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Allometric Relationship of Freshwater Crabs *Oziotelphusa bouvieri* and *Spirallothelphusa wuellerstorfi* of Puzhal Lake, Chennai, Tamil Nadu, India

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Abstract: Freshwater crabs are the most dominant and specifically endemic species in India. Ecologically and nutritionally freshwater crabs proved to be the best alternative for marine crabs. Culturing of freshwater crabs are less tedious than freshwater fishes but lack of proper research on stock assessment becomes major drawback. Stock assessment helps in evaluating actual population dynamics in order to assess its population density which would be further used for designing aquaculture practices. Simple regression proved to be effective statistical tool for calculating relative growth. Due to very fragmentary work on allometry of freshwater crab species, there is an urgent need to evaluate the actual population dynamics of freshwater crabs.

Keywords: Allometry, Aquaculture, Fisheries studies, Freshwater crabs, *Oziotelphusa bouvieri*, *Spirallothelphusa wuellerstorfi*

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Introduction

Allometric studies deal with examining the differences between different morphological characters with each other. Simple allometric studies on fiddler crabs had been used to determine relative growth based on morphological characters (Huxley, 1924). Relative growth determines the growth of body with respect to other body parts (Hartnoll, 1974). Simple regression proved to be effective statistical tool for calculating relative growth. Allometric studies using simple regression was used previously for variety of marine crabs but this work is a pioneer work on freshwater crabs *Oziotelphusa bouvieri* and *Spirallothelphusa wuellerstorfi*. Both the species are ecologically important and nutritious edible alternative for marine crab. Allometric study help in determining the growth pattern of the species in their habitat. Statistical approach of calculating allometry of specified species help in advancing the

aquacultural practice and provide valuable information about the species to fishery studies. The present study will help in assessing various growth patterns of these species by estimating allometric relationship between various body parts and calculating it using regression method.

Materials and Methods

Freshwater crabs *Oziotelphusa bouvieri* and *Spirallothelphusa wuellerstorfi* were collected from Puzhallake, Redhills (13°10'00"N 80°10'17.5"E). In total, 102 males and 112 females of *Oziotelphusa bouvieri* species and 104 male and 106 females of *Spirallothelphusa wuellerstorfi* species were collected and preserved in laboratory. Different morphometric characters of crabs were analyzed for morphometric studies. Carapace width (CW), Carapace length (CL), Abdominal width (AW), Abdominal length (AL), Left cheliped propodus width (LCPW), Right cheliped propodus width (RCPW), Left cheliped total length (LCTL) and Right cheliped total length (RCTL) were the morphometric characters measured (in mm) using Vernier calliper. Regression method (Excel 2010 version) was employed for estimating b and a value and also correlation coefficient (r^2) values. b values were converted to tangent values and P value was also calculated to determine its significance. If the tangent angles greater than or lesser than 45°, then it is said to be positive or negative allometry, respectively. If the tangent value is 45° then it is said to exhibit Isometric character.

Results

Various combinations of morphometric characters of both the species were calculated using linear regression method and also obtained correlation coefficient. Mean and Standard deviation of both species for all morphometric characters were obtained (Tables 1-4). In *Oziotelphusa bouvieri* except for the following combinations CW×CL, CW×LCPW, CL×RCPW, CL×LCPW all other combinations showed negative allometry (Tables 5-6). In *Spirallothelphusa wuellerstorfi* except for the following combinations CW×RCTL, CW×RCPW, CW×LCTL, CW×LCPW, CL×RCTL, CL×RCPW, CL×LCTL, CL×LCPW, CL×AW, CL×AL all other combinations showed negative allometry (Tables 7-8).

Discussion

Allometric analysis of this species revealed that most of the body parts of both the species exhibited negative allometry which indicate lesser or low growth rate with respect to body parts. But when compared to *S. wuellerstorfi, O. bouvieri* species showed higher negative allometric growth which depicts that body parts of latter species are relatively small and lead to hypo-allometric growth compared to former one. Among three types of allometric growth namely, ontogenetic, static and evolutionary, this study describes and highlights static allometric growth which is studied for species having same developmental stage (Gould,1966).

