Stock structure analysis of '*Aristeus alcocki* Ramadan, 1938 (Decapoda: Aristeidae)' in the Indian coast with truss network morphometrics

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Abstract: *Aristeus alcocki* Ramadan, 1938 is a deep sea penaeid shrimp that forms a major commercial fishery in the Indian coast. However, the spawning population of this species along the Indian coast is poorly known. To study this, stock structure of *A. alcocki* using truss morphometry was employed. A total of 1842 matured specimens were collected from five geographical locations (Tuticorin (SET), Chennai (SEC), Nagapattianam (SEN), Sakthikulangara (SWS), and Kalamuku (SWK)) along the Indian coast. Thirty-nine truss distances were extracted from each specimen and analyzed by multivariate methods via principal component analysis (PCA), discriminant functions (DF) and hierarchical cluster analysis. The results of PCA analysis indicate that the first two components cumulatively explained >70% (female: 72.1%; male: 71.5%) of the total morphometric variation. Stepwise discriminant function analysis indicated abdominal variables significantly discriminated the populations at different locations. The results clustered the five samples into a minimum of two groups, group-I included the samples from SWK while rest of the samples clustered in group-II. Morphometric variation between the groups was significant for each sex. Significant differences between the groups may be attributed to geographical and environmental conditions suggesting separate management strategies for the resource sustainability.

Key words: Aristeus alcocki, Truss morphometry, PCA, Deep sea shrimp, DF

Introduction

In fisheries management, the term ‘stock’ refers to a sub-set of a particular fish or shellfish species inhabiting a particular geographical area with the same growth and mortality parameters (Gulland 1983). Stock structure means the contribution of stock units that represent the entire population and not the population structure in terms of their length/ size. The major objective of stock assessment programs is to manage fishery resources by providing advice on the optimum exploitation (Sparre and Venema 1998). Thorough knowledge of the stock structure of the target species in commercial fisheries forms the basis to formulate resource management strategies (Shaklee and Bentzen 1998). If the stock structure is not considered while formulating plans for fisheries management, it can lead to the collapse of the population due to the changes in biological attributes and loss in productivity rates (Begg et al. 1999; Cadrin 2005). Stock structure analysis is, therefore, a pre-requisite for developing fishery management plans to understand the existing levels of recruitment that may replenish the population (Cadrin et al. 2005).

The study of morphometrics using truss network is a quantitative method to represent the complete shape of the fish (Strauss and Bookkstein 1982). This representation is formed by interlinking the measurements between morphometric landmarks that give rise to a systematic pattern of connected cells covering the entire body structure (Turan 1999) which has been successfully used for population and taxonomic studies (Lin et al. 2005; Mevlut et al. 2006). Stock identification by truss network analysis is a practically useful and an effective strategy for the description of the body shape in comparison to the traditional morphometric method (Cadrin 2005). It is effectively used to discriminate the stocks and differentiate between the population's shapes (Stratuss and Bookstein 1982).

A large number of studies using the box-truss network method gave better results in categorizing individuals accurately and classifying them to their intraspecific groups (Turan 1999). In particular, the truss is a landmark-based technique that poses no restriction on the direction and localization of change in shape and is highly effective in capturing data on the shape of the organism (Cavalcanti et al. 1999). Phenotypic characters have been successfully used for stock differentiation in many shrimps, *Macrobrachium* *vollenhovenii* (Herklots, 1857) (Konan et al. 2010), *Macrobrachium nipponense* (De Haan, 1849 (in De Haan, 1833-1850)) (P-C Chen et al. 2015) and fish species *viz*., *Decapterus russelli* (Rüppell, 1830) (Sen et al. 2011), *Harpadon nehereus* (Hamilton, 1822) (Pazhayamadom et al. 2015), *Sardinella longiceps* Valenciennes, 1847 (Remya et al. 2015), and *Nemipterus japonicus* (Bloch, 1791) (Sreekanth et al. 2015) while homogeneity was reported in the population of *Farfantepenaeus notialis* (Pérez Farfante, 1967) at Caribbean sea (Paramo and Saint-paul 2010). Homogenous fish populations are often composed of discrete stocks which may have unique demographic properties and responses to exploitation, which should be managed separately to ensure sustainable fishery benefits and efficient conservation (Kinsey et al. 1994; Begg and Brown 2000; Stransky et al. 2008; Neves et al. 2011).

Aristeus alcocki Ramadan, 1938 (Decapoda, Aristeidae), commonly known as Red Ring or Arabian red shrimp is distributed along the southern Indian coast at a depth range of 200-1000 m (Silas 1969; Suseelan 1989; Madhusoodana 2008; CMFRI 2015). It forms a commercial fishery confining only along the southeast and southwest coast, and it’s not recorded along the northern coast of India (Mohamed and Suseelan 1973). The catch landed between 2008 and 2015 indicate that the *A. alcocki* is the prime species in order of biomass among the deep sea penaeid catch accounting to about 36% from the whole Indian coast and the trend in catch rates indicates a decline of these deep-sea shrimps (CMFRI 2008-2015). In this study we aim to investigate the effectiveness of the truss variables in differentiating the populations of *A. alcocki* along the Indian coast using truss morphometry, to provide management advisory for fisheries sustainability.

Materials and methods

Sampling

Samples of *A. alcocki* were collected from five different fishing harbors i.e., Tuticorin (SET), Chennai (SEC), Nagapattianam (SEN) on the southeast, and Sakthikulangara (SWS), Kalamuku (SWK) on the southwest Indian coast (Fig. 1). The sampling sites were chosen such that they are distantly apart in latitudinal aspect to reduce the chances of mixing specimens from the same population. In total, 1842 specimens were collected from the selected sampling sites i.e., from commercial fishing harbors where the catch is landed by multiday trawlers along the southern coast during December 2014 and January 2015. The samples were collected during peak breeding season (November to January) to ensure that they represent to their parent population. The matured specimens (carapace length: female>3.5 cm; male: >2.0 cm) were sorted from the samples collected from each fishing location and used for truss morphometric analysis. The species exhibit a high degree of sexual dimorphism where males were identified by the presence of petasma and females were sorted based on the presence of thelycum. Specimens showing physical damage *viz*., broken rostrum or any other body parts may distort the shape characteristics and hence they were not included in the samples for the study (Table 1).

