EFFECT OF SALINITY ON WIDTH-WEIGHT RELATIONSHIP OF ORANGE MUD CRAB (*Scylla olivacea* HERBST 1896) THRIVING IN INDIAN SUNDARBANS

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Abstract: Width-weight relationship of mangrove mud crab *Scylla olivacea* Herbst 1896 thriving in three salinity zones of Hooghly estuary were investigated for a period of one year from July 2015 to June 2016. Males were bigger than females and showed isometric and positive allometric growth whereas females showed negative allometric growth at all tested salinities. Width-weight relationship of both sexes indicated marked differences in different salinities. Regression equation depicting relationship of salinity and width-weight relationship for female ($y = 0.0052x + 2.9834$, $R^2 = 0.8068$) and male ($y = 0077x + 2.6708$, $R^2 = 0.9252$) indicated significant ($p<0.05$) positive correlation.

***Index Terms – Scylla olivacea*, salinity, width-weight relationship, Indian Sundarbans**

I. INTRODUCTION

Mud crabs are generally associated with mangrove forests and coastlines. *Scylla olivacea* Herbst 1896 commonly called as orange mud crab thrives in areas inundated with reduced salinity seawater for the greater part of the year [1]. Through their life activities, mud crabs exert extraordinary influence on the structure and function of the mangrove ecosystem. Mangrove leaf litter consumption by mud crabs significantly enhance retention and recycling of nutrients and organic matter internally and their wastes can support coprophagous organisms further ensuring conservation of materials within the forest [2]. Additionally, mud crabs represent a valuable component of traditional and small scale coastal fisheries in several tropical and subtropical South East Asian countries which stands as a significant commodity that fetches a high price in the international seafood market [3]. Mud crabs form the 'candidate species for aquaculture' owing to its winsome qualities such as faster growth, larger size, high reproductive capacity (fecundity), disease resistance, marketability, adaptability to farming systems etc. In India, the mud crabs have come into prominence since early eighties with the commencement of live crab export to the South East Asian countries which have created a renewed interest in the exploitation as well as in the production of mud crabs through aquaculture.

Confusion prevailed over last 50 years on the taxonomic nomenclature of the genus *Scylla* until publication of revised taxonomy using biotechnological tools which proved the occurrence of four species namely, *Scylla serrata*, *S. tranquebarica*, *S.olivacea* and *S. paramamosain* [4]. This recent revision created ambiguity over previous works done regarding the identification of species of genus *Scylla*. Most of the earlier works on mud crabs mention the mono-specific term *S. serrata* and as per the revised taxonomy, it unravels the fact that different species of genus *Scylla* might be erroneously treated as *S. serrata*.

Mangrove ecosystems are influenced by seasonal changes in climate, especially seasonal variations in rainfall as well as sea level [5]. Such changes in meteorological parameters especially in view of global climatic change are being thought to impart a profound impact on mangrove-estuarine biodiversity of Sundarbans [6, 7]. The biological components of marine systems are tightly coupled to physical factors, allowing them to respond quickly to rapid environmental change and thus rendering them ecologically adaptable. Some species also have wide genetic variability throughout their range, which may allow for adaptation to climate change [8]. Being an ecologically and economically important component of Sundarbans, information regarding width-weight relationship of *S. olivacea* occurring in different salinity zones is important in the context of changing salinity in the region. The present study was aimed to assess the width-weight relationship of orange mud crab *S. olivacea* thriving in varied salinity zones in the lower stretch of Hooghly estuary.

II. MATERIALS AND METHODS

A. Study area and sampling stations

Lower stretch of Hooghly River (21º 30´ to 22º 40´ N, 88º 00´ to 89º 08´ E) was selected for the present study. Diamond Harbour, Kakdwip and Frazerganj were selected as sampling stations where respective low, medium and high salinity prevails.

B. Analysis of water quality parameters

Surface water samples were collected monthly during high tide from all sampling stations. Temperature and salinity were measured on spot using the probe WTW Tetracon325 fitted with multi-kit WTW Multi 340 iset, Merck, Germany. Total alkalinity was determined following APHA [9] taking 50 ml sample in conical flask and titrating with 0.02 N H_2SO_4 after addition of two drops of methyl orange indicator. Total alkalinity was derived using the following formula: Total alkalinity (mg L^{-1} of $CaCO_3$) = Volume of titrant required × 20.

