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Morphometric studies on wild caught and cultured shrimp *Penaeus monodon* (Fabricius, 1798) from Parangipettai, India

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ABSTRACT

A study was carried out in a commercial shrimp farm situated on the Northern banks of Vellar estuary (Lat. 11^0 29' N; Long. 79^0 46' E). Total of 700 cultured shrimps and 400 shrimps of wild males and females Penaeus monodon were collected and studied relationship between the 15 morphometric measurements. In wild males, PTL X FSL, PCL X FiSL, CD X FSL and CD X SSL combinations showed positive allometric growth relationship. Combination of PTL X SSL, PCL X FSL, PCL X SSL and CD X TSL, showed isometric growth. In cultured males, PTL X PCL, PTL X CW, PTL X CD, PTL X FSL, PTL X SSL, PTL X TSL, PTL X FoSL, PTL X FiSL, PTL X AAC and SSD X AAC showed positive allometry. PTL X SSD, PCL X SSL, CD X SSL, FSL X SSL and FSL X TSL showed isometric. In wild females, PTL X CW, PTL X CD, PTL X FSL, PTL X SSL, PTL X TSL, PTL X AAC, and PTL X PAC showed positive allometric and combinations of PTL X PCL, PCL X FSL, showed isometric. In cultured females, PTL X PCL, PTL X CD, PTL X FSL, PTL X SSL, PTL X TSL, PTL X FoSL, PTL X SiSL, PTL X AAC, PCL X TSL, FSL X TSL and SSL X TSL combinations showed positive allometric. PTL X CW, PTL X PAC, PCL X CD and PCL X SSL showed isometric and the remaining combinations showed negative allometric growth relationships. Important of this work is essential in stock assessment from wild and exploitation.

Keywords: *Penaeus monodon, morphometric characters, positive allometric, isometric, negative allometric.*

INTRODUCTION

The giant tiger shrimp, *Penaeus monodon,* is the major species cultured and accounts for 58% of total shrimp production from farms worldwide [1]. Morphological characters have been commonly used in fishery biology to measure discreteness and relationships among various taxonomic categories. There are many well documented morphometric studies, which provide evidence for stock discreteness [2-7]. Number of surveys have been attempted to detect the differences in morphometric traits between sexes and among localities and size groups of penaeid shrimps [3,8-12]. The most common body measurements in penaeid shrimps are carapace length, body length and total length. In general, shrimp farmers are more concerned about the biomass of the cultured shrimp that they record only the body weight, whereas biologists and researchers prefer morphometric measurements, which are not subjected to wide variations [13].

The present investigation was carried out to study the morphometric variations of *P. monodon* between two different localities and sexes.

MATERIALS AND METHODS

Study area

The study was carried out in a commercial shrimp farm situated on the Northern banks of Vellar estuary (Lat. 11^0 29' N; Long. 79^0 46' E). This shrimp farm with three ponds and a reservoir has a total water spread area of 2.9 ha (Pond 1-0.6 ha; Pond 2-0.6 ha, pond 3-0.7 ha and Reservoir pond-1 ha). Ponds 1 and 2 were used as experimental ponds and pond 3 was used as the control.

A total of 700 cultured shrimps and 400 shrimps of wild *P. monodon* were collected and fifteen morphometric measurements were considered in this study. These measurements were done following the procedures proposed by [14,]. The measurements 1 – 15 listed below are shown in fig.1-2.

1. Partial Carapace Length (PCL): Distance from the posterior margin of orbit to the posterior edge of the carapace
2. Carapace Width (CW): Greatest width at the point of last dorsal rostral tooth
3. Carapace Depth (CD): Greatest depth between the top and bottom of the carapace
4. First Segment Length (FSL): Distance between the posterior carapace margin and posterior margin of first abdominal segment along the mid dorsal line with the abdomen fully extended.
5. Second Segment Length (SSL): Distance between the posterior margin of the first and posterior margin of the second abdominal segment
6. Third Segment Length (TSL): Distance between the posterior margin of the second to the posterior margin of the third segment
7. Fourth Segment Length (FoSL): Distance between the posterior margin of the third segment to the posterior margin of the fourth segment
8. Fifth Segment Length (FiSL): Distance between the posterior margin of the fourth to the posterior margin of the fifth segment
9. Sixth Segment Length (SiSL): Distance from the posterior margin on the fifth segment to the posterior margin of the sixth segment
10. Sixth Segment Depth (SSD): Depth at the mid-point of the 8^{th} segment
11. Anterior Abdominal Circumference (AAC): Circumference of the abdomen at the interaction of the second and third abdominal segments
12. Posterior Abdominal Circumference (PAC): Circumferences of the abdomen at the interaction of the fifth and sixth abdominal segment

13. Exopod of Uropod Length (EUL): Distance between the posterior margin of protopodite to the tip of the exopod of uropod
14. Endopod of Uropod Length (EnUL): Distance between the posterior margin of the protopodite to the tip of the endopod of uropod
15. Partial Total Length (PTL): Length from the posterior margin of the orbit to the tip of endopod of uropod

Measurements of individuals exhibiting body deformities were excluded from consideration. Correlation techniques were also used to find out the relationship. The formula used to find out the correlation value is

$$r = \frac{\sum XY - \frac{\sum X . \sum Y}{N}}{\left(\sum X^2 - \frac{\left(\sum X\right)^2}{N} \cdot \sum Y^2 - \frac{\left(\sum Y\right)^2}{N} \right)^{\frac{1}{2}}}$$

The general linear equation Y = a + bx was employed in regression analysis, where

X = Partial total length
Y = Other morphometric measurements
a = the intercept
b = the regression coefficient
'a' and 'b' values were worked out using the following formula

$$b = \frac{\sum XY - \frac{\sum X . \sum Y}{N}}{\sum X^2 - \frac{\left(\sum X\right)^2}{N}}$$

$$a = \frac{\sum X}{N} - \left(b . \frac{\sum X}{N} \right)$$

RESULTS AND DISCUSSION

The relationship between the 15 morphometric characters of *P. monodon* of cultured and wild males and females were studied separately by all possible combinations using the linear regression techniques and correlation coefficient. The regression coefficient 'a' and 'b' values were presented. The 'b' values were converted into tangent values shown in fig.3-6. The body characters having the tangent values above 45^0 are positive allometry, while values below 45^0 are negative allometry and values equal to 45^0 are isometry.