Digitization of specimens and fixing anatomical landmarks

Shrimp samples were first cleaned with running water, allowed the water to drain, wiped with tissue paper and finally placed on a graph paper (Fig. 2). Each specimen was placed on a flat platform with a graph paper over a thermofoam, appendages (pereiopods and pleopods) and telson were erected by positioning the rostrum portion towards the left side, telson on the right by assuming symmetry between left and right side of the shrimps and was labeled with a specific ID code. This helps us in identifying specimens if more landmarks are required to be fixed or if the morphometric measurements are to be repeated. Digital images of the specimens were captured using a camera (Canon *G*-15) which was fixed on a tripod stand directly above the specimen and the lens was adjusted so the margins of viewfinder align with margins of the graph paper in *X-Y* directions and each image included a scale to standardize the individual sizes and further scaling was applied in tpsdig utilizing the millimeter grid in graph paper (Fig. 2). These images were used further in fixing the anatomical landmarks and measuring linear distances between them i.e., truss variables. In many previous studies, it has been found that differences in sex are likely to contribute to shape differences affecting total variance in morphometric distances (Sajina et al. 2011; Reiss and Grothues 2015; Pazhayamadom et al. 2015). In the present analysis, both males and females were included to accommodate the effect of sex on their morphometry. The extraction of numeric truss distances from the digital images of specimens were carried out by using two software platforms, 1) tpsDig2 V2.1 for marking the landmark coordinates on the digital images (Rohlf 2006) and 2) paleontological statistics (PAST) for extracting the values pertaining to the marked distances (Hammer et al. 2001). The data extracted by this method ensures stability, accuracy, and repeatability.

Analysis of truss morphometric data

The normality and homogeneity variance assumptions were verified with the log-transformed data, using the SAS PROC UNIVARIATE procedure (SAS 2014), and the data rows with outliers (7-10%) were removed from each location, before proceeding further for analysis. MANCOVA was used to establish significant differences among sex, location using log-transformed data and carapace length (CL) was incorporated into the models as a covariate. Therefore, the whole truss measurements (39 distances) were transformed to size-independent shape variables using an allometric method as suggested by Reist (1985) in Equation 1.

$M_{trans} = logM - \beta\ (log\ CL - log\ CL\ mean)$ Equation 1,

Where M_{trans} is the truss measurement after transformation, M is the original truss measurement, CL is the carapace length of the shrimp which is reported to be more reliable than using total length (TL) in the case of crustaceans (FAO 1974), $CL\ mean$ is the overall mean carapace length, and β is the slope regressions of the $log\ M$ against log CL.

Correlation coefficients were checked between each pair of variables before and after the size effect removal. In such analysis, the absolute values of correlation coefficients were expected to decrease after size effect removal (Murta 2000). Mean ($\bar{x}$), standard error (SE), standard deviation (SD), maximum and minimum of all measurements were recorded for each population. The percentage of coefficient of variation (CV%) was computed as CV% = 100×SD/ $\bar{x}$ of morphometric variables in each population. Multivariate analysis used in this study consisted of principal component analysis (PCA), discriminant functions (DF) and hierarchical cluster analyses.

PCA was used to evaluate morphometric variation among specimens and identify variables contributing substantially to that variation. DF was run to test the effectiveness of variables in predicting different group locations (Tomovi´c and Dˇzuki´c 2003; Loy et al. 2008). The stepwise inclusion procedure was carried out to reduce the number of variables and identify the combination of variables that best separates the groups (Hair et al. 1996; Jain et al. 2000; Poulet et al. 2005) to obtain confusion table matrix. Hierarchical cluster analysis (HCA) based on Mahalanobis distances matrices determined with DF, was used to evaluate population relationships, as implemented by Slabova and Frynta (2007) and Ferrito et al. (2007). All the analysis in the present study was done by using Statistical Analysis System software (SAS 2014).

Results

Descriptive statistical results showed less coefficients of variation (CV) (<25%) in all the truss variables for both the sex at five different locations (Table 2). The range of CV for female varied from 7.6 to 20% and for male was 4.9 to 21.6%. The morphometric variability within populations was low for all the locations.

Correlation coefficients between the morphometric variables were estimated before and after the size effect removal (see Supplementary Table. S1 and S2). Before the size effect, removal coefficient values were highly significant while it was reduced after the correction which suggested that the effects of size had been effectively removed from the morphometric data. The mean carapace length specifies that the males are much smaller than females, a significant difference on sex and location was observed (Table 3).

The results of PCA analysis indicate that the first two components cumulatively explained >70% (female: 72.1%; male: 71.5%) of the total morphometric variation. A few truss distances loaded heavily on PC1 (1-2, 1-18, 2-18, 3-17, and 5-15) which alone explained >63% of the entire variance. The loadings of two variables i.e., the 1-2 distances that correspond to the rostral length and the 1-18 distances that connect the rostrum tip to the pterygostomian spine contributed a substantial proportion of the total variance. PC2 explained 8.21% of the total variation, and 3 distance variables (3-4, 15-16, and 4-17) corresponding to the abdominal region of the shrimp loaded heavily on this component. The distances with high loadings on both PC1 and PC2 characterize the rostrum and 2nd to 3rd abdominal segment portion of the shrimp (Fig. 3) and they all were found to be positive, signifying the positive correlation between the variables within a component i.e., these attributes grow in proportion with one another. A scatter plot between PC1 and PC2 resulted in the separation of SWK from other populations (Fig. 4).

With respect to the stepwise discriminant function analysis, 6 out of 39 variables were efficiently discriminated the different populations. The pairwise *F*-tests on these primary important characters were obtained and shown in Table 4. The well-defined female populations were from SWK with classified individual percentage >70 % (Table 5). A minimum proportion of 1.4% of each population was allocated to every population. The highest misclassification rate of 14.1 % was observed between SEN and SWK. While in male population also SWK was classified with >50% individuals and minimum 5.4% of each population was allocated to other population and with higher misclassification rate (21.4 %) compared to the female population. The overall rate of correct classification is 68.5% in female and 40.0% in the male. This analysis revealed that the Mahalanobis distances between the different groups were significant ($P<0.001$). The well-separated population was SWK and most closely related samples were SEN and SET.

From cross-validation analysis, 64.4% of female and 48.1% of male individuals were correctly classified to their corresponding group (Table 5). The greatest proportion of classification was obtained in SET female populations (83.5%) and SWK male population (54.1%). The higher proportions of misclassified female individuals from SWK were allocated to SWS and males of SEC were allocated to SET (26.4 %).

The first two canonical functions carry the analysis through the 89.9% and 84.7% for female and male, respectively, indicating that the greatest level of variation was due to the first two canonical variables. The ordination of female and male individuals on the canonical factor I and II (Fig. 5) showed well separation in SWK population from other populations based on the II canonical factor.

The results of hierarchical cluster analysis showed two distinct groups from five populations of both sexes (Fig. 6). The group-I included SWK population and SWS, SET, SEN, SEC populations clustered in group-II. This analysis showed that SWK samples constituted phenotypically a separate population, while the morphometric resemblance between SWS, SET, SEN and SEC stocks were found to be high. The analysis of the present study revealed that the variables used in this study were capable to clearly differentiate SWK population from the other group.

Discussion

This is the first report on the study of *A. alcocki* population collected from five locations along the Southeast and west coast of India. The results of the present study demonstrated that *A. alcocki* exhibited morphometric variability revealing two groups, SWK separately clustered in group-I while the samples collected from other four locations clustered in group-II.

