisthosomal width, tail width at anal region and tail width at tip, PW and distance between lateral eye, length of opisthosoma and width of right TAG to left TAG, length of opisthosoma and width of anal region, prosomal length and total length of the body, length of opisthosoma and total length of the body, and tail length and total length of the body. These ratios were taken to know the changes in shape according to the environment.

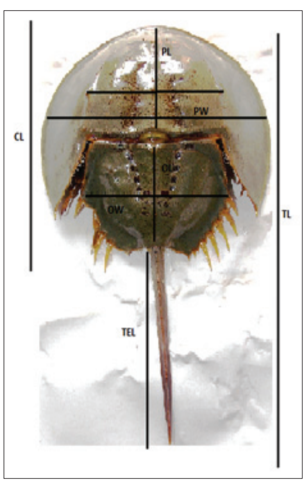

Figure 1: Morphometric parameters of horseshoe crab where, PW: Prosomal width, CL: Carapace length, TEL: Telson length, TL: Total length, IO: Intraocular distance (distance between median eye)

Data obtained for all measurements were pooled according to the species and sex of specimens. The mean and standard deviation of various morphometric parameters were calculated and categorized with respect to sex of specimens. Further, the statistical significance of differences in morphometric parameters between different sexes of the specimen was investigated by ANOVA analysis using Minitab software. The relationship between different morphometric parameters was determined using linear regression analysis using Minitab software.

RESULT AND DISCUSSION

Morphometric relationship provides an important information about comparative growth of various body parts. A proper understanding of allometry (study of relationship between differences in one body parameters to the other) of carapace and other body parts of horseshoe crab is essential to know the growth of a species. The morphometric characters and their allometric relationship depend upon age, local environmental conditions, and population density of the species. It is known that animals changing their body proportion may also change their shape, so regression analysis was used to explain such relationship. The concept of allometry was first postulated by Huxley and Tessier, and it is mainly used by biologists to estimate the population growth characteristics of organisms. Relation between total length with different parameters was expressed by regression equation $Y = aX + b$, where a and b are considered as multiplying and additive constants, respectively.

Opisthosomal length versus total length relationship was linear, with a high degree of correlation for male ($r = 0.79$) and for female ($r = 0.77$), indicating that the opisthosomal length increases proportionately with the gradual increase of total length. CL versus total length relationship was linear, with a high degree of correlation for male (r = 0.78) and for female (r = 0.76), indicating that the CL increases proportionately with the gradual increase of total length. TEL versus total length relationship highlighted a proportionate increase in TEL to the total length. The relationship between prosomal length and total body length was linear with a very high degree of correlation, for male (r = 0.71) and for female (r = 0.74), indicating that the increase in carapace width (CW) to CL was proportionate (Table 1). TEL versus total length relationship indicated a linear relationship and found proportionately increasing, thus suggesting uniform growth pattern of body dimensions with the advancement of growth (Figures 2-6). The increase in the soft body parts could probably be due to increased feeding efficiency and food availability to horseshoe crabs. CW and CL relationship also showed a proportionate increment in these parameters. The changes in body dimensions of the *C. routandicauda* population indicate that the relationship could indirectly be influenced by population density, feeding efficiency, food availability, and local environmental conditions.

A total 61 individuals were collected for this study, out of which 31 were female and 30 were males. The female individuals show higher measurements in all body parameters than male. The PW and CW of *C. routandicauda* vary with sexes; females are larger than males. In this study PW male varies from 13.116 to16.2 cm whereas PW in female varies from 16.916 to 19.784 cm. Likewise OW in male varies from 9.58 to 9.116 cm where as OW in females varies from 10.84 to 11.62 cm. (Table 2).