Fig.1. Diagramatic representation of the morphometric characters of *Penaeus monodon*

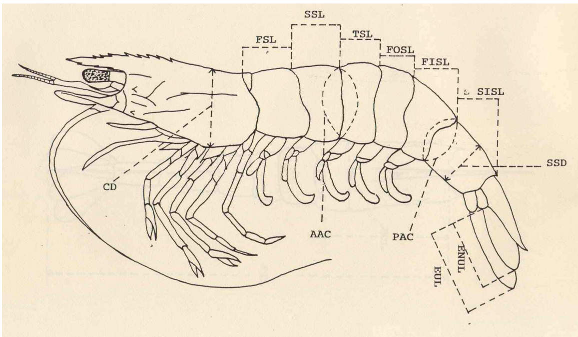


Fig.2. Diagramatic representation of the morphometric characters of *Penaeus monodon*

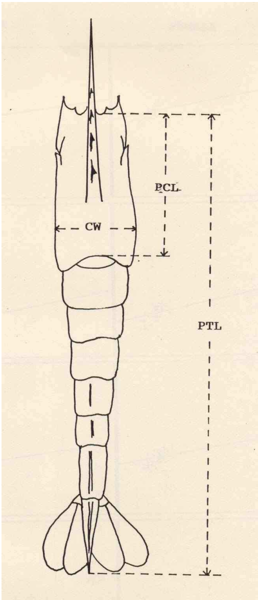
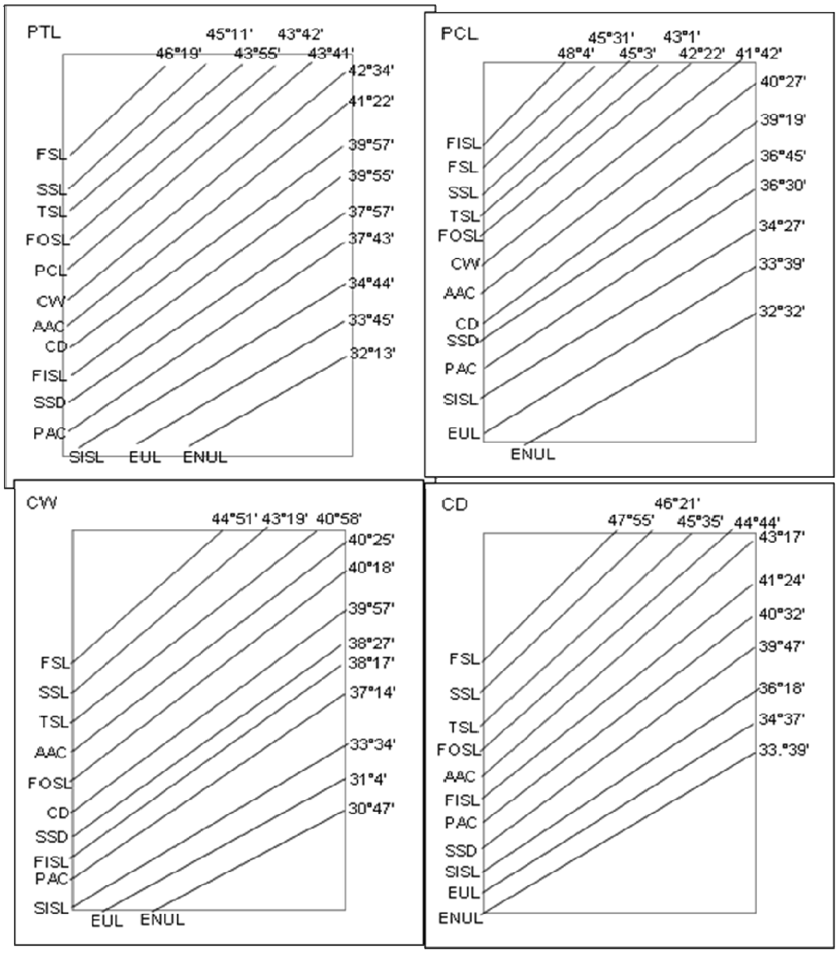
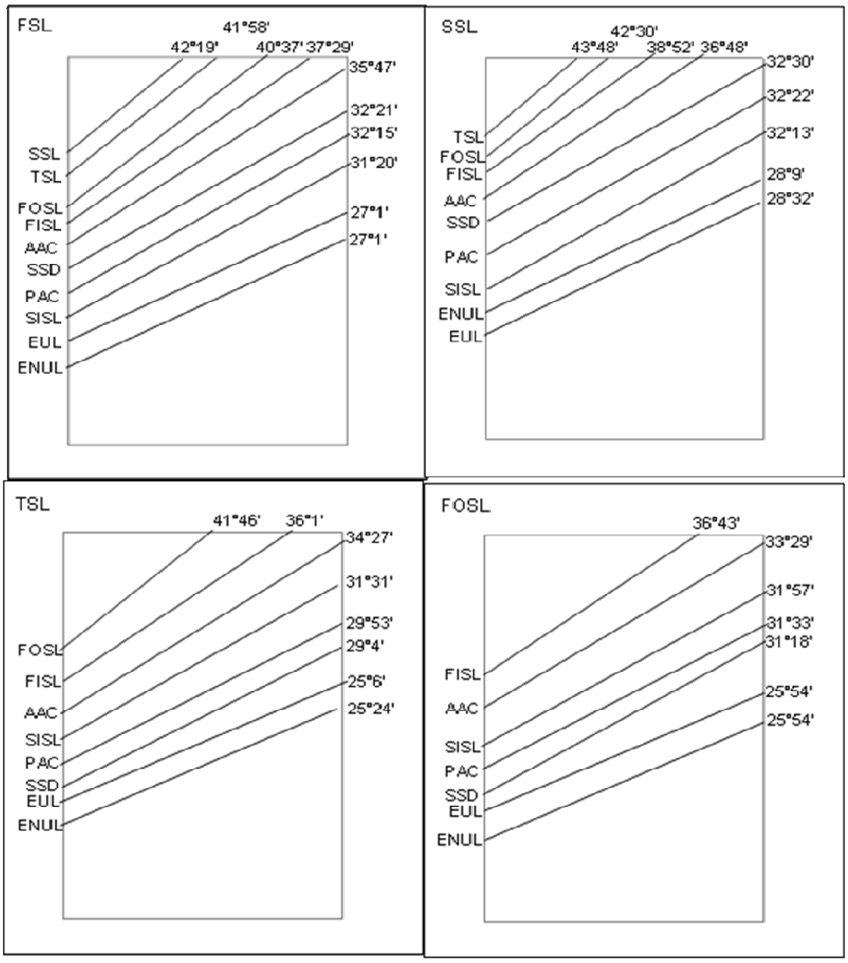