MANCOVA showed a clear trend of sexual dimorphism in *A. alcocki.* In male's rostrum was always noticed to be shorter than in females, which helps for mating, swimming behavior (Burukovsky and Romensky 1972), sexual segregation, and feeding activity (Cartes and Sardà 1989; Kapiris and Thessalou-Legaki 2001; Chakraborty et al. 2015). A similar observation was made in *Aristeus antennatus* (Risso, 1816) from Mediterranean Sea (Sardà and Gordoa 1986; Sardà and Demestre 1987; Kapiris et al. 2002). Female individuals tend to have greater dimensions in their cephalic and abdominal segments, as well as in the rostral length. The lesser coefficient of variation (<25%) for all the variables at five locations was noticed, indicating low variation in the intra-population from all the locations. It might be due to high inheritability and less influence of environmental parameters (both abiotic and biotic, e.g., availability of food) on the individuals which reduces the expression of significant differences within populations.

The principal component analysis revealed that the phenotypical differences were relatively less between the different populations of SEC, SEN, SET, SWS except for SWK suggesting close relationship mainly due to the less variation in abdominal segments among these populations. The probable reasons hypothesized for this similarity was larval dispersal and long-distance migration for food, breeding and current patterns from the Arabian Sea to Bay of Bengal. SWK population was well separated due to the variability in the shorter abdominal characters (3-4 and 15-16) compared to the rest of the populations. These differences are likely to manifest adaptations to environmental conditions and also an exhaustive study is required to understand this intricacy. The geographic barrier and uncommon hydrological conditions (e.g. salinity, current flow, and temperature) play an important role in affecting gene flow between populations responsible in differentiation among the individuals (Macholán 2001; Brian et al. 2006; Ferrito et al. 2007; Chamarthi et al. 2008). Bagherian and Rahmani (2009) reported slender body shape in *Chalcalburnus chalcoides* (Güldenstädt, 1772) due to high water velocity. Also, the current pattern of Bay of Bengal and

Arabian Sea was found to modify the morphometry of *Megalaspis cordyla* (Linnaeus, 1758) (Sajina et al. 2010) and *Macrobrachium nipponense* (Chen et al. 2015).

The consistent level of classification was obtained by discriminant functions due to the environmentally induced morphological changes between shrimp populations. This demonstrated the efficiency of morphometric variables in distinguishing the populations. In fact, a strong differentiating power of the morphometric variables was found for comparison between populations (Ferrito et al. 2007; Anastasiadou et al. 2009). The misclassification results of discriminant functions clearly support that similarity between the populations within and between coasts can be attributed to a common environment, genetic origin at an earlier period, and the resemblance may also be associated to genetic introgression of the shrimps particularly that are in the transition zones. The present study revealed the close relationship between SET, SEN, SEC and SWS population. The highest similarity among SEN and SET specimens was supported by hierarchical cluster analysis (Fig. 6) which grouped SWK population in a group-I and got together SEC, SEN, SET, SWS populations in group-II in both sex, demonstrating the morphometric variability in *A. alcocki* populations. However, these results need to be verified through the molecular genetic studies.

Conclusion

The truss morphometric characters in *A. alcocki* can be efficiently used in the discrimination of populations as studied in other species of freshwater and marine environments. The major discriminating variable to differentiate the populations into two groups was attributed to the abdominal measurements, suggesting a need to adopt separate management strategies for the resource sustainability and policy regulations. However, future studies based on the genetic markers and biochemical methods can be used to validate the findings of this study.

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Supplementary material

Supplementary data associated with this article can be found, in the online version.

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Figure legends

Figure 1. Sampling locations used for the collection of *A. alcocki* specimens.

Figure 2. *A. alcocki* (a. Male, b. Female), placed on the graph paper showing 18 landmarks and 39 truss distances.

Figure 3. Variables with high loadings observed in the first (a) and second (b) component when morphometric variables were subjected to PCA.

Figure 4. Scatterplot of first two principle components from the PCA for both sex of *A. alcocki*.

Figure 5. Scatterplot of first two discriminant factor from the DF analysis for each sex in *A. alcocki*.

Figure 6. Dendrogram showing the patterns of morphometric similarity among *A. alcocki* from five locations along the Indian coast, (a) Female, (b) Male.

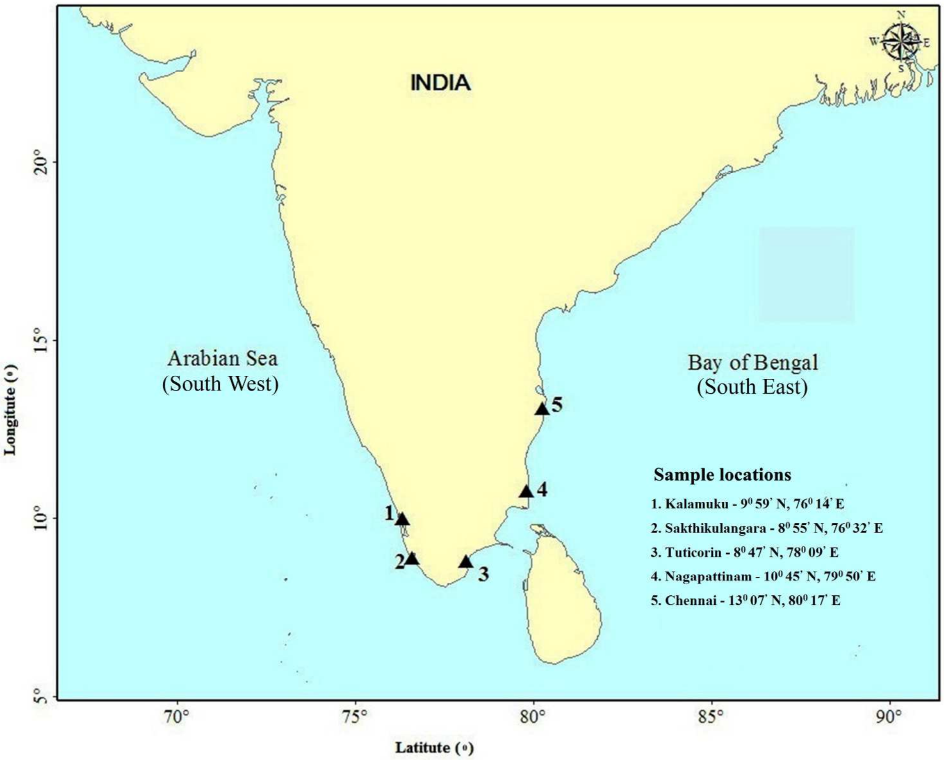

Figure 1. Sampling locations used for the collection of A. alcocki specimens.