Similarly, negative allometry was found by analyzing the carapace width of male and female shore crab *Pachygrapsus transversus* (Flores and Fransozo, 1999). But in *Sudanoutes aubryi* positive allometric correlation was observed in almost most of the body parts evaluated (Muse *et al.,* 2017). Similarly, in *Potamon fluviatile* positive correlation was observed but, in some parts, negative allometries were observed for propodus length of female crabs (Spani and Scalici, 2016). In *Ucathayeri*, drastic ontogentic changes were observed after analyzing male major cheliped and abdomen of female (Fransozo *et al.,* 2003).

Apart from stock assessment studies, allometric study and morphometric profile of crabs are good tool for taxonomic study as well (Muse *et al.,* 2017). Positive and negative allometry of different combination of morphometric characters reveal actual growth pattern of that species. Allometric studies of freshwater crabs in India is so limited and this study could provide deep insight and clear view on ecological investigations. Allometric studies help in analyzing the growth pattern of population in that habitat (Micheli *et al.,* 1990). Various

Table 1: Mean and Standard Deviation of morphometric characters of *Oziotelphusa bouvieri* (Male)

Parameters	Mean (mm)	Standard deviation	Standard error
Carapace width (CW)	40.54	6.89	0.68
Carapace Length (CL)	32.11	5.79	0.57
Right Cheliped Total Length (RCTL)	31.52	7.96	0.78
Left Cheliped Total Length (LCTL)	32.15	6.61	0.65
Right Cheliped Propodus width (RCPW)	13.47	3.09	0.30
Left Cheliped Propodus Width (LCPW)	14.45	3.54	0.35
Abdominal Length (AL)	20.14	2.32	0.23

Table 2: Mean and Standard Deviation of morphometric characters of *Oziotelphusa bouvieri* (Female)

Parameters	Mean (mm)	Standard deviation	Standard error
Carapace width (CW)	42.01	7.065	0.66
Carapace Length (CL)	32.72	4.073	0.38
Right Cheliped Total Length (RCTL)	28.17	5.86	0.55
Left Cheliped Total Length (LCTL)	27.87	6.78	0.64
Right Cheliped Propodus width (RCPW)	12.08	3.61	0.34
Left Cheliped Propodus Width (LCPW)	11.47	3.09	0.29
Abdominal Length (AL)	23.97	2.14	0.20
Abdominal Width (AW)	25.25	2.78	0.26

Table 3: Mean and Standard Deviation of morphometric characters of *Spirallothelphusa wuellerstorfi* (Male)

Parameters	Mean (mm)	Standard deviation	Standard error
Carapace width (CW)	30.75	5.81	0.56
Carapace Length (CL)	25.31	4.95	0.48
Right Cheliped Total Length (RCTL)	18.10	7.80	0.76
Left Cheliped Total Length (LCTL)	18.43	8.25	0.80
Right Cheliped Propodus width (RCPW)	7.97	3.05	0.29
Left Cheliped Propodus Width (LCPW)	8.26	3.08	0.30
Abdominal Length (AL)	15.32	2.95	0.28

Table 4: Mean and Standard Deviation of morphometric characters of *Spirallothelphusa wuellerstorfi* (Female)

Parameters	Mean (mm)	Standard deviation	Standard error
Carapace width (CW)	30.93	5.96	0.57
Carapace Length (CL)	25.25	4.39	0.42
Right Cheliped Total Length (RCTL)	19.12	4.60	0.44
Left Cheliped Total Length (LCTL)	19.08	5.23	0.50
Right Cheliped Propodus width (RCPW)	7.23	2.09	0.20
Left Cheliped Propodus Width (LCPW)	7.16	2.05	0.19
Abdominal Length (AL)	20	3.78	0.36
Abdominal Width (AW)	21.50	4.29	0.41

Table 5: Allometric relationship of *Oziotelphusa bouvieri* (Male)

Dependent Variable: Carapace Width

S. No.	Independent variable	'a'	'b'	'r²'	Angle of tangent	Allometry	P value
1.	CL	-0.1346	1.0202	0.8784	45.57°	+	<0.001
2.	RCTL	0.3536	0.7016	0.0911	35.06°	-	<0.001
3.	RCPW	-0.2624	0.8589	0.2067	40.65°	-	<0.001
4.	LCTL	0.2417	0.7846	0.4527	38.11°	-	<0.001
5.	LCPW	-0.6969	1.1514	0.6822	49.02°	+	<0.001
6.	AL	0.4766	0.5149	0.5488	27.24°	-	<0.001