C. Crab collection and laboratory procedures

Live specimens of *S.olivacea* were collected monthly from sampling stations for a period of one year (July'2015-June'2016). Identification of specimens was done following the keys provided by Marine Species Identification Portal. Minimum 30 numbers of crabs were analysed every month. Males and females were segregated first and carapace widths were measured using a slide caliper. Weights of the specimens were determined using a digital electronic balance.

D. Determination of width-weight relationship

The mathematical relationship between carapace width and weight was calculated using the following equation [10]:

$$W = aX^b$$

Where W is crab weight (g), X is carapace width (cm), 'a' is the proportionality constant and 'b' is the isometric exponent. Basically it is a modification of the expression W= aL^b, where L is the length.

III. RESULTS AND DISCUSSION

Water quality parameters of the selected stations throughout the study period are presented in Table 1. At Diamond Harbour, temperature ranged between 17.58 – 30.09 ºC with mean value of 24.34±1.26 ºC. Mean salinity was 1.50±0.30 ppt which ranged between 0.11 – 3.18 ppt. Total alkalinity varied between 84 –160 (123.33±6.97) mg L^{-1}. Diamond Harbour was characterized with lowest salinity among studied stations. Kakdwip was characterized with moderate salinity (11.70±1.33 ppt) ranging between 3.75 ppt during October and 17.65 ppt during June. Temperature and total alkalinity varied between 17.88 – 30.14 (24.53±1.24) ºC and 88 – 164 (125.33±7.24) mg L^{-1}, respectively. Highest temperature (24.31±1.22, 17.88 – 30.14 ºC), salinity (17.79±1.64, 9.50 – 26.29 ppt) and total alkalinity (127.67±7.39, 92 – 160 mg L^{-1}) among all the studied stations were observed at Frazerganj. Salinity differed significantly ($p<0.05$) among stations while temperature and alkalinity remained similar.

Table 1: Water quality parameters of lower stretch of Hooghly River at Diamond Harbour (D), Kakdwip (K) and Frazerganj (F) during July 2015 – June 2016

Months	Temperature (ºC)			Salinity (ppt)			Total alkalinity (mg L^{-1})		
	D	K	F	D	K	F	D	K	F
Jul	27.4	27.6	28.1	2.5	13.4	21.5	132	136	144
Aug	27.2	27.3	27.2	1.2	7.6	14.4	116	112	120
September	25.8	26.0	26.4	0.1	3.7	9.5	88	92	92
October	24.8	25.1	25.3	0.2	6.5	11.2	84	88	96
November	21.4	21.7	22.0	0.5	8.4	12.8	108	104	92
December	19.6	20.0	20.7	0.9	9.9	14.5	112	116	120
January	17.5	17.8	18.3	1.1	12.1	17.2	120	128	124
February	18.9	19.2	19.3	1.3	13.3	18.3	132	128	136
March	22.4	22.5	22.4	1.8	14.7	20.1	140	132	140
April	27.7	27.6	27.8	2.1	16.0	22.2	140	148	156
May	30.1	30.1	30.2	2.7	16.8	25.1	148	156	160
June	28.7	29.1	29.4	3.2	17.6	26.3	160	164	152
Mean	**24.3**	**24.5**	**24.8**	**1.5^{c}**	**11.7^{b}**	**17.7^{a}**	**123**	**125**	**128**
SE	**1.2**	**1.2**	**1.2**	**0.30**	**1.33**	**1.64**	**7**	**6**	**7**

Different superscripts in a row indicates significant differences

Carapace width and body weight of females collected from Diamond Harbour ranged between 7.48 – 9.96 cm and 73.02 – 140.94 g and those for males ranged between 6.4 – 10.05 cm and 51.24 – 174.43 g, respectively. Lowest exponent (b) of width-weight relationship (WWR) was observed in Diamond Harbour. Exponent value of WWR for female (b=2.69) and male (b=3) respectively indicated negative allometric and isometric growth, respectively (Figure 1).