CONCLUSION

Horseshoe crab is a very ancient group of animals and fossils of their ancestors are almost 450 million years before, i.e., 200 million years before dinosaurs existed;

Table 1: Regression relationship between various body parts of *C. routandicauda* of Bhitarkanika

Body parameters	Regression relationships
Male	
Opisthosomal length (cm) versus total body length (cm)	Y=0.1104X+2.8458, r^2=0.626
CL (cm) versus total body length (cm)	Y=0.2558X+6.8916, r^2=0.6043
TEL (cm) versus total body length (cm)	Y=0.6958X+5.2813, r^2=0.8897
Prosomal length (cm) versus total body length (cm)	Y=0.1476X+3.9955, r^2=0.5062
Opisthosomal length (cm) versus prosomal length (cm)	Y=0.6300X+0.829, r^2=0.5535
Prosomal length (cm) versus TEL (cm)	Y=0.1647X+5.8043, r^2=0.5331
CW (cm) versus CL (cm)	Y=1.1624X+6.9864, r^2=0.6339
Female	
Opisthosomal length (cm) versus total body length (cm)	Y=0.0758X+4.995, r^2=0.5929
CL (cm) versus total body length (cm)	Y=0.1438X+13.412, r^2=0.5854
TEL (cm) versus total body length (cm)	Y=0.7954X+10.767, r^2=0.8246
Prosomal length (cm) versus total body length (cm)	Y=0.0567X+8.82, r^2=0.5429
Opisthosomal length (cm) versus prosomal length (cm)	Y=0.5397X+1.9361, r^2=0.6352
Prosomal length (cm) versus TEL (cm)	Y=0.0487X+10.007, r^2=0.6193
CW (cm) versus CL (cm)	Y=0.8558X+13.362, r^2=0.6507

Regression equation Y=aX+b. Where, a and b are consider as multiplying and additive constants respectively. CL: Carapace length, TEL: Telson length, CW: Carapace width, *C. rotundicauda: Carcinoscorpius rotundicauda*

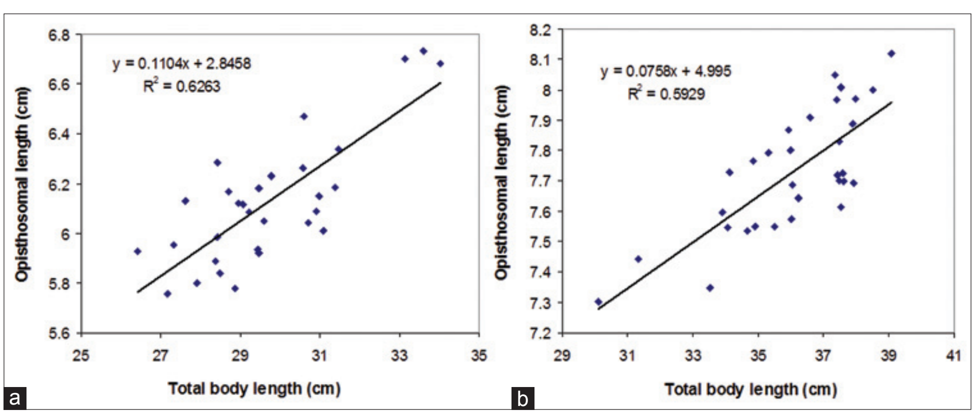

Figure 2: Regression relationship between opisthosomal length and total body length (a) male, (b) female