Fig.3. Graphical representation with tangent values for allometric relationship in male *Penaeus monodon* (wild)

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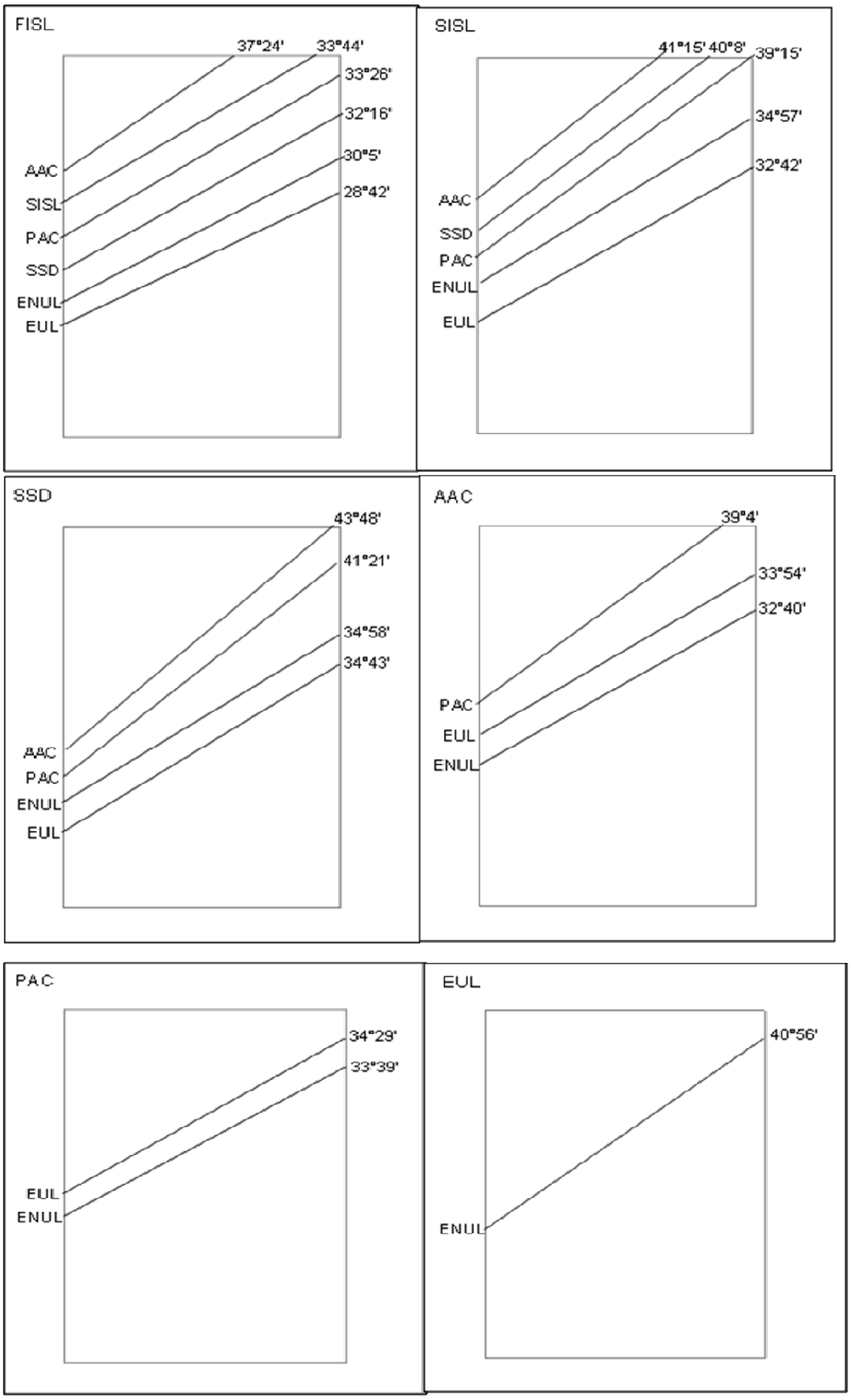
42°19'
40°37' 37°29'
35°47'
32°21'
32°15'
31°20'
27°1'
27°1'
SSL
TSL
FOSL
FISL
AAC
SSD
PAC
SISL
EUL
ENUL
SSL
42°30'
43°48'
38°52' 36°48'
32°30'
32°22'
32°13'
28°9'
28°32'
TSL
FOSL
FISL
AAC
SSD
PAC
SISL
ENUL
EUL
TSL
41°46'
36°1'
34°27'
31°31'
29°53'
29°4'
25°6'
25°24'
FOSL
FISL
