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Morphological variations in the Pacific white shrimp, *Litopenaeus vannamei* (Boone, 1931), reared in two different culture ponds

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Short Communication

Abstract

The shrimp (*Litopenaeus vannamei*) shows differences in morphometric variables due to genetic and environmental factors during phenotypic development. For the proposed study the morphological variables were measured from shrimp (*L. vannamei*) specimens which were randomly collected from two different types of ponds: earthen and polyethylene-lined ponds (500 each). The morphometric variables show proportional growth with the increasing total length of the shrimp. The range of correlation coefficient (r) was 0.171-0.881 in an earthen pond and 0.107-0.906 in a polyethylene-lined pond respectively which shows that morphometric parameters are linearly and positively related to the actual total length of shrimp. The growth coefficient (*b*) was maximum (2.504 and 2.997) for the actual total length and weight in earthen and polyethylene lined ponds respectively while it was minimum of 0.723 for the actual total length and carapace width in the earthen pond and 0.619 for actual total length and third segment length of shrimp in polyethylene lined pond. The growth coefficient (b) was determined <3.0 which indicated that the growth of shrimp in both cultured ponds was negatively allometric. A difference in mean of different morphometric parameters was found at 0.622-15.270 in the earthen pond and 0.578-18.960 in polyethene lined pond which was categorized into two categories (<10 and >15) groups, depicting that out of seventeen parameters sixteen parameters were genetically controlled while only one parameter was environmentally controlled. The findings of such a study certainly help the farm managers and researchers to find out the growth status and improve the farm operations that will support to enhanced harvest of shrimp for more production.

Keywords: *Shrimp, morphometric, earthen and polyethene-lined culture pond*

Introduction

The Pacific whiteleg shrimp (*Litopenaeus vannamei,* Boone, 1931) is a tropical species and farmed extensively across the world (Prajapati and Ujjania, 2021) in extensive, intensive and semi-intensive systems (Erchao *et al.*, 2015). Owing to the availability of specific pathogen-free and genetically improved stock, this species has become the key factor for the rapid growth of the shrimp aquaculture industry in South Asia, including India (Prajapati and Ujjania, 2021). The morphological measurements, shape and size provide useful information for taxonomic status (Ihsaan *et al.*, 1981). It is considered the earliest and most authentic method for the identification of species (Nayman, 1965) and comparative examination of morphological characters based on a set of measurements of the body form (Hubbs and Lagler, 1947). The heterogeneous environment in diverse areas caused morphometric differences between species (Balai *et al.*, 2017). These reliable data often prevented species identification but overstated the genetic control of morphological characters (Mamuris *et al.*, 1998). The morphometric characteristics of *P. japonicus* were analyzed in the East China Sea and reported that the knowledge of stock structure is essential for rational exploitation and management of exploited species (Tzeng and Ahean, 1999). A few studies have allocated morphometric variation in the quantitative behaviours of shellfish (Nelson *et al.*, 1984). Gujarat is one of the leading states of the country in shrimp farming and no detailed information is available on this important biological aspect of *L. vannamei* cultured in different (earthen and polyethylene) ponds of the state. Therefore, the present study on morphological variations of the shrimp species was conducted.

Material and methods

The study was carried out at the commercial shrimp farms, which were using both types of culture ponds *i.e.*, earthen pond (EP) and polyethylene lined pond (PELP) and followed the same protocol of management *i.e.*, pond preparation, stocking, feeding, probiotics and biosecurity management according to best management practices during culture cycle (106 days) in 2021. The ponds were stocked with post-larvae (PL-8). The shrimp seeds were PCR test passed with a negative result, healthy and stress-free, brought from a reputed Coastal Aquaculture Authority (CAA) registered hatchery and were stocked during midnight in both culture ponds with proper acclimatization process. For the study, a total number of 1000 shrimp specimens (500 from each EP and PELP) were randomly collected and morphometric characteristics were measured. The morphometric characters (total length, partial total length, carapace width, partial carapace length, carapace depth, first segment length, second segment length, third segment length, fourth segment length, fifth segment length, sixth segment length, sixth segment depth, endopod of uropod length, exopod of uropod length, posterior abdomen circumference and anterior abdomen circumference) were measured to follow the standard procedure of Lester (1983). These different morphometric characters of the specimen (Fig. 1) were measured with the help of a digital vernier calliper at the accuracy of ±0.02 mm whereas weight was taken to the nearest 0.01 g by using electronic single pan balance. The intensity of the relationship among the morphometric parameters was determined by regression equation, Log Y = a + b Log X (Ricker, 1973) where 'X' is actual total length, 'Y' is other morphometric measurements, '*a*' is intercept and '*b*' is regression coefficient. Based on the range (differences in the mean value of morphometric parameters), these morphometric parameters were divided into three groups, (i) genetically controlled characters (<10), (ii) intermediate characters (10-15) and (iii) environmentally controlled characters (>15) (Johal *et al.*, 1994; Ujjania *et al.*, 2012). The data computation was completed with the help of MS Excel 2010.