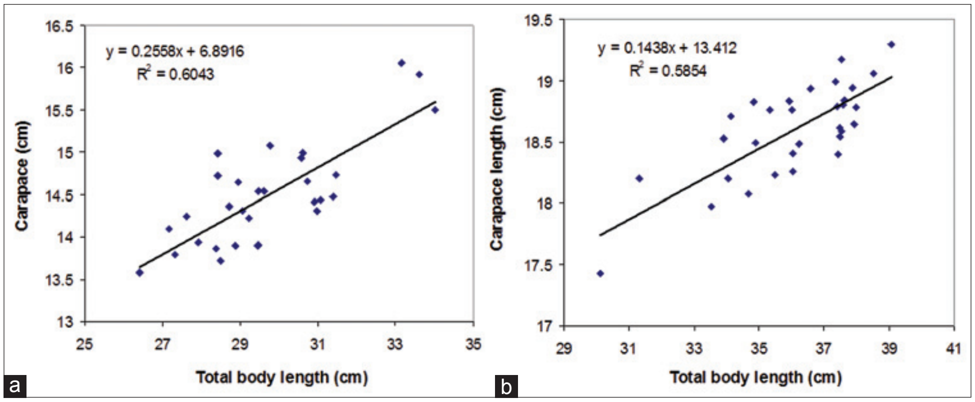

Figure 3: Regression relationships between carapace length and total body length (a) male, (b) female

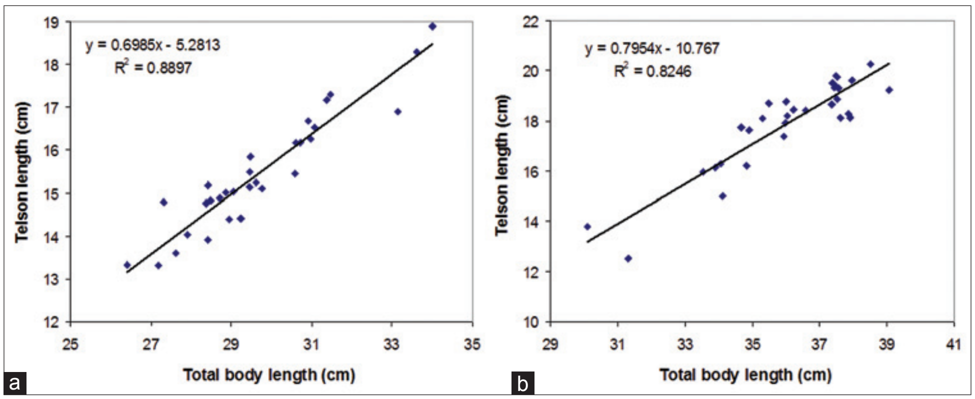

Figure 4: Regression relationships between Telson length and total body length (a) male, (b) female

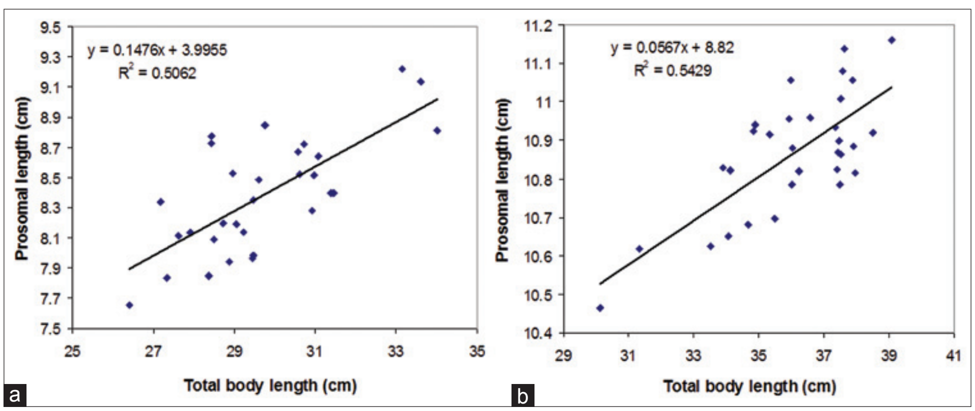

Figure 5: Regression relationships between prosomal length and total body length (a) male, (b) female