AAC
SISL
PAC
SSD
EUL
ENUL
FOSL
36°43'
33°29'
31°57'
31°33'
31°18'
25°54'
25°54'
FISL
AAC
SISL
PAC
SSD
EUL
ENUL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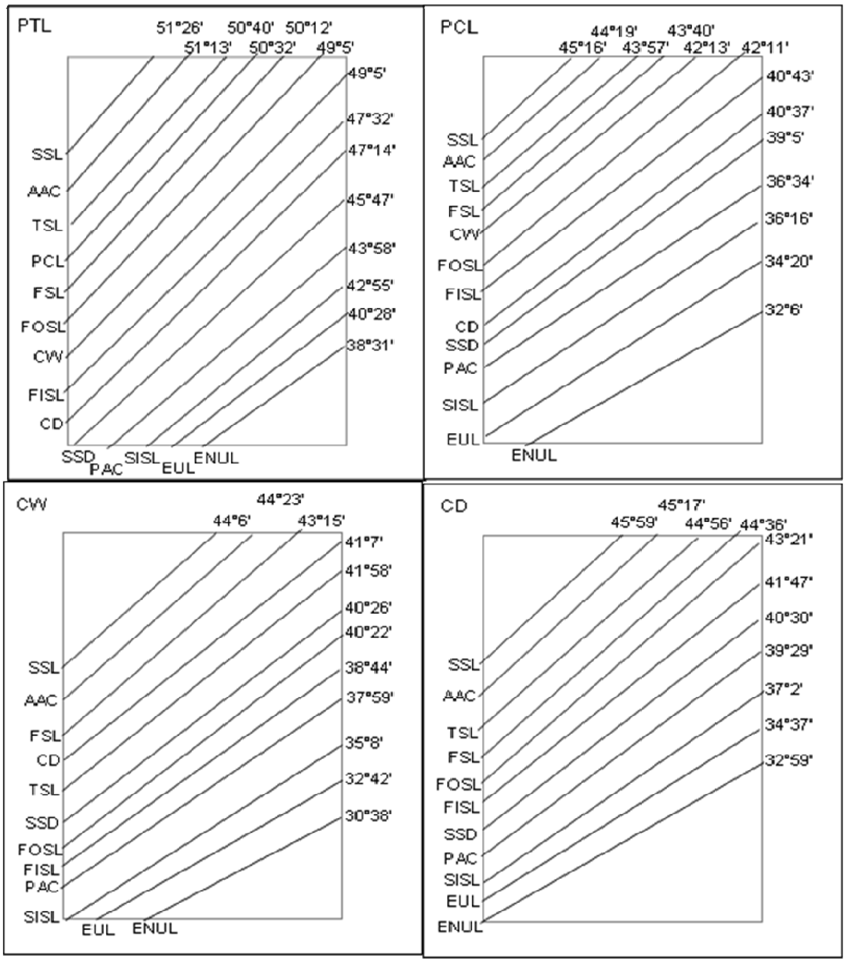
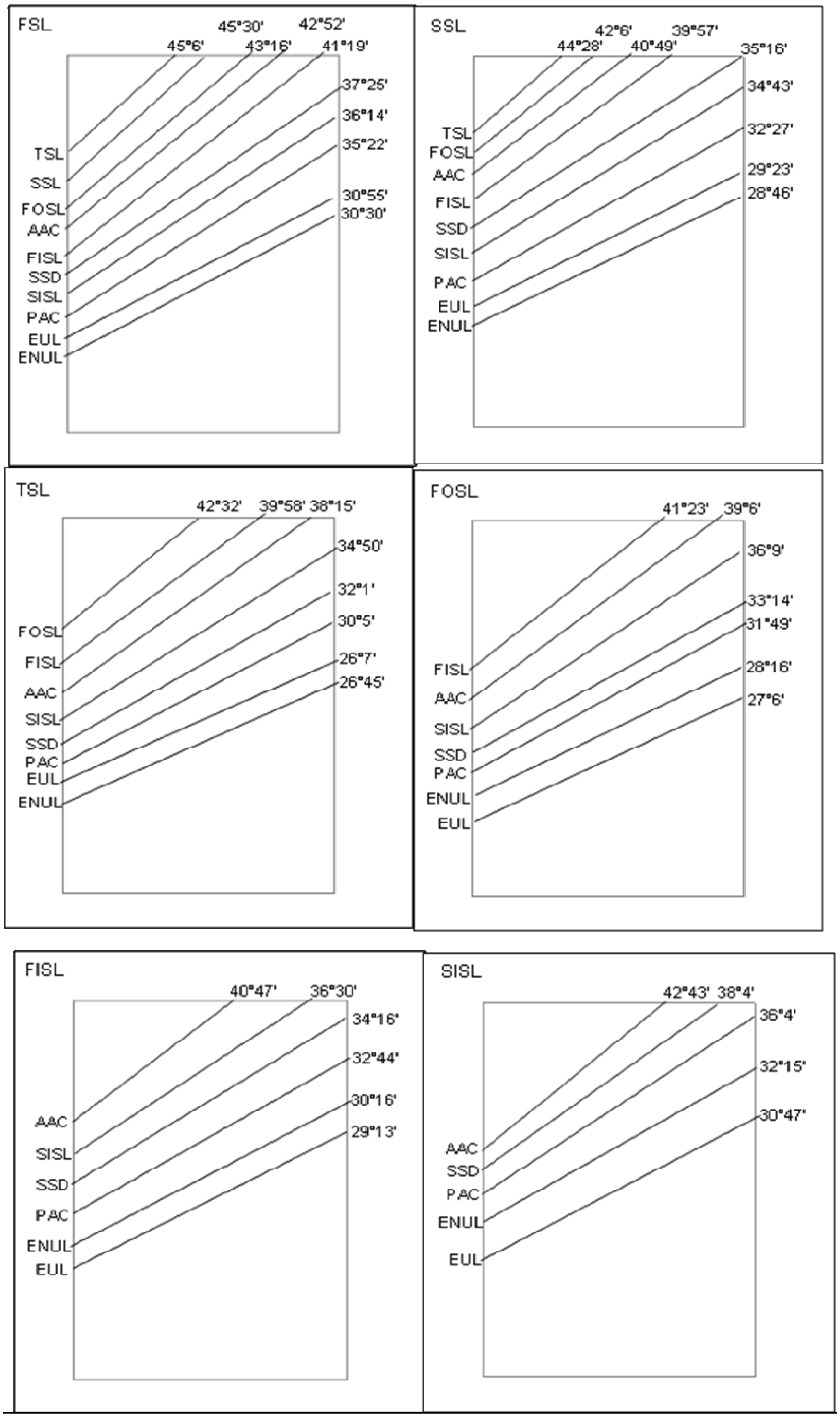
33°26'
32°16'
30°5'
28°42'
AAC
SISL
PAC
SSD
ENUL
EUL
SISL
41°15'
40°8'
39°15'
34°57'
32°42'
AAC
SSD
PAC
ENUL
EUL
SSD
43°48'
41°21'
34°58'
34°43'
AAC
PAC
ENUL
EUL
AAC
39°4'
33°54'
32°40'
PAC
EUL
ENUL
PAC
34°29'
33°39'
EUL
ENUL
EUL
40°56'
ENUL