At Kakdwip, carapace width and weight of female crabs ranged between 8.14 – 9.92 cm and 71.85 – 45.11g and those for males, ranged between 7.50 – 9.64 cm and 72.31 – 186.66 g, respectively. Exponent of WWR for female (b=2.74) and male (b=3.02) respectively indicated negative allometric and insignificantly ($p>0.05$) positive allometric growth (Figure 2).

Carapace width and body weight of female crabs collected from Frazerganj varied between 6.73 – 9.16 cm and 49.42 – 117.81 g and those for male varied between 6.66 – 9.35 cm and 40.74 – 150.03 g, respectively. Exponent of WWR for female (b=2.81) and male (b=3.08) respectively indicated negative allometric and significant ($p<0.05$) positive allometric growth (Figure 3). Females were smaller than males throughout the study period in all the stations. Gradual increase in exponent of WWR with increasing salinity indicated better condition at higher salinity.

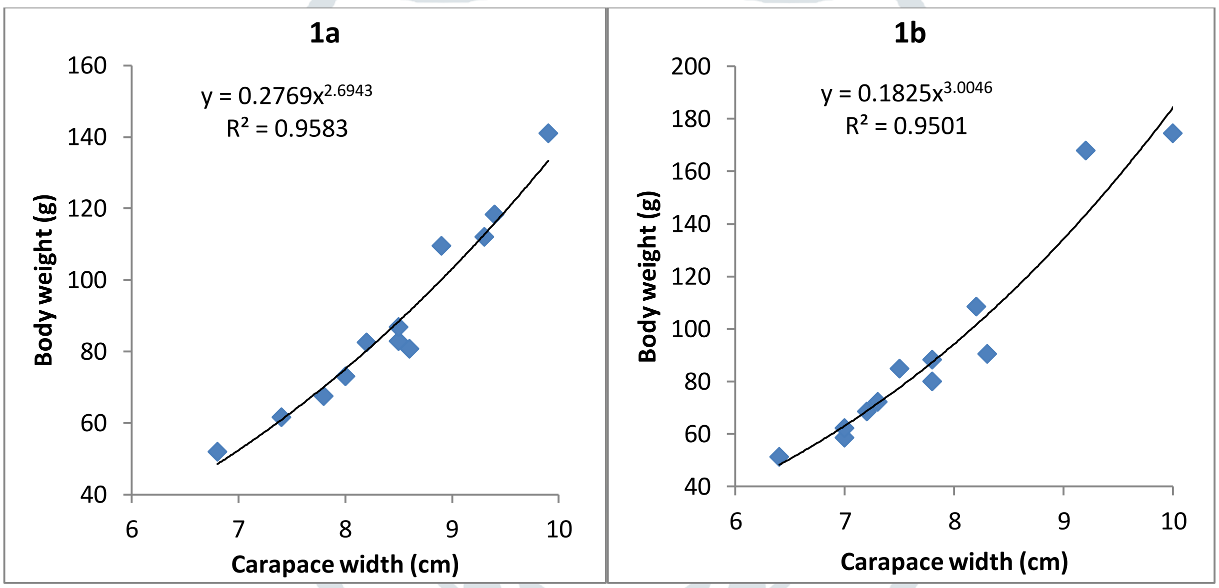

Fig. 1. Width-weight relationship of female (1a) and male (1b) *Scylla olivacea* at Diamond Harbour