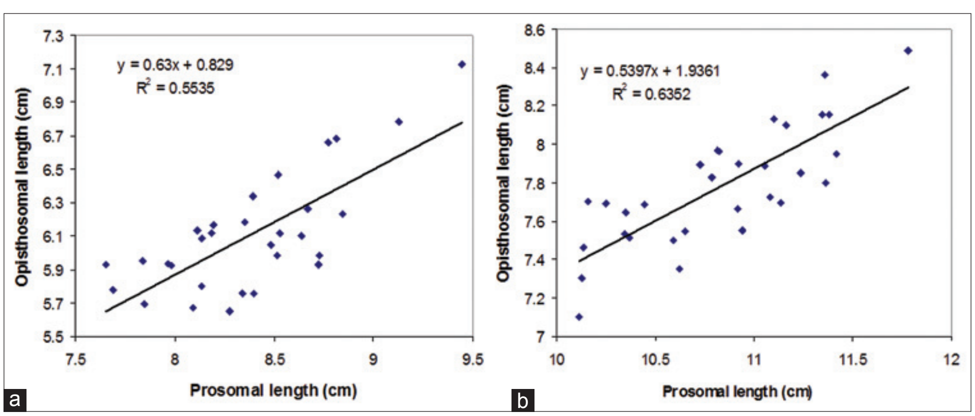

Figure 6: Regression relationships between opisthosomal length and prosomal length (a) male, (b) female

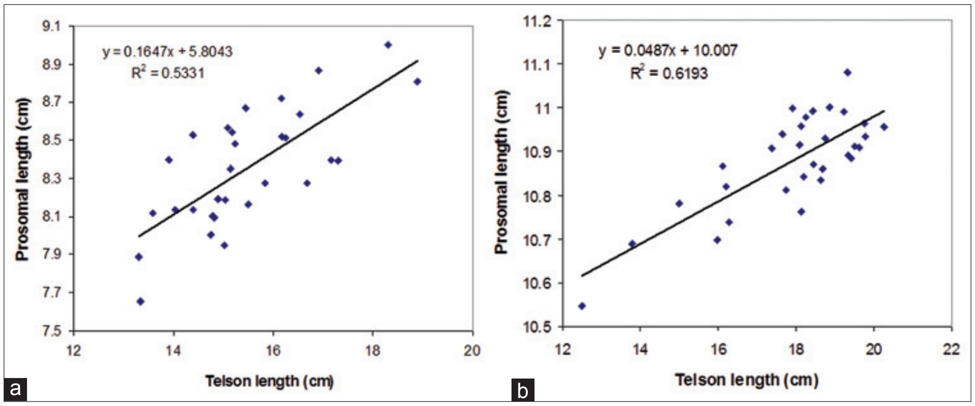

Figure 7: Regression relationships between prosomal length and Telson length (a) male, (b) female

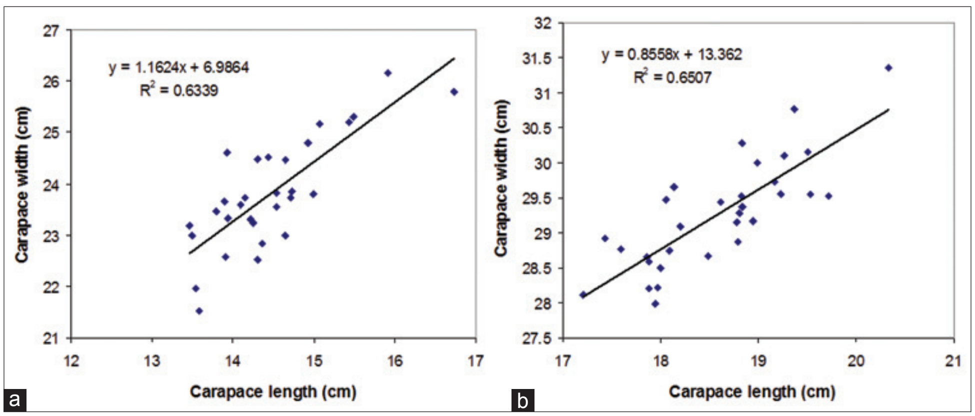

Figure 8: Regression relationships between carapace width and carapace length (a) male, (b) female

Table 2: The mean and standard deviation of morphometric parameters measured from Bhitarkanika area