Dependent Variable: Carapace Length

S. No.	Independent variable	'a'	'b'	'r²'	Angle of tangent	Allometry	P value
1.	RCTL	0.5005	0.6514	0.0931	33.08°	-	<0.001
2.	RCPW	-0.1617	0.8504	0.2401	40.37°	-	<0.001
3.	LCTL	0.4815	0.6782	0.4008	34.14°	-	<0.001
4.	LCPW	0.1013	0.6986	0.2935	34.93°	-	<0.001
5.	AL	0.5673	0.4895	0.5876	26.08°	-	<0.001

Dependent Variable: Right Cheliped Total Length

S. No.	Independent variable	'a'	'b'	'r²'	Angle of tangent	Allometry	P value
1.	RCPW	0.0886	0.6936	0.7282	34.74°	-	<0.001
2.	LCTL	1.1545	0.2327	0.2152	13.09°	-	<0.001
3.	LCPW	0.832	0.2132	0.1264	12.03°	-	<0.001
4.	AL	1.1341	0.1131	0.1429	6.45°	-	<0.001

Dependent Variable: Right Cheliped Propodus Width

S. No.	Independent variable	'a'	'b'	'r²'	Angle of tangent	Allometry	P value
1.	LCTL	1.2751	0.2005	0.1055	11.33°	-	<0.001
2.	LCPW	0.7107	0.3919	0.2821	21.40°	-	<0.001
3.	AL	1.1278	0.1557	0.1791	8.84°	-	<0.001

Dependent Variable: Left Cheliped Total Length

S. No.	Independent variable	'a'	'b'	'r²'	Angle of tangent	Allometry	P value
1.	LCPW	0.1449	0.6688	0.313	33.77°	-	<0.001
2.	AL	0.6418	0.4401	0.5451	23.75°	-	<0.001

Dependent Variable: Left Cheliped Propodus Width

S. No.	Independent variable	'a'	'b'	'r²'	Angle of tangent	Allometry	P value
1.	AL	0.8809	0.3664	0.54	20.12°	-	<0.001

Table 6: Allometric relationship of *Oziotelphusa bouvieri* (Female)

Dependent Variable: Carapace Width

S. No.	Independent variable	'a'	'b'	'r²'	Angle of tangent	Allometry	P value
1.	CL	0.6189	0.5523	0.7242	28.50°	-	<0.001
2.	RCTL	0.6502	0.4846	0.0672	25.85°	-	<0.001
3.	RCPW	0.2096	0.5278	0.0944	27.82°	-	<0.001
4.	LCTL	0.8341	0.3571	0.0151	19.65°	-	<0.001
5.	LCPW	0.4899	0.3369	0.022	18.61°	-	<0.001
6.	AW	1.0748	0.2011	0.1246	11.37°	-	<0.001
7.	AL	0.988	0.235	0.236	13.22°	-	<0.001

Dependent variable: Carapace Length

S. No.	Independent variable	'a'	'b'	'r²'	Angle of tangent	Allometry	P value
1.	RCTL	0.0781	0.8967	0.097	41.88°	-	<0.001
2.	RCPW	-0.6774	1.1513	0.1892	49.02°	+	<0.001
3.	LCTL	-0.0906	0.9937	0.0491	44.81°	-	<0.001
4.	LCPW	-0.8415	1.2423	0.1259	51.16°	+	<0.001
5.	AW	0.9775	0.2793	0.1013	15.60°	-	<0.001
6.	AL	0.7486	0.4163	0.3121	22.60°	-	<0.001

Dependent Variable: Right Cheliped Total Length

S. No.	Independent variable	'a'	'b'	'r²'	Angle of tangent	Allometry	P value
1.	RCPW	0.0025	0.7396	0.6477	36.48°	-	<0.001
2.	LCTL	0.0779	0.9303	0.3571	42.93°	-	<0.001
3.	LCPW	0.1935	0.5865	0.2356	30.39°	-	<0.001
4.	AW	1.3152	0.059	0.0375	3.37°	-	<0.001
5.	AL	1.3593	0.0129	0.0025	0.73°	-	<0.001