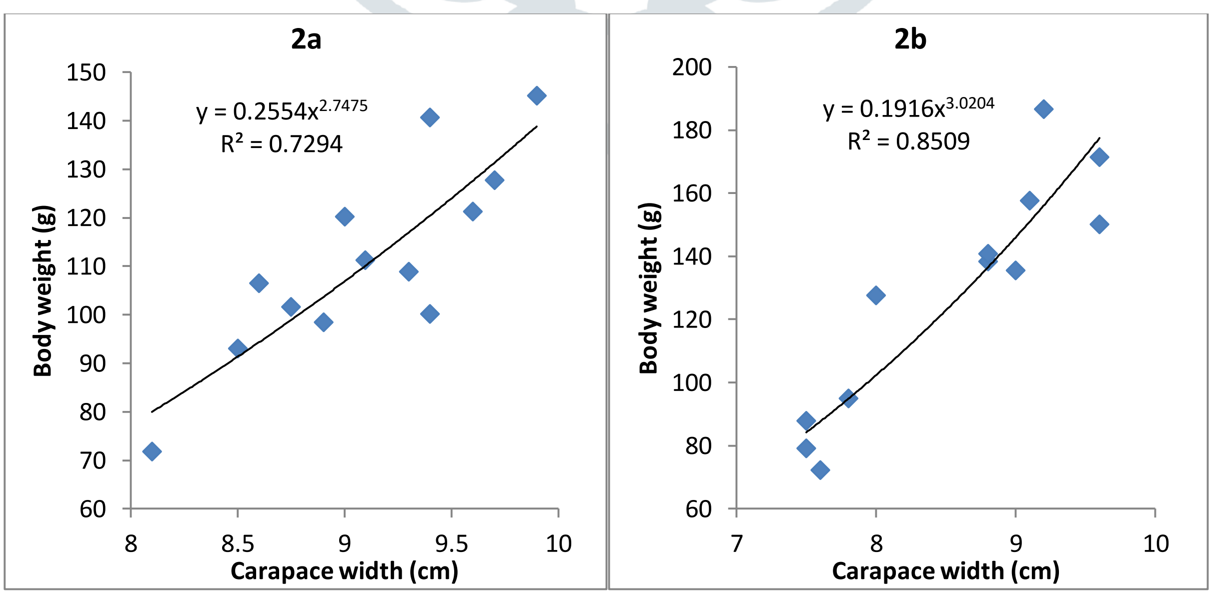

Fig. 2. Width-weight relationship of female (2a) and male (2b) *Scylla olivacea* at Kakdwip

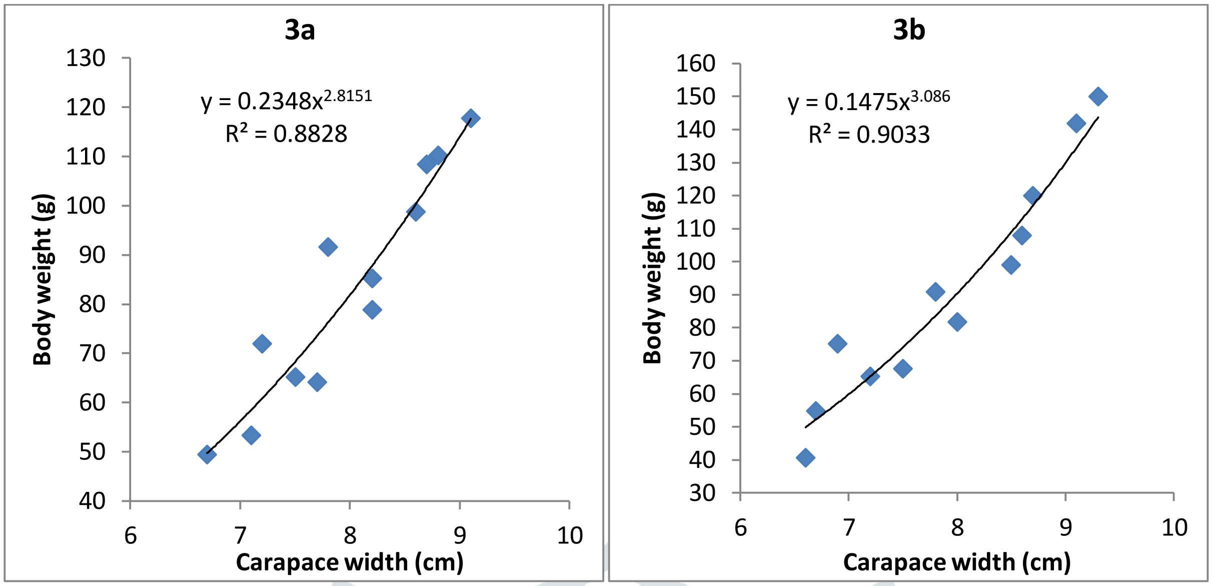

Fig. 3. Width-weight relationship of female (3a) and male (3b) *Scylla olivacea* at Fraserjunj

Effect of salinity on WWR was found to be prominent. Regression equation depicting relationship of salinity and WWR for female and male were y = 0.0052x + 2.9834 (R^2 = 0.8068) and y = 0077x + 2.6708 (R^2 = 0.9252), respectively (Figure 5). Regression equation and R^2 value indicated almost similar significant ($p<0.05$) positive correlation between salinity and WWR for female and male.