Results and discussion

The correlation coefficients (r) recorded were 0.171-0.881 and 0.107-0.906 between the variables (ACT and all morphometric parameters) of the shrimp in EP and PELP respectively (Table 1). The value of the coefficient lay between (0 to +1.0) which depicted that all these morphometric parameters are positively correlated with the actual total length. A significant positive correlation of morphometric parameters with total length was reported by Balai *et al.* (2017) in Indian major carps from Rajasthan, Negi and Negi (2010) in *S. richardsonii* from Uttarkashi district of Uttarakhand, Naeem *et al.* (2012) in wild *Labeo calbasu* from Chenab River, Pakistan, Pathak *et al.* (2013) in tilapia of Vadodara, Gujarat and Arora and Julka (2013) in *Tor putitora* from Himachal Pradesh. The growth constant (b) of the variables (ATL/Weight) shows that the growth of shrimps was negative allometric (3.0 > 2.504) in EP whereas it was isometric (3.0=2.997) in PELP (Table 1). Similarly, growth constant (b) for all morphometric parameters with actual total length was minimum (0.723 and 1.268) and maximum (0.619 and 1.286) in EP and PELP respectively (Table 1 and Fig. 1). The observed growth constant was < 3.0, which indicate negative allometric growth of morphometric parameters concerning actual total length. Similar findings were reported by Santhi *et al.* (2011) in wild and cultured stock of shrimp (*Penaeus monodon*) and different combinations of morphometric parameters showed growth as positive allometric, isometric and negative allometric. The relationship between different morphometric parameters and total length was established and negative allometric growth was reported by Balai *et al.* (2017) in mrigal. The growth constant in weight with total length was noted as isometric in shrimp (Konan *et al.*, 2014; Udoinyang *et al.*,

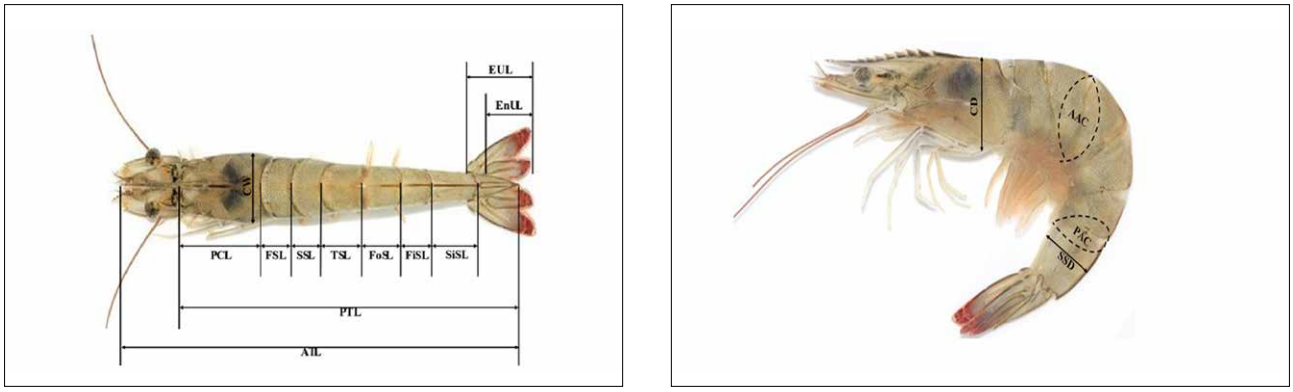

Fig. 1. Morphometric parameters of shrimp (*L. vannamei*). Actual total length (ATL), Partial total length (PTL), Carapace width (CW), Partial carapace length (PCL), Carapace depth (CD), First segment length (FSL), Second segment length (SSL), Third segment length (TSL), Forth segment length (FoSL), Fifth segment length (FiSL), Sixth segment length (SiSL), Sixth segment depth (SSD), Endopod of uropod length (EnUL), Exopod of uropod length (EUL), Posterior abdomen circumference (PAC) and Anterior abdomen circumference (AAC)

2016), whereas positive allometric growth was reported in *L. vannamei* (Prajapati and Ujjania, 2021).

The actual total body length was 12.138-15.420 (13.948±0.029) cm and 11.488-15.581 (13.393±0.034) cm and weight was 15.260-31.130 (22.668±0.130) g and 12.260-31.220 (19.612±0.162) g of the shrimp was observed in EP and PELP respectively (Table 2). The measurements of other morphological parameters are given in Fig.1 and Table 2. The mean value of the weight of shrimp depicted that comparatively heavier shrimps were found in earthen ponds. The range value of morphometric parameters (ATL, PTL, CW, PCL, CD, FSL, SSL, TSL, FoSL, FiSL, SiSL, SSD, EnUL, EUL, PAC and AAC) was noted <10.0 (0.622 to 3.282) in EP and (0.578 to 4.093) in PELP whereas range value was >15.0 (15.270 and 18.960) for the weight of shrimp in EP and PELP respectively (Table 2). Based on range values, these 16 morphometric parameters are genetically controlled and only the weight of shrimp is environmentally controlled (>15.0) in both culture ponds. Similarly, different stocks of mahseer show differences in their morphometric characteristics due to genetically and environmentally controlled (Dube and Dubey, 1987). Ujjania *et al.* (2012); Negi and Negi (2010) and Gandotra *et al.* (2008) in different aquatic organisms.