Parameters	Mean±SD	
	Male	Female
Prosomal length	8.38±0.41	10.82±0.45
PW	14.81±1.21	18.1±0.65
Width from right TAG to left TAG	6.745±0.32	8.517±0.38
Length of opisthosoma	6.088±0.39	7.766±0.35
Length from TAG to anus (spines)	4.907±0.49	5.955±0.36
Width of anal region	4.068±0.32	4.851±0.28
Tail length	15.47±1.37	17.92±1.8
Tail width at tip	0.509±0.06	0.528±0.06
Tail width near anus	0.806±0.05	0.893±0.08
Length of prosoma through lateral compound eye	8.237±0.49	10.52±0.43
Length of hinge	5.581±0.3	6.97±0.39
Length of TAG	4.085±0.25	5.167±0.46
Distance between left side of TAG to anal spine	7.82±0.43	9.585±0.35
Width of opisthosoma	9.112±0.54	11.23±0.39
Total length of body	29.71±1.85	36.06±2.05
Distance between lateral eyes	7.675±0.34	10.31±1.25

TAG: Transverse auricular groove, SD: Standard deviation, PW: Prosomal width

hence, they are also known as "living fossils." They are marine animals usually bottom dwellers and belong to the phylum *Arthropoda*. The female individuals show higher measurements in all body parameters than male. The PW and CW of *C. routandicauda* vary with sexes; females are larger than males. In this study, PW in male varies from 13.116 to 16.2 cm whereas PW female varies from 16.912 to 19.784 cm. Likewise, OW in male varies from 21.292 to 26.116 cm whereas OW in female varies from 27.426 to 32.308 cm. Regression analysis was used to explain the relationship between various body parts. A linear relationship was found between different body parameters and also the female is larger. The changes in body dimensions of the *C. routandicauda* population indicate that the relationship could indirectly be influenced by population density, feeding efficiency, food availability, and local environmental conditions.

REFERENCES

1. Carmichael RH, Rutecki D, Valiela I. Abundance and population structure of the Atlantic horseshoe crab *Limulus polyphemus* in Pleasant Bay, Cape Cod. Mar Ecol Prog Ser 2003;246:225-39.
2. Clark KE, Niles LJ, Burger J. Abundance and distribution of migrant shorebirds in Delaware Bay. Condor 1993;95:694-705.
3. Gerrodette T. TRENDS: Software for a power analysis of linear regression. Wildl Soc Bull 1993;21:515-6.

4. Hiatt RW. The biology of the lined shore crab, *Pachygrapsus crassipes* randall. Pac Sci 1948;2:39-48.
5. Itow T, Loveland RE, Botton ML. Developmental abnormalities in horseshoe crab embryos caused by exposure to heavy metals. Arch Environ Contam Toxicol 1998;35:33-40.
6. Rudloe A. Aspects of the biology of juvenile horseshoe crabs, Limulus polyphemus. Bull Mar Sci 1981;31:125-33.
7. Sahu AC, Dey L. Spawning density and morphometric characteristics of the horseshoe crab *Tachypleus gigas* (Müller) on the Balasore coast of Bay of Bengal, India. Sci Vis 2013;13:1-84.
8. Shuster CN, Botton ML. A contribution to the population biology of horseshoe crabs, *Limulus polyphemus* (L.), in Delaware Bay. Estuaries 1985;8:363-72.
9. Sekiguchi K, Nakamura K, Seshimo H. Morphological variation of a horseshoe crab, *Carcinoscorpius rotundicauda*, from the Bay of Bengal and Gulf of Siam. Proc Jpn Soc Syst Zool 1978;15:24-30.
10. Vijaykumar R, Das S, Chatterji A, Parulekar AH. Morphometri characteristics in the horseshoe crab *Tachypleus gigas* (*Arthropoda*: *Merostomata*). Indian J Mar Sci 2000;29:333-5.

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