Fig.4. Graphical representation with tangent values for allometric relationship in male *Penaeus monodon* (culture)

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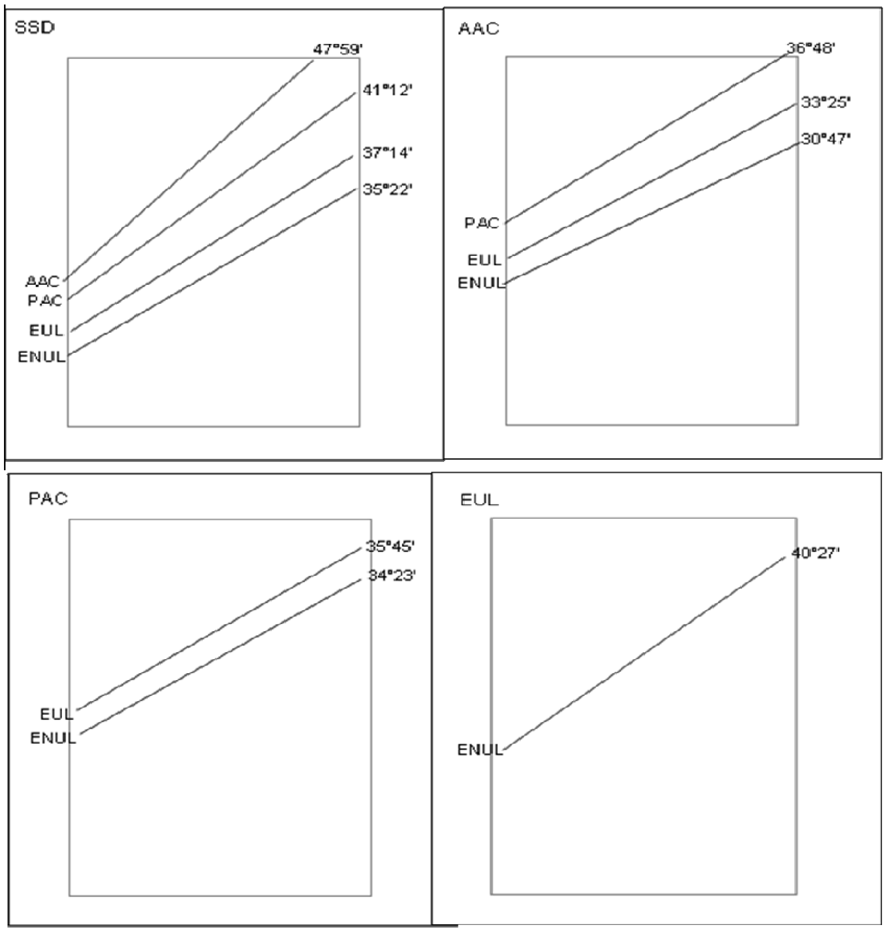
45°6' 43°16' 41°19'
37°25'
36°14'
35°22'
30°55'
30°30'
TSL
SSL
FOSL
AAC
FISL
SSD
SISL
PAC
EUL
ENUL
SSL
42°6' 39°57'
44°28' 40°49'
35°16'
34°43'
32°27'
29°23'
28°46'
TSL
FOSL
AAC
FISL
SSD
SISL
PAC
EUL
ENUL
TSL
42°32' 39°58' 38°15'
34°50'
32°1'
30°5'
26°7'
26°45'
FOSL
FISL
AAC
SISL
SSD
PAC
EUL
ENUL
FOSL
41°23' 39°6'
36°9'
33°14'
31°49'
28°16'
27°6'
FISL
AAC
SISL
SSD
PAC
ENUL
EUL
FISL
40°47' 36°30'
34°16'
32°44'
30°16'
29°13'
AAC
SISL
SSD
PAC
ENUL
EUL
SISL
42°43' 38°4'
36°4'
32°15'
30°47'
AAC
SSD
PAC
ENUL
EUL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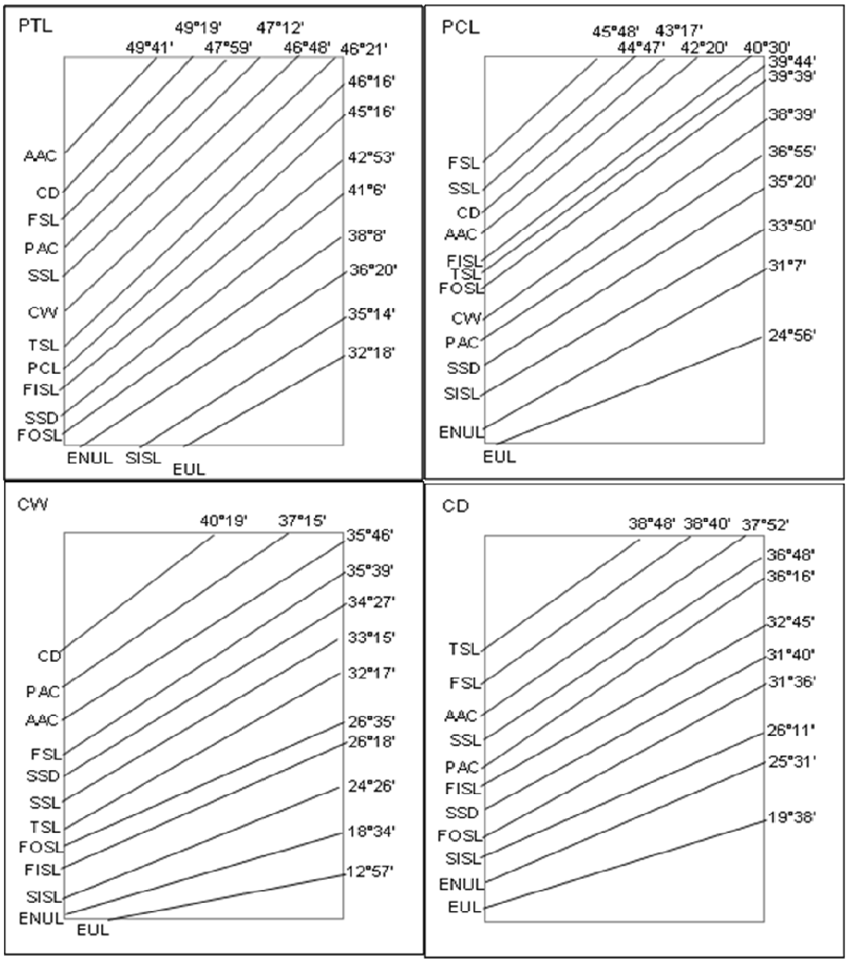
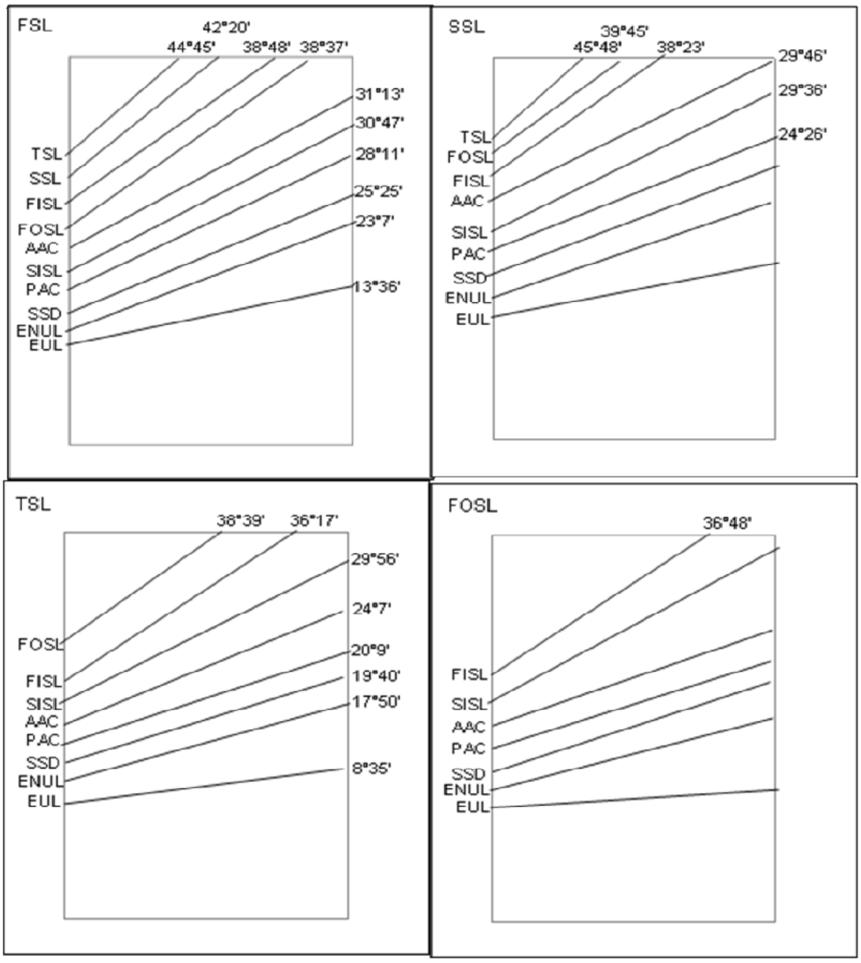
PAC
EUL
ENUL
AAC
36°48'
33°25'
30°47'
PAC
EUL
ENUL
PAC
35°45'
34°23'
EUL
ENUL
EUL
40°27'
ENUL