221x178mm (300 x 300 DPI)

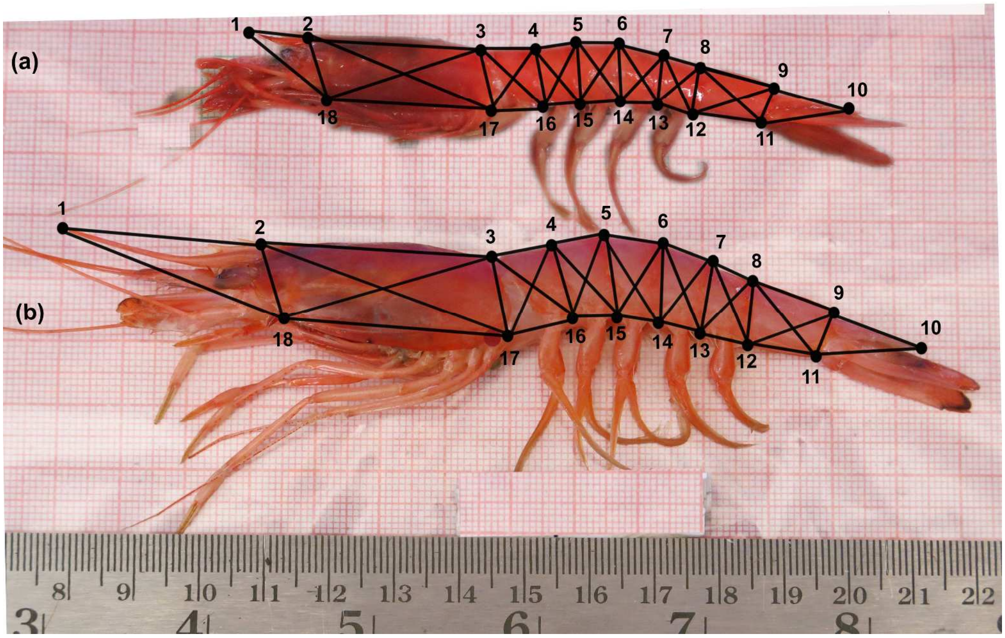

Figure 2. A. alcocki (a. Male, b. Female), placed on the graph paper showing 18 landmarks and 39 truss distances.

355x228mm (300 x 300 DPI)

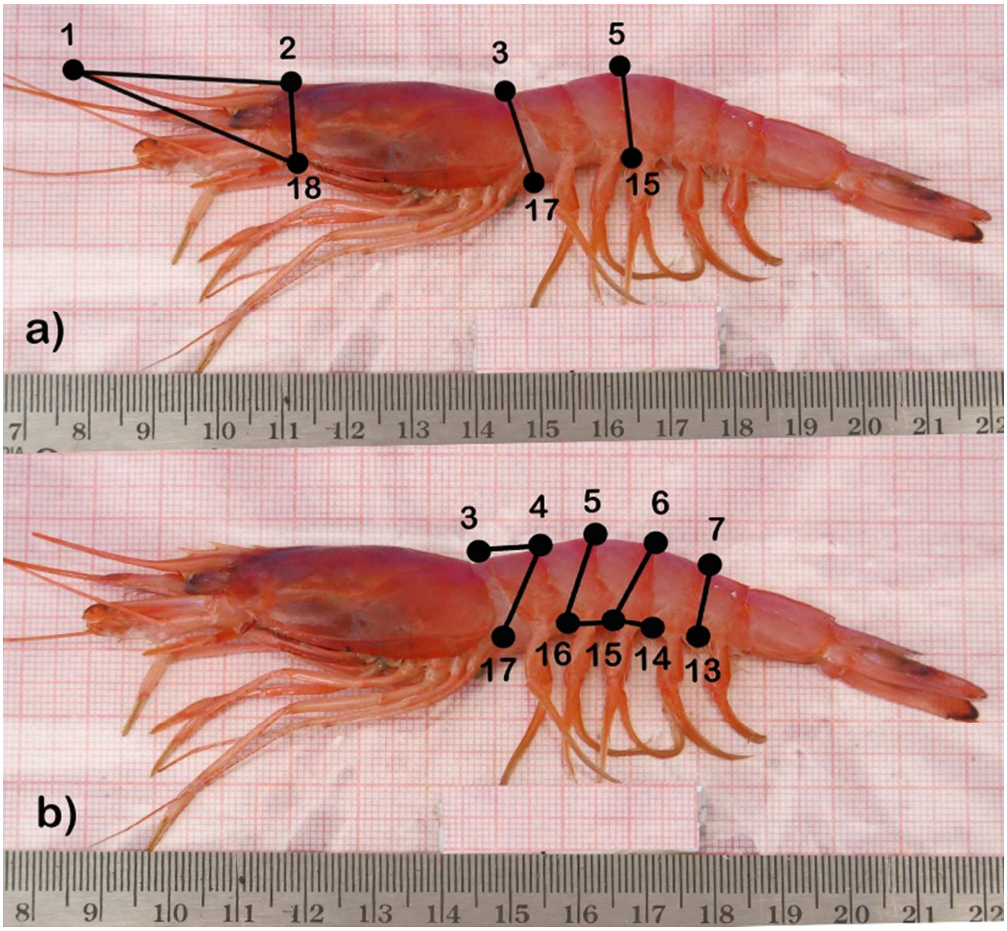

Figure 3. Variables with high loadings observed in the first (a) and second (b) component when morphometric variables were subjected to PCA.

206x190mm (300 x 300 DPI)