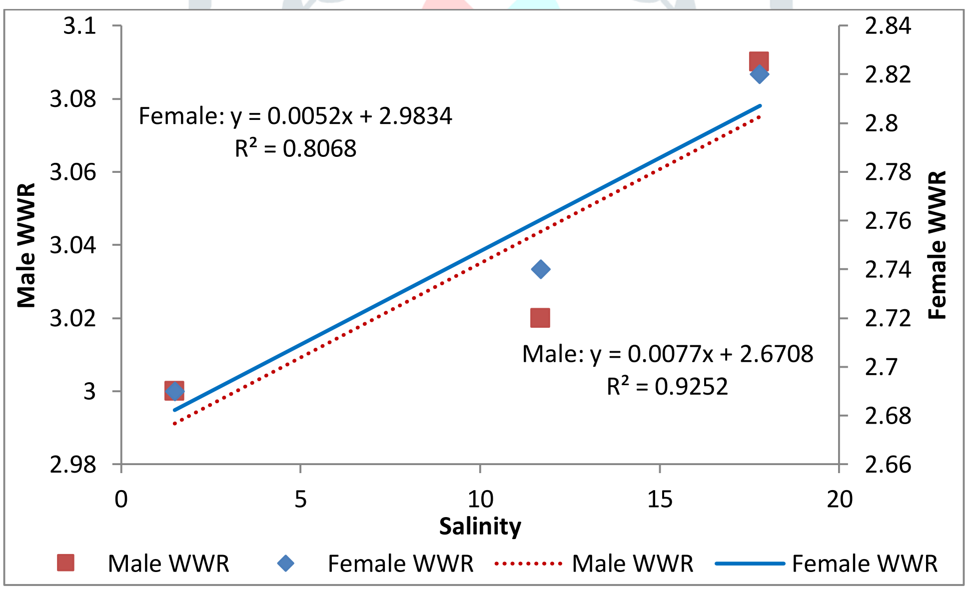

Fig. 4. Regression analysis regarding the effect of salinity on width-weight relationship of *Scylla olivacea*

Calculated values indicated clear sexual dimorphism with males attaining larger size. Growth, condition, reproductive development and metabolism of euryhaline species are often affected by salinity because the energy used for osmoregulation is not available for growth and other developments [11]. The exponent (b) of width-weight relationship in the present study indicated negative allometric growth of females and isometric and positive allometric growth of males. When the b parameter is equal to 3, growth is isometric and when it is less than or greater than 3, it is allometric [12]. More specifically, growth is positive allometric when crab weight increases more than width (b>3), and negative allometric when width increases more than weight (b<3) [13].Higher 'b' values for males than females in other species of crab were observed from Andaman Sea [14], Bangladesh [15] and Chilika Lagoon of India [16]. Higher 'b' value of males may be attributed to allometric enlargement of male chelae with sexual maturation. Lower exponentof WWR at lower salinity indicates higher energy consumption for osmoregulation as competition for space and food is not likely in suchnatural environment.

Width-weight relationship indicating health status of mangrove mud crab was improved with increment in salinity. There is evidence that the Indian Sundarbans is experiencing the effects of climate change over the last three decades. Specifically, the temperature in these waters has risen at the rate of 0.5°C per decade, much higher than that observed globally or for the Indian Ocean. Increasing melting of Himalayan ice might have decreased the salinity at the mouth of the Ganges River at the western end of Sundarbans deltaic complex [17]. Area of the present study lies within the western part of deltaic Sundarbans. Decreasing salinity in this region might deteriorate width-weight relationship of *S.olivacea* in the long run.

IV. CONCLUSION

Observations on the width-weight relationship of orange mud crab, *Scylla olivacea* at different salinity conditions in western part of Indian Sundarbans indicated marked differences. Exponents of width-weight relationship of both sexesincreased with increasing salinity. With decreasing salinity in the western sector of Indian Sundarbans, deterioration of width-weight relationship of *S. olivacea* might result in future. It is therefore suggested that the species may be cultured in the high saline central sector of Indian Sundarbans as a part of livelihood for the island dwellers and local inhabitants.

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