Fig.5. Graphical representation with tangent values for allometric relationship in female *Penaeus monodon* (wild)




FSL
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38°48'
38°37'
31°13'
30°47'
28°11'
25°25'
23°7'
13°36'
TSL
SSL
FISL
FOSL
AAC
SISL
PAC
SSD
ENUL
EUL
SSL
39°45'
45°48'
38°23'
29°46'
29°36'
24°26'
TSL
FOSL
FISL
AAC
SISL
PAC
SSD
ENUL
EUL
TSL
38°39'
36°17'
29°56'
24°7'
20°9'
19°40'
17°50'
8°35'
FOSL
FISL
SISL
AAC
PAC
SSD
ENUL
EUL
FOSL
36°48'
FISL
SISL
AAC
PAC
SSD
ENUL
EUL

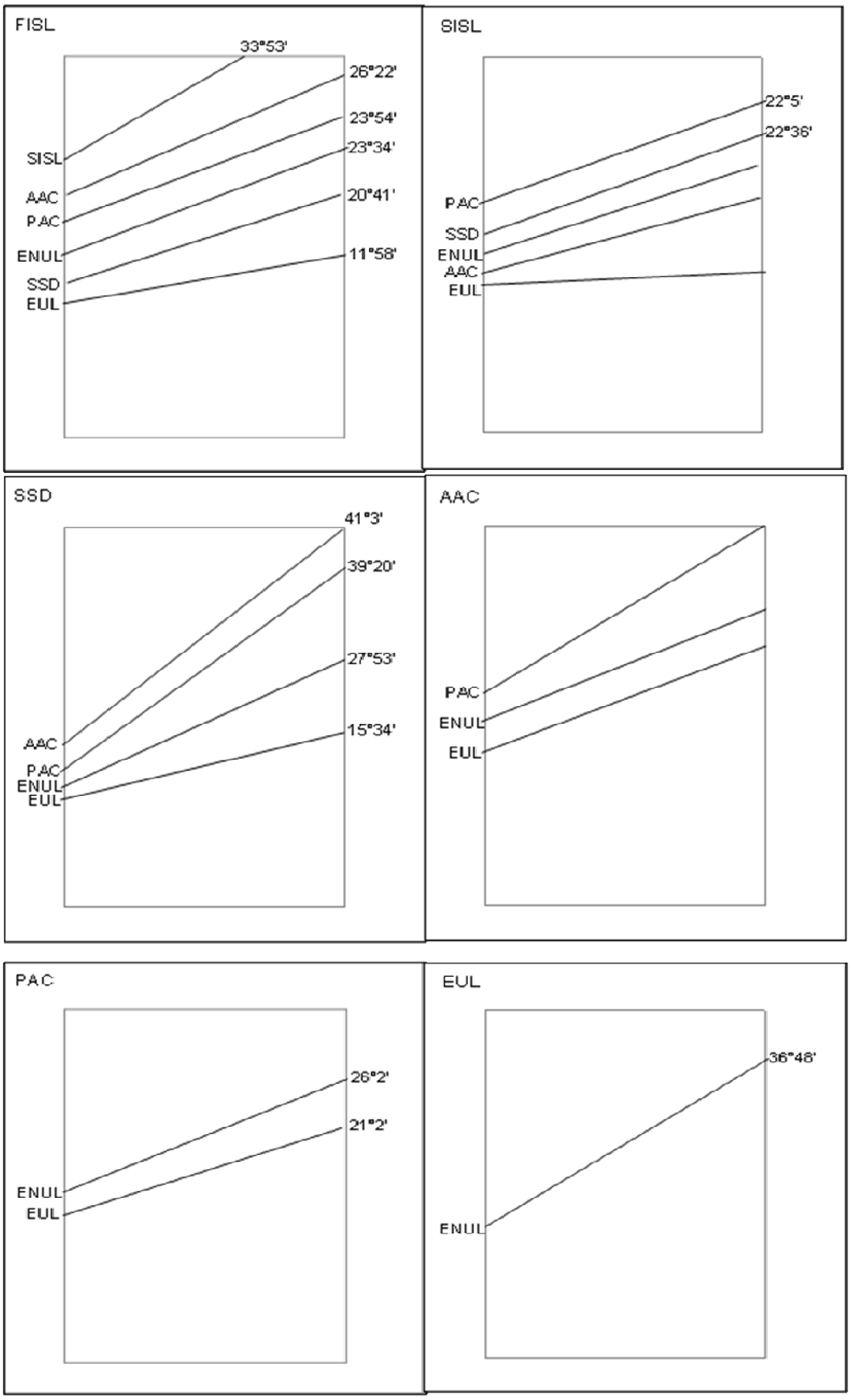
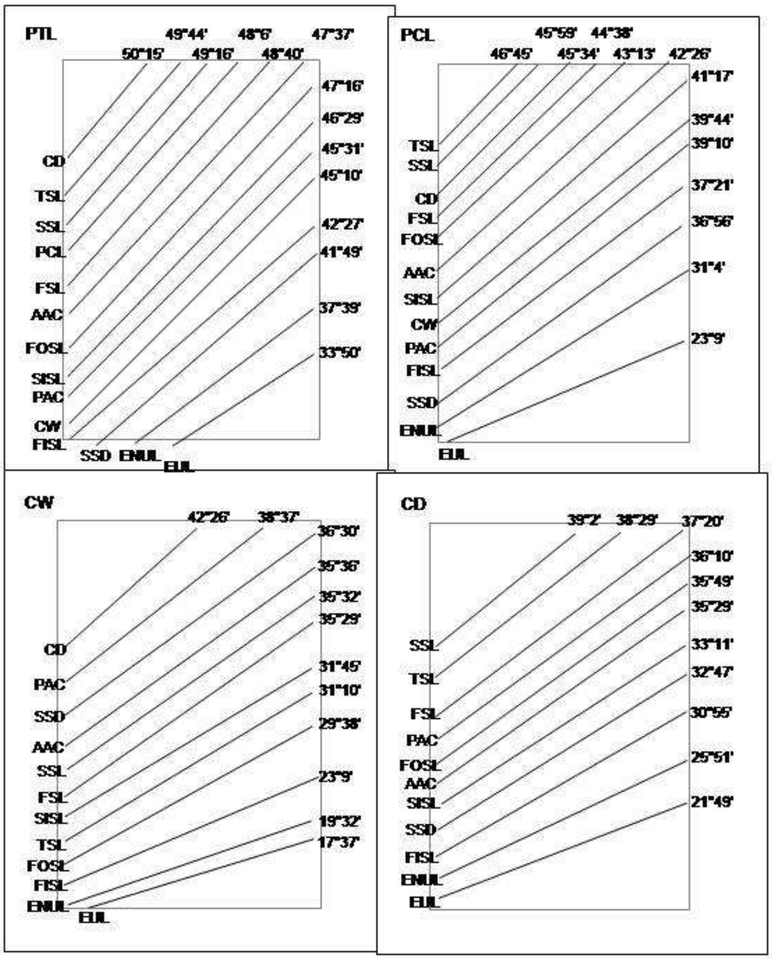
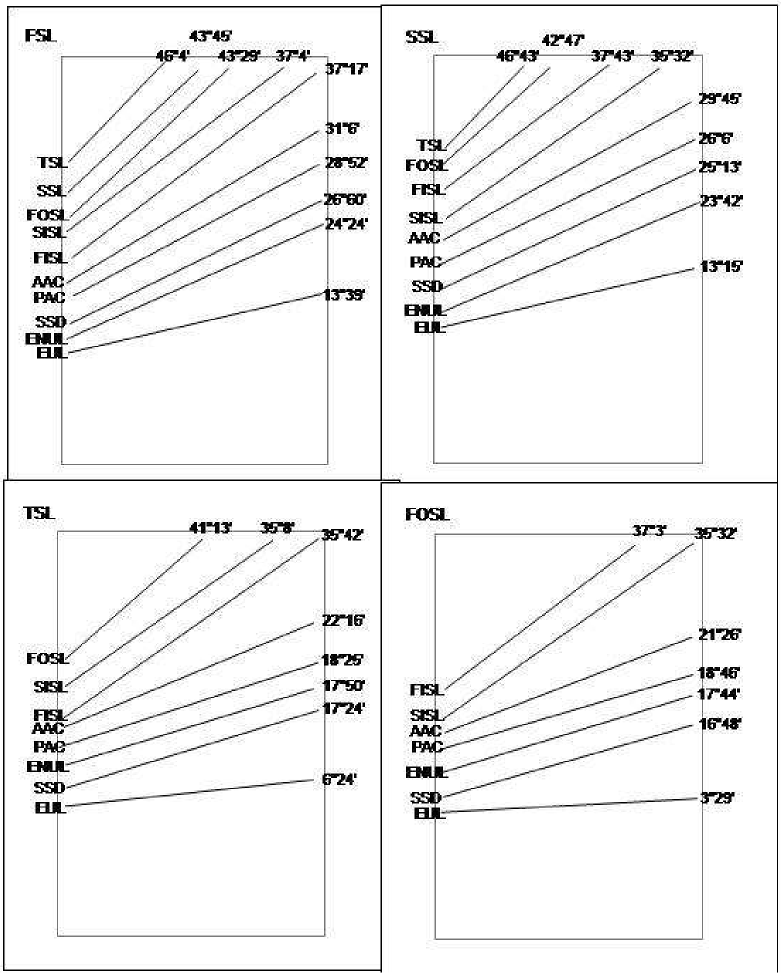

FISL
33°53'
26°22'
23°54'
23°34'
20°41'
11°58'
SISL
AAC
PAC
ENUL
SSD
EUL
SISL
22°5'
22°36'
PAC
SSD
ENUL
AAC
EUL
SSD
41°3'
39°20'
27°53'
15°34'
AAC
PAC
ENUL
EUL
AAC
PAC
ENUL
EUL
PAC
26°2'
21°2'
ENUL
EUL
EUL
36°48'
ENUL

Fig.6. Graphical representation with tangent values for allometric relationship in female *Penaeus monodon (*culture)