Dependent Variable: Right Cheliped Propodus Width

S. No.	Independent variable	'a'	'b'	'r²'	Angle of tangent	Allometry	P value
1.	LCTL	0.4928	0.8644	0.2604	40.84°	-	<0.001
2.	LCPW	0.2038	0.7815	0.3532	38°	-	<0.001
3.	AW	1.4269	-0.0255	0.0059	-1.46°	-	<0.001
4.	AL	1.4043	-0.0249	0.0078	-1.42°	-	<0.001

Dependent Variable: Left Cheliped Total Length

S. No.	Independent variable	'a'	'b'	'r²'	Angle of tangent	Allometry	P value
1.	LCPW	0.0642	0.6873	0.7839	34.50°	-	<0.001
2.	AW	1.3792	0.0146	0.0055	0.83°	-	<0.001
3.	AL	1.3682	0.0068	0.0017	0.38°	-	<0.001

Dependent Variable: Left Cheliped Propodus Width

S. No.	Independent variable	'a'	'b'	'r²'	Angle of tangent	Allometry	P value
1.	AW	1.4154	-0.0151	0.0036	-0.865°	-	<0.001
2.	AL	1.3788	-0.0009	0.0002	-0.051°	-	<0.001

Dependent Variable: Abdominal Width

S. No.	Independent variable	'a'	'b'	'r²'	Angle of tangent	Allometry	P value
1.	AL	0.5122	0.6184	0.5306	31.73°	-	<0.001

Table 7: Allometric relationship of *Spiralothelphusa wuellerstorfi* (Male)

Dependent Variable: Carapace Width

S. No.	Independent variable	'a'	'b'	'r²'	Angle of tangent	Allometry	P value
1.	CL	0.0075	0.9374	0.8519	43.14°	-	<0.001
2.	RCTL	-1.227	1.6346	0.2684	58.54°	+	<0.001
3.	RCPW	-1.676	1.711	0.4533	59.69°	+	<0.001
4.	LCTL	-1.5034	1.8229	0.3126	61.25°	+	<0.001
5.	LCPW	-1.3899	1.5296	0.3799	56.82°	+	<0.001
6.	AL	0.3373	0.568	0.4028	29.59°	-	<0.001

Dependent Variable: Carapace Length

S. No.	Independent variable	'a'	'b'	'r²'	Angle of tangent	Allometry	P value
1.	RCTL	-0.4377	1.1677	0.1413	49.42°	+	<0.001
2.	RCPW	-1.1478	1.4355	0.329	55.13°	+	<0.001
3.	LCTL	-0.6132	1.2951	0.1628	52.32°	+	<0.001
4.	LCPW	-0.8206	1.2143	0.247	50.52°	+	<0.001
5.	AL	0.4066	0.5529	0.3937	28.93°	-	<0.001

Dependent Variable: Right Cheliped Total Length

S. No.	Independent variable	'a'	'b'	'r²'	Angle of tangent	Allometry	P value
1.	RCPW	-0.037	0.7477	0.8617	36.78°	-	<0.001
2.	LCTL	0.6646	0.4426	0.1834	23.87°	-	<0.001
3.	LCPW	0.4541	0.3505	0.1986	19.31°	-	<0.001
4.	AL	1.0848	0.0774	0.0744	4.42°	-	<0.001

Dependent Variable: Right Cheliped Propodus Width

S. No.	Independent variable	'a'	'b'	'r²'	Angle of tangent	Allometry	P value
1.	LCTL	0.6828	0.5962	0.216	30.80°	-	<0.001
2.	LCPW	0.4015	0.5509	0.3183	28.85°	-	<0.001
3.	AL	1.0905	0.1012	0.0827	5.77°	-	<0.001

Dependent Variable: Left Cheliped Total Length

S. No.	Independent variable	'a'	'b'	'r²'	Angle of tangent	Allometry	P value
1.	LCPW	0.0153	0.7184	0.891	35.69°	-	<0.001
2.	AL	1.0711	0.0887	0.1045	5.06°	-	<0.001

Dependent Variable: Left Cheliped Propodus Width

S. No.	Independent variable	'a'	'b'	'r²'	Angle of tangent	Allometry	P value
1.	AL	1.097	0.0916	0.0645	5.23°	-	<0.001

Table 8: Allometric relationship of *Spiralothelphusa wuellerstorfi* (Female)