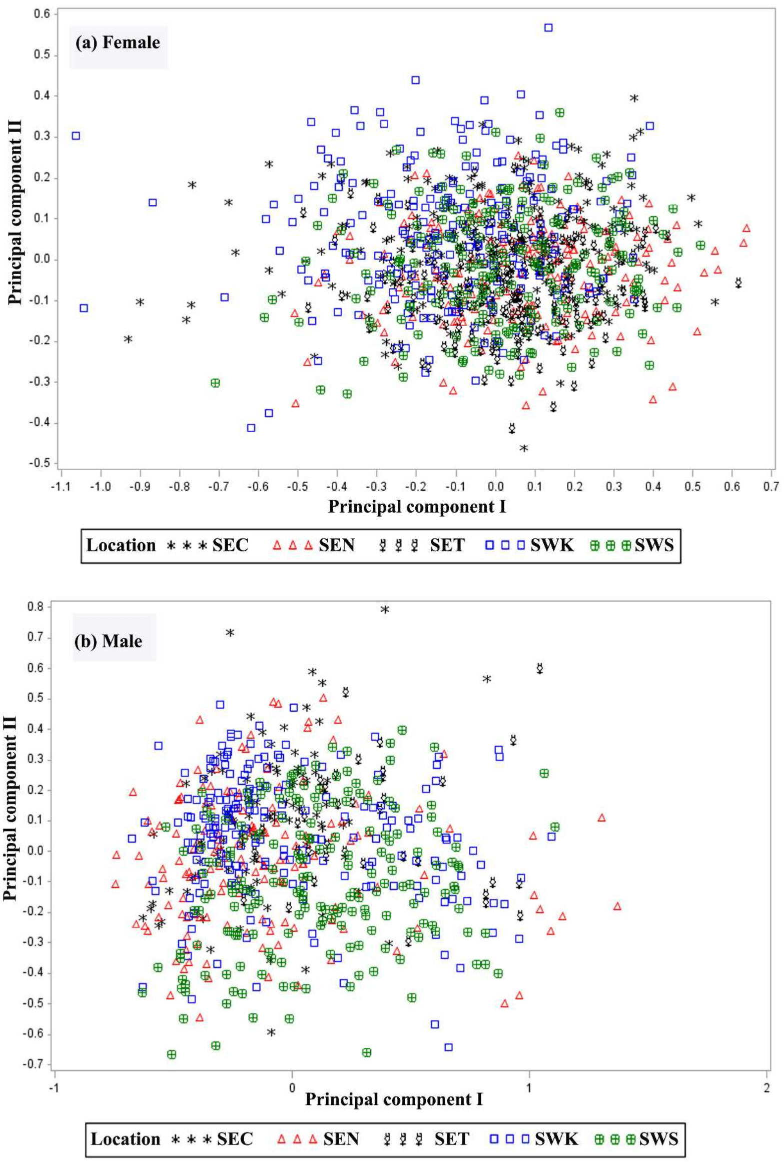

Figure 4. Scatterplot of first two principle components from the PCA for both sex of A. alcocki.

215x317mm (300 x 300 DPI)

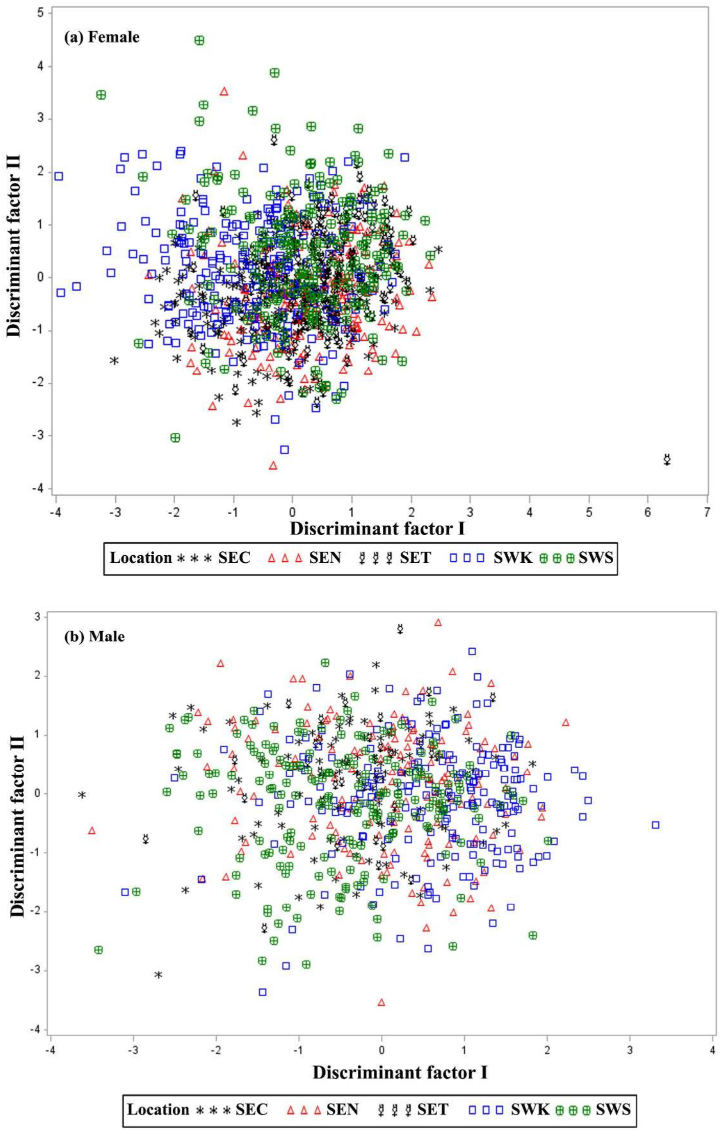

Figure 5. Scatterplot of first two discriminant factor from the DF analysis for each sex in A. alcocki.

203x304mm (300 x 300 DPI)

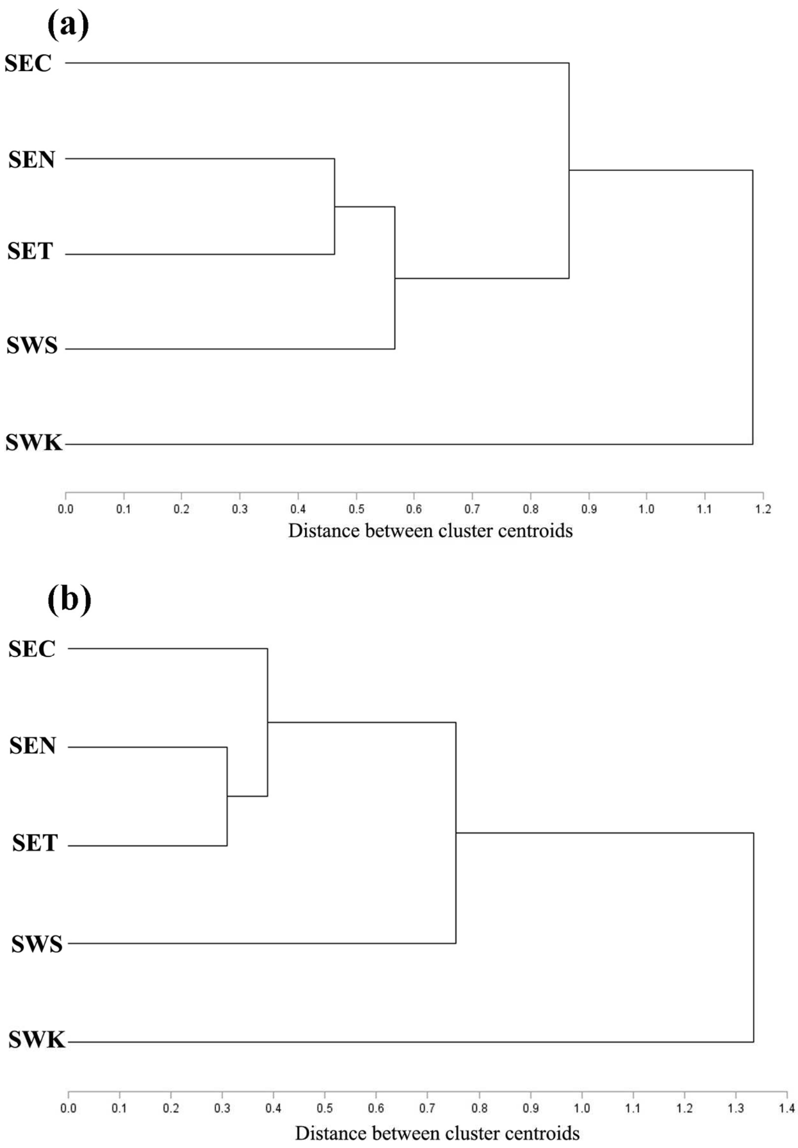

Figure 6. Dendrogram showing the patterns of morphometric similarity among A. alcocki from five locations along the Indian coast, (a) Female, (b) Male.