FSL
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46°4'
43°29'
37°4'
37°17'
31°6'
28°52'
26°60'
24°24'
13°39'
TSL
SSL
FOSL
SISL
FISL
AAC
PAC
SSD
ENUL
EUL
SSL
42°47'
46°43'
37°43'
35°32'
29°45'
26°6'
25°13'
23°42'
13°15'
TSL
FOSL
FISL
SISL
AAC
PAC
SSD
ENUL
EUL
TSL
41°13'
35°8'
35°42'
22°16'
18°25'
17°50'
17°24'
6°24'
FOSL
SISL
FISL
AAC
PAC
ENUL
SSD
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FOSL
37°3'
35°32'
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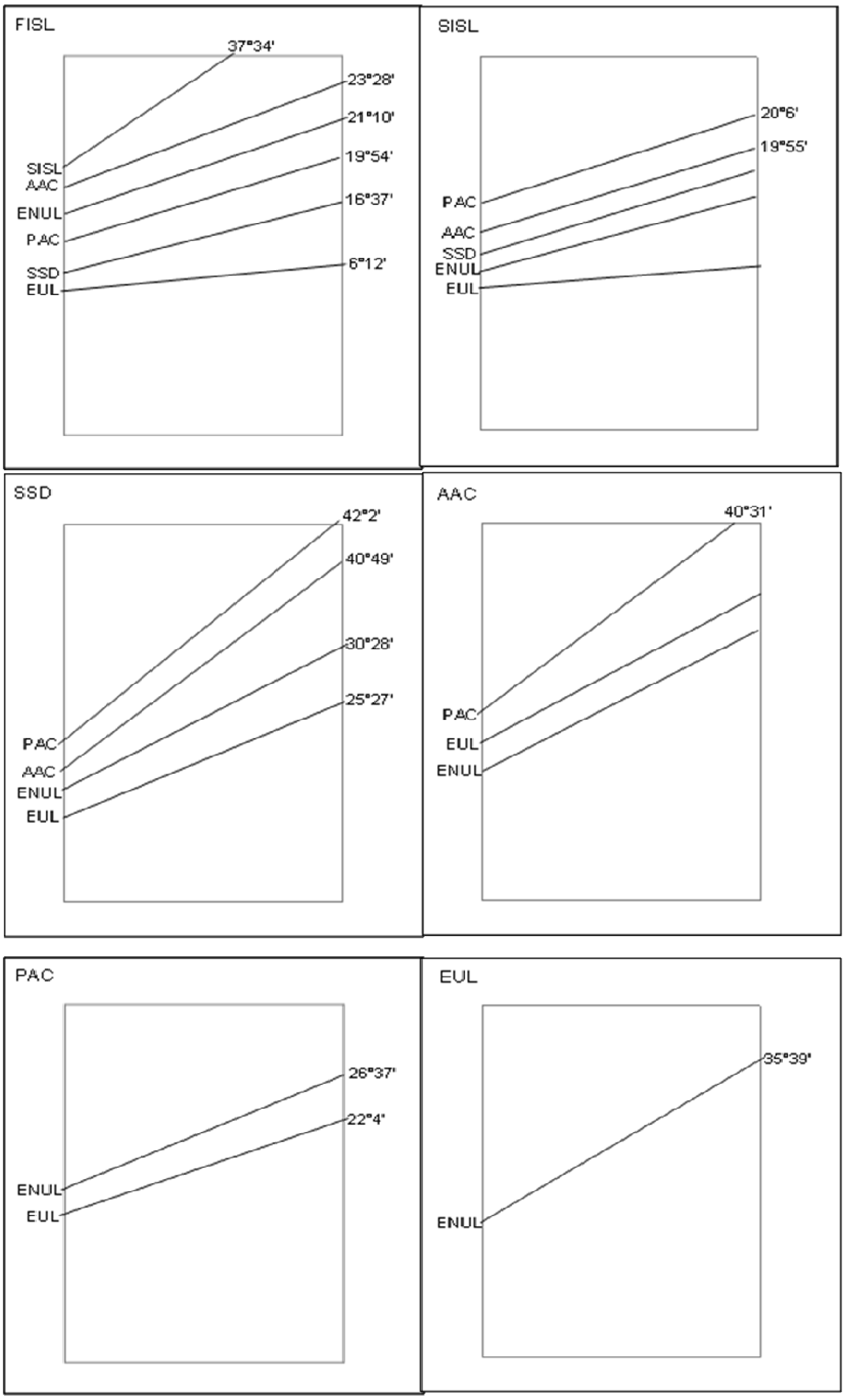

In the present study, in the wild males, PTL X FSL, PCL X FiSL, CD X FSL and CD X SSL were the combinations that showed positive allometric relationships. The following combinations, PTL X SSL, PCL X FSL, PCL X SSL and CD X TSL, showed isometric growth relationships. All the other combinations had negative allometric relationships.

In cultured males, PTL X PCL, PTL X CW, PTL X CD, PTL X FSL, PTL X SSL, PTL X TSL, PTL X FoSL, PTL X FiSL, PTL X AAC and SSD X AAC showed positive allometry. PTL X SSD, PCL X SSL, CD X SSL, FSL X SSL and FSL X TSL showed isometric relationship. All the other combinations showed negative allometry.

In wild females, PTL X CW, PTL X CD, PTL X FSL, PTL X SSL, PTL X TSL, PTL X AAC, and PTL X PAC showed positive allometric growth. Isometric growth was observed between the combinations of the following characters, PTL X PCL, PCL X FSL, and SSL X TSL. All the other combinations had negative allometric relationship.

In cultured females, PTL X PCL, PTL X CD, PTL X FSL, PTL X SSL, PTL X TSL, PTL X FoSL, PTL X SiSL, PTL X AAC, PCL X TSL, FSL X TSL and SSL X TSL were the combinations that showed positive allometric relationship. PTL X CW, PTL X PAC, PCL X CD and PCL X SSL showed isometric growth relationship. The remaining combinations showed negative allometric growth relationships.

From the above observations, more number of combinations showed positive allometric growth relationships in cultured males and females than their wild counterparts. This may be attributed to the favourable environmental conditions in the culture systems.

A few studies have dealt with morphometric and genetic variation in quantitative traits of decapods crustaceans [14,15,16,17]. Study on the morphometric variability of brood stock for genetic improvement in *P. monodon* was done by [18] and stated that heterogeneous environment at different localities caused morphometric differentiation among different samples. The morphometric characters of the kuruma shrimp *P. japonicus* in the East China Sea and the Taiwan Strait was analyzed by [19] and reported that the knowledge of stock structure is essential for rational exploitation and management of exploited species. Morphological variability among different geographical populations could be attributed to different genetic structure of populations and to different environmental conditions prevailing in each geographic area [20]. The animals, therefore with the same morphometric measurements are often assumed to constitute a stock [21] and that has been used widely in fishery stock differentiation studies [22]. Recent research on the shrimp growth was carried out by [23]. Report on the antibacterial activity on shrimp pathogen also a recent contribution on shrimp [24].

CONCLUSION

Studying the morphometric character is essential to assess the stock in the wild for exploitation. The morphometric characters for cultured male and female shrimps showed better result than the wild caught shrimps since cultured shrimps grow rapidly in captive conditions.

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