Dependent Variable: Carapace Width

S. No.	Independent variable	'a'	'b'	'r²'	Angle of tangent	Allometry	P value
1.	CL	0.1904	0.8134	0.8731	39.12°	-	<0.001
2.	RCTL	0.0327	0.8346	0.5439	39.84°	-	<0.001
3.	RCPW	-0.2525	0.7367	0.2468	36.37°	-	<0.001
4.	LCTL	-0.0264	0.8676	0.243	40.94°	-	<0.001
5.	LCPW	-0.4863	0.891	0.297	41.70°	-	<0.001
6.	AW	-0.1423	0.9887	0.8622	44.67°	-	<0.001
7.	AL	-0.0551	0.9098	0.8892	42.29°	-	<0.001

Dependent variable: Carapace Length

S. No.	Independent variable	'a'	'b'	'r²'	Angle of tangent	Allometry	P value
1.	RCTL	-0.0277	0.9294	0.511	42.90°	-	<0.001
2.	RCPW	-0.4987	0.9587	0.3167	43.79°	-	<0.001
3.	LCTL	-0.1047	0.9772	0.2336	44.33°	-	<0.001
4.	LCPW	-0.7169	1.1112	0.3501	48.01°	+	<0.001
5.	AW	-0.2266	1.11	0.8236	47.98°	+	<0.001
6.	AL	-0.1394	1.0264	0.8576	45.74°	+	<0.001

Dependent Variable: Right Cheliped Total Length

S. No.	Independent variable	'a'	'b'	'r²'	Angle of tangent	Allometry	P value
1.	RCPW	0.0063	0.656	0.2506	33.26°	-	<0.001
2.	LCTL	0.009	0.9847	0.4009	44.55°	-	<0.001
3.	LCPW	0.0196	0.6412	0.197	32.66°	-	<0.001
4.	AW	0.4375	0.697	0.5488	34.87°	-	<0.001

5.	AL	0.4684	0.6494	0.5802	32.99°	-	<0.001

Dependent Variable: Right Cheliped Propodus Width

S. No.	Independent variable	'a'	'b'	'r²'	Angle of tangent	Allometry	P value
1.	LCTL	0.9462	0.3723	0.0984	20.42°	-	<0.001
2.	LCPW	0.1082	0.8644	0.6149	40.84°	-	<0.001
3.	AW	0.9789	0.4089	0.3244	22.22°	-	<0.001
4.	AL	1.0404	0.3004	0.2132	16.72°	-	<0.001

Dependent Variable: Left Cheliped Total Length

S. No.	Independent variable	'a'	'b'	'r²'	Angle of tangent	Allometry	P value
1.	LCPW	0.0596	0.6147	0.438	31.5°	-	<0.001
2.	AW	0.9241	0.3161	0.273	17.54°	-	<0.001
3.	AL	0.9406	0.2795	0.2599	15.61°	-	<0.001

Dependent Variable: Left Cheliped Propodus Width

S. No.	Independent variable	'a'	'b'	'r²'	Angle of tangent	Allometry	P value
1.	AW	0.9931	0.3946	0.367	21.53°	-	<0.001
2.	AL	1.0386	0.3045	0.2661	16.93°	-	<0.001

Dependent Variable: Abdominal Width

S. No.	Independent variable	'a'	'b'	'r²'	Angle of tangent	Allometry	P value
1.	AL	0.1497	0.8644	0.91	40.84°	-	<0.001

allometric studies have been conducted on marine crabs, freshwater prawns etc., but very limited study has done on freshwater crabs. Being nutritive and cheap alternative, these crabs are largely consumed by the local people.

Proper allometric and reproductive study help in analyzing the exact condition and also its growth patterns. Irregular growth pattern or negative allometry is a result of indirect relationship of food consumption to body growth. In this study, majority of combinations of both the species reported negative allometry, which indicates that the energy consumed by the crab is not evenly distributed to all parts of the crab.

The reason for this condition can be ecological fluctuations of crab's habitat, food availability, climate, geographic location etc. This method is also useful in reviving the condition of the species and also help in culturing of species in large scale. Therefore, this study is helpful in indirect influence on growth, population density, feeding efficiency of the species.

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