The growth constant (*b*) for weight in shrimps of EP showed negative allometric values, while in PELP it was isometric. Similarly, the growth constant for all morphometric parameters also indicated negative allometric concerning actual total length. The information on growth and morphological

Table 1. The statistical equation for morphometric parameters of shrimp (*L. vannamei*)

Morphometric parameters	Regression equation Log Y = a + b Log X					
	a		b		r	
	EP	PELP	EP	PELP	EP	PELP
ATL (X) / WEIGHT (Y)	-1.513	-2.090	2.504	2.997	0.821	0.906
ATL (X) / PTL (Y)	-0.027	-0.067	0.975	1.006	0.881	0.880
ATL (X) / CW (Y)	-0.235	-0.824	0.723	1.224	0.171	0.560
ATL (X) / PCL (Y)	-0.574	-0.747	0.931	1.079	0.570	0.779
ATL (X) / CD (Y)	-0.778	-1.072	0.937	1.176	0.328	0.577
ATL (X) / FSL (Y)	-1.172	-1.095	1.176	1.114	0.436	0.520
ATL (X) / SSL (Y)	-1.167	-1.180	1.130	1.144	0.349	0.513
ATL (X) / TSL (Y)	-1.060	-0.476	1.114	0.619	0.378	0.107
ATL (X) / FoSL (Y)	-1.052	-1.230	1.038	1.218	0.195	0.557
ATL (X) / FiSL (Y)	-1.365	-1.283	1.268	1.217	0.254	0.543
ATL (X) / SiSL (Y)	-0.931	-0.822	1.063	0.991	0.438	0.570
ATL (X) / SSD (Y)	-1.093	-1.322	1.080	1.286	0.459	0.570
ATL (X) / EnUL (Y)	-0.580	-0.691	0.865	0.973	0.390	0.568
ATL (X) / EUL (Y)	-0.406	-0.746	0.758	1.062	0.405	0.656
ATL (X) / PAC (Y)	-0.655	-0.705	1.103	1.148	0.404	0.475
ATL (X) / AAC (Y)	-0.204	-0.561	0.856	1.166	0.383	0.571

Table 2. Shrimp (*L. vannamei*) morphometric parameters range observation

Morphometric parameters	Values of morphometric parameters			
	Minimum-Maximum (Mean ± SE)		Range	
	EP	PELP	EP	PELP
Weight	15.260-31.130 (22.668±0.130)	12.260-31.220 (19.612±0.162)	15.270	18.960
ATL	12.138-15.420 (13.948±0.029)	11.488-15.581 (13.393±0.034)	3.282	4.093
PTL	10.484-13.583 (12.269±0.026)	10.016-13.760 (11.663±0.032)	3.099	3.744
CW	2.928-4.586 (3.920 ±0.014)	2.898-5.508 (3.594±0.016)	1.658	2.610
PCL	2.606-3.575 (3.108±0.008)	2.261-3.537 (2.948±0.009)	0.969	1.276
CD	1.500-2.336 (1.974±0.006)	1.414-2.339 (1.793±0.007)	0.836	0.925
FSL	1.164-1.799 (1.497±0.005)	1.134-1.771 (1.449±0.005)	0.635	0.637
SSL	1.009-1.631 (1.339±0.005)	0.994-1.572 (1.289±0.005)	0.622	0.578
TSL	1.282-2.079 (1.641±0.006)	1.287-2.700 (1.676±0.009)	0.797	1.413
FoSL	0.975-1.791 (1.374±0.006)	1.043-1.777 (1.391±0.005)	0.816	0.734
FiSL	0.833-1.540 (1.225±0.006)	0.942-1.563 (1.227±0.005)	0.707	0.621
SiSL	1.568-2.368 (1.937±0.006)	1.610-2.348 (1.974±0.006)	0.800	0.738
SSD	1.109-1.759 (1.395±0.004)	1.037-1.946 (1.341±0.006)	0.650	0.909
EnUL	2.057-3.075 (2.568±0.007)	1.987-3.152 (2.542±0.008)	1.018	1.165
EUL	2.339-3.307 (2.897±0.007)	2.321-3.551 (2.827±0.009)	0.968	1.230
PAC	3.300-5.300 (4.063±0.015)	2.800-4.600 (3.892±0.016)	2.000	1.800
AAC	4.900-6.900 (5.976±0.017)	4.400-7.000 (5.670±0.022)	2.000	2.600

Note: EP for Earthen Pond, PELP for Polyethylene lined Pond
Note: EP for Earthen Pond, PELP for Polyethylene lined Pond

parameters helps to determine the shrimps' conditions and growth status.

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