155x206mm (300 x 300 DPI)

Table 1. Details of sampling locations, geographical coordinates, time of sampling, and length ranges.

Coast	Location	Collection Date	latitude and longitude	Sex	Length ranges (cm)	Sample size (*n*)
South west	Kalamuku (SWK)	Dec 2014	9^{0} 59$^{'}$ 01.60$^{''}$ N	Female	12.0-19.0	226
			76^{0} 14$^{'}$ 32.50$^{''}$ E	Male	8.5-10.5	205
	Sakthikulangara (SWS)	Dec 2014	8^{0} 55$^{'}$ 58.38$^{''}$ N	Female	11.3-20.2	215
			76^{0} 32$^{'}$ 30.97$^{''}$ E	Male	8.5-10.8	192
	Tuticorin (SET)	Jan 2015	8^{0} 47$^{'}$ 41.85$^{''}$ N	Female	12.6-17.0	204
			78^{0} 09$^{'}$ 33.80$^{''}$ E	Male	8.4-10.1	114
South east	Nagapattinam (SEN)	Jan 2015	10^{0} 45$^{'}$ 36.54$^{''}$N	Female	12.3-20.1	194
			79^{0} 50$^{'}$ 57.27$^{''}$ E	Male	8.2-10.5	158
	Chennai (SEC)	Jan 2015	13^{0} 07$^{'}$ 27.05$^{''}$N	Female	12.0-20.6	198
			80^{0} 17$^{'}$ 48.90$^{''}$ E	Male	8.0-10.0	136
Total						1842

Table 2. Descriptive statistics of morphometric variables of *A. alcocki* at the five locations.

V: Variables; $\bar{X}$: Mean value (mm); SE: standard error; S.D.: standard deviation; CV: coefficient of variation; SEC-Chennai; SEN-Nagapatinam; SET-Tuticorin, SWK-Kalamuku; SWS-Sakthikulangara; FM-Female, M-Male.

Statistic	**SEC**		**SEN**		**SET**		**SWK**		**SWS**	
	FM	M	FM	M	FM	M	FM	M	FM	M
$\bar{X}$ ± SE	40.0 ± 0.26	25.15± 0.16	41.1 ± 0.40	25.19± 0.19	35.8±0.29	22.14±0.39	38.4±0.47	23.7±0.14	37.3±0.51	25.09± 0.16
Range	29.96-49.14	21.1-29.01	26.92-51.04	19.47– 30.39	25.6-51.3	14.8-27.1	20.6-50.5	19.6-29.7	20.0-50.4	18.10-29.86
S.D	3.78	1.58	5.2	2.38	4.18	2.4	6.9	1.9	7.4	2.34
CV (%)	9.45	6.29	13.3	9.48	11.6	10.9	18.0	8.2	19.9	9.32
$\bar{X}$ ± SE	38.25 ± 0.33	10.78± 0.15	39.0 ± 0.38	11.00 ± 0.18	34.0±0.27	12.09±0.30	37.0±0.38	11.6±0.16	35.6±0.37	11.26 ± 0.17
Range	23.96-53.12	8.53-15.47	26.2-53.6	7.43-22.29	25.2-44.2	8.5-16.4	17.4-50	7.7-19.7	21.8-49	7.44-18.63
S.D	4.72	1.58	5.2	2.37	3.8	1.9	5.6	2.2	5.4	2.48
CV (%)	11.5	6.29	13.4	21.62	11.4	15.7	15.2	19.2	15.2	21.07
$\bar{X}$ ±SE	45.95 ± 0.37	15.65± 0.15	47.2 ± 0.43	15.98±0.17	40.8±0.32	16.3±0.28	44.8±0.45	16.4±0.15	43.4±0.44	16.67 ± 0.16
Range	29.42- 61.14	12.7-20.08	32.8-60.7	12.18–25.00	28.6-53.6	13.0-19.9	21.5-59.2	11.4-24.8	25.3-59.1	12.15-23.23
S.D	5.30	1.43	5.9	2.17	4.6	1.7	6.7	2.1	6.4	2.29
CV (%)	11.54	9.16	12.6	13.59	11.3	10.8	15.0	12.9	14.8	13.74
$\bar{X}$ ±SE	45.01 ± 0.29	28.65± 0.16	46.2±0.43	28.54± 0.20	40.3±0.32	25.7±0.43	43.3±0.50	27.3±0.15	41.8±0.54	28.39 ± 0.18
Range	31.41-55.72	23.7-32.89	30.5-56.3	22.53–34.51	30.0-55.2	20.06-31.9	24.1-56.2	22.5-34.6	23.2-56.0	21.02-33.74
S.D	4.19	1.61	5.8	2.57	4.5	2.7	7.3	2.1	7.9	2.60
CV (%)	9.31	5.65	12.7	9.03	11.3	10.5	17.0	7.9	19.12	9.15
$\bar{X}$ ±SE	14.67 ± 0.12	9.71± 0.16	15.3±0.14	9.60± 0.07	13.5±0.12	8.9±0.12	14.2±0.16	9.0±0.06	13.7±0.17	9.19 ± 0.06
Range	9.84-18.65	7.50-11.05	10.0-19.5	6.89-11.84	9.7-18.9	6.7-10.3	6.6-19.7	6.5-11.6	7.4-19.2	6.77-11.47
S.D	1.73	0.70	1.9	0.95	1.7	0.77	2.4	0.89	2.5	0.96
CV (%)	11.82	7.23	12.8	9.99	12.7	8.7	17.4	9.8	18.4	10.49
$\bar{X}$ ± SE	10.98 ± 0.09	8.49± 0.10	11.8±0.11	8.39± 0.08	10.5±0.08	7.7±0.19	10.0±0.12	8.0±0.07	10.5±0.13	8.47± 0.07
Range	7.80-14.32	5.74-10.45	6.4-14.9	5.38-11.84	6.9-14.1	5.1-10.2	5.9-14.3	4.8-10.1	5.5-14.8	4.99-10.67
S.D	1.31	0.99	1.56	1.06	1.16	1.19	1.8	1.00	1.9	1.05
CV (%)	11.94	11.67	13.2	12.67	11.10	15.4	18.6	12.5	18.3	12.44
$\bar{X}$ ±SE	18.35 ± 0.11	12.91± 0.09	18.6±0.15	12.70± 0.09	17.2±0.11	11.9±0.21	17.3±0.16	12.3±0.07	17.2±0.18	13.11± 0.08
Range	12.69-22.29	10.7-15.26	12.5-23.0	9.27-16.23	12.7-22	9.6-14.1	10.0-21.9	9.5-15.1	9.6-22.6	9.71-15.63
S.D	1.65	0.89	2.14	1.21	1.6	1.3	2.4	1.0	2.7	1.21
CV (%)	9.00	6.93	11.4	9.52	9.5	10.8	14.2	8.5	15.9	9.25
$\bar{X}$ ±SE	12.97 ± 0.09	9.25± 0.09	13.5±0.10	8.95± 0.06	12.4±0.09	8.7±0.12	12.6±0.12	8.6±0.05	12.1±0.13	8.99± 0.06
Range	8.82-16.96	7.12-11.60	9.9-16.8	7.05-11.52	9.2-15.8	7.0-10.0	7.8-17.8	6.6-10.8	6.87-17.6	6.83-11.18
S.D	1.34	0.866	1.4	0.83	1.3	0.75	1.9	0.79	1.9	0.94
CV (%)	10.32	9.35	10.4	9.28	10.4	8.64	15.0	9.16	15.9	10.53
$\bar{X}$ ± SE	38.43 ± 0.24	24.96± 0.15	39.3±0.36	24.79± 0.18	34.3±0.26	21.9±0.35	36.6±0.44	23.1±0.13	35.0±0.48	24.24 ± 0.16
Range	27.61-47.00	21.2-27.91	25.3-48.4	19.00-30.78	25.3-45.9	17.9-26.6	19.0-48.0	19.1-27.6	19.0-47.2	17.59-29.80
S.D	3.48	1.47	4.9	2.34	3.8	2.1	6.5	1.9	7.0	2.38
CV (%)	9.07	5.89	12.6	9.45	11.16	9.8	17.8	8.2	19.9	9.83
$\bar{X}$ ± SE	8.69 ± 0.05	6.73± 0.77	8.89±0.067	6.53± 0.05	8.15±0.05	6.19±0.09	8.6±0.08	6.3±0.04	8.6±0.09	6.92 ± 0.05
Range	5.57-11.17	5.20-8.55	6.47-11.49	5.13-8.57	6.17-10.7	5.05-7.7	4.8-11.5	4.8-8.4	5.2-11.7	5.25-8.70
S.D	0.82	0.77	0.92	0.71	0.80	0.60	1.3	0.66	1.3	0.71
CV (%)	9.46	11.47	10.45	10.87	9.8	9.7	15.15	10.3	15.2	10.38

$\bar{X}$ ± SE	16.22 ± 0.10	11.63± 0.85	16.2±0.12	11.33± 0.07	15.2±0.09	10.5±0.16	15.6±0.14	10.9±0.05	15.4±0.15	11.64 ± 0.07
Range	11.09 -19.97	9.53-13.95	11.07-19.5	8.88-13.82	11.9-19.5	8.45-12.4	8.5-19.6	8.9-13.1	8.9-20.3	8.72-14.05
S.D	1.50	0.81	1.76	1.00	1.3	0.99	2.1	0.80	2.2	1.05
CV (%)	9.28	7.04	10.8	8.86	9.0	9.4	13.8	7.3	14.8	9.09
$\bar{X}$ ± SE	13.03 ± 0.08	9.15± 0.73	13.14±0.09	8.83± 0.05	11.9±0.07	8.3±0.09	12.4±0.11	8.55±0.04	12.0±0.11	8.93 ± 0.05
Range	8.79 -16.10	7.74-11.48	9.3-15.7	6.97-10.33	9.3-15.7	7.05-9.2	7.11-15.5	6.7-10.2	7.12-16.0	6.92-10.93
S.D	1.20	0.70	1.31	0.71	1.13	0.61	1.65	0.6	1.7	0.75
CV (%)	9.26	7.68	9.9	8.11	9.4	7.32	13.2	7.4	14.3	8.40
$\bar{X}$ ± SE	16.52 ± 0.11	12.25± 0.12	17.4±0.12	12.12± 0.09	15.7±0.10	11.5±0.17	16.0±0.16	11.5±0.07	16±0.15	12.07 ± 0.08
Range	11.55 -21.03	8.87-15.22	13.1-21.0	9.44-15.58	12.0-21.8	9.6-14.3	10.2-21.4	8.9-14.3	10.0-21.5	8.67– 15.07
S.D	1.60	1.19	1.7	1.15	1.5	1.10	2.3	1.0	2.2	1.20
CV (%)	9.70	9.76	10.1	9.55	9.5	9.58	14.7	9.4	14.3	9.95
$\bar{X}$ ± SE	8.65 ± 0.06	6.50± 0.89	8.8±0.06	6.72± 0.06	8.27±0.05	6.3±0.09	8.6±0.08	6.5±0.05	8.6±0.07	6.86 ± 0.05
Range	5.95 - 11.20	4.72-8.69	5.9-11.2	5.06-9.19	6.04-10.7	5.0-7.8	4.6-11.5	4.9-8.6	5.8-11.7	4.99– 9.34
S.D	0.89	0.85	0.92	0.84	0.81	0.59	1.2	0.74	1.14	0.74
CV (%)	10.37	13.13	10.4	12.62	9.8	9.46	14.7	11.4	13.2	10.81
$\bar{X}$ ± SE	16.31 ± 0.10	11.68± 0.09	16.2±0.12	11.66± 0.08	15.4±0.09	10.75±0.14	15.4±0.13	11.0±0.06	15.4±0.14	11.65 ± 0.06
Range	11.79-20.12	9.27-13.63	11.8-18.9	9.29-14.32	11.7-20.1	9.13-12.5	8.6-19.1	8.7-13.2	9.3-19.7	9.14– 13.78
S.D	1.40	0.90	1.64	1.02	1.3	0.86	2.05	0.86	2.12	0.95
CV (%)	8.62	7.76	10.1	8.76	8.85	8.03	13.2	7.7	13.7	8.16
$\bar{X}$ ± SE	13.22 ± 0.08	9.44± 0.078	13.2±0.09	9.14± 0.05	12.5±0.08	8.78±0.10	12.5±0.10	8.7±0.04	12.3±0.11	9.24 ± 0.05
Range	9.09-16.02	7.54-11.72	9.9-15.6	7.49-10.97	9.6-16.1	7.3-9.7	7.6-15.5	7.27-10.1	7.3-16.0	7.06– 11.15
S.D	1.21	0.74	1.2	0.72	1.14	0.6	1.5	0.61	1.6	0.74
CV (%)	9.19	7.91	9.6	7.88	9.14	7.5	12.4	7.03	13.6	8.09
$\bar{X}$ ± SE	14.22 ± 0.08	10.43± 0.07	14.8±0.09	10.24± 0.06	13.3±0.08	9.82±0.10	13.5±0.11	9.7±0.05	13.4±0.12	10.58± 0.06
Range	9.79-17.68	7.54-11.72	11.3-17.7	8.10-12.21	10.0-17.6	8.15-11.05	9.08-16.7	7.9-11.5	7.9-16.4	7.87– 12.57
S.D	1.24	0.763	1.3	0.79	1.25	0.66	1.6	0.74	1.7	0.87
CV (%)	8.72	7.31	8.8	7.73	9.3	6.7	12.2	7.6	13.2	8.25
$\bar{X}$ ± SE	9.44 ± 0.06	6.84± 0.096	8.7±0.08	6.98± 0.07	8.13±0.05	6.4±0.13	8.4±0.09	6.7±0.06	8.8±0.09	6.91± 0.06
Range	7.01-12.12	4.66-8.65	4.7-11.2	4.37-9.50	5.59-11.3	4.4-8.1	5.0-11.5	4.6-8.8	5.6-12	4.60– 9.49
S.D	0.96	0.919	1.16	0.92	0.80	0.85	1.42	0.85	1.3	0.87
CV (%)	10.26	13.48	13.2	13.26	9.94	13.2	16.7	12.5	15.3	12.71
$\bar{X}$ ± SE	16.15 ± 0.09	11.46± 0.09	15.7±0.12	11.57± 0.09	14.8±0.08	10.6±0.16	14.7±0.13	10.9±0.06	14.9±0.14	11.50 ± 0.06
Range	11.52-19.15	8.56-13.52	11.2-19.3	8.58-14.92	11.2-19.2	8.6-12.6	8.9-18.8	8.8-13.7	9.3-19.2	9.08– 13.90
S.D	1.33	0.90	1.6	1.16	1.27	1.0	1.9	0.87	2.04	0.98
CV (%)	8.23	7.91	10.47	10.05	8.6	9.6	13.3	7.9	13.6	8.56
$\bar{X}$ ± SE	13.02 ± 0.08	9.20± 0.07	13.1±0.09	9.04± 0.05	12.2±0.07	8.7±0.10	12.11±0.1	8.5±0.04	12.1±0.11	9.11 ± 0.05
Range	9.20-15.56	7.25-11.10	9.5-15.4	7.30-11.47	9.4-15.5	7.5-9.8	7.7-15.4	7.04-10.6	7.4-15.5	7.28– 10.73
S.D	1.13	0.66	1.29	0.71	1.06	0.6	1.5	0.63	1.6	0.73
CV (%)	8.72	7.27	9.8	7.88	8.69	7.7	12.5	7.44	13.8	8.02
$\bar{X}$ ± SE	14.06 ± 0.08	10.40± 0.08	14.5±0.09	10.16± 0.06	13.2±0.08	9.9±0.11	13.3±0.11	9.7±0.05	13.3±0.12	10.53 ± 0.06
Range	10.02-16.77	7.83-13.28	10.9-171	8.25-12.04	10.6-17.4	8.3-11.5	8.9-17.3	8.2-11.3	7.8-16.9	8.07– 12.52
S.D	1.21	0.85	1.2	0.76	1.17	0.72	1.6	0.75	1.7	0.91
CV (%)	8.72	8.16	8.6	7.55	8.8	7.2	12.4	7.80	13.11	8.71
$\bar{X}$ ± SE	6.76 ± 0.04	5.52± 0.06	7.2±0.06	5.46± 0.05	6.3±0.05	4.8±0.07	6.6±0.06	5.13±0.04	6.9±0.07	5.28 ± 0.04
Range	4.59-8.66	3.96-7.11	4.7-9.5	3.93-7.25	4.6-9.1	4.03-5.8	4.3-9.6	3.7-7.1	4.07-9.4	3.88– 7.71
S.D	0.69	0.57	0.9	0.66	0.72	0.48	1.02	0.60	1.1	0.67
CV (%)	10.23	10.39	12.5	12.19	11.3	9.9	15.3	11.8	15.9	12.73
$\bar{X}$ ± SE	13.52 ± 0.08	9.98± 0.07	13.8±0.11	9.95± 0.07	12.9±0.08	9.18±0.12	12.7±0.11	9.3±0.05	12.9±0.12	9.95 ± 0.05
Range	9.63-16.53	8.20-12.24	10.0-17.1	7.70-12.02	9.3-16.6	7.8-10.7	8.11-16.8	7.64-11.6	7.6-16.6	7.81– 11.86
S.D	1.20	0.68	1.54	0.90	1.27	0.74	1.6	0.75	1.8	0.83

CV (%)	9.45	6.86	11.15	9.07	9.8	8.16	13.0	8.08	14.1	8.37
$\bar{X}$ ± SE	10.91 ± 0.07	7.97± 0.05	11.1±0.08	7.67± 0.05	10.4±0.06	7.38±0.08	10.2±0.09	7.15±0.04	10.2±0.10	7.66 ± 0.04
Range	7.12-13.70	6.54-9.24	7.8-13.7	6.25-9.43	7.6-13.1	6.3-8.5	6.5-13.8	5.8-8.7	6.3-13.2	5.99– 9.09
S.D	1.30	0.52	1.15	0.63	0.98	0.54	1.3	0.56	1.4	0.65
CV (%)	9.45	6.57	10.3	8.21	9.4	7.4	13.1	7.8	14.3	8.57
$\bar{X}$ ± SE	13.09 ± 0.07	9.89± 0.07	13.5±0.09	9.42± 0.06	12.4±0.07	9.2±0.11	12.3±0.10	9.0±0.05	12.5±0.11	9.72 ± 0.05
Range	9.55-15.56	7.42-11.23	10.06-15.9	7.55-11.32	9.48-15.0	7.6-10.8	8.17-15.4	7.27-10.8	8.4-15.5	7.50– 11.42
S.D	1.14	0.70	1.25	0.75	1.08	0.73	1.5	0.75	1.6	0.82
CV (%)	8.43	7.07	9.2	8.02	8.7	7.9	12.5	8.3	13.2	8.47
$\bar{X}$ ± SE	13.16 ± 0.07	11.21± 0.07	13.9±0.09	10.66± 0.07	12.7±0.07	9.7±0.11	13.16±0.1	10.1±0.06	13.5±0.11	10.83 ± 0.05
Range	10.03-15.83	8.79-12.95	10.7-16.9	8.28-13.18	10.0-16.1	8.09-10.8	9.29-16.1	7.9-12.8	8.7-17.1	8.73– 13.12
S.D	1.08	0.70	1.24	0.93	1.06	0.713	1.5	0.89	1.67	0.84
CV (%)	8.22	6.25	8.9	8.79	8.3	7.3	11.7	8.7	12.4	7.75
$\bar{X}$ ± SE	15.40 ± 0.08	12.40± 0.06	16.1±0.11	11.95± 0.07	14.7±0.08	10.9±0.13	15.1±0.12	11.5±0.05	15.2±0.13	12.27 ± 0.06
Range	11.41-18.78	10.74-13.9	12.1-19.4	9.56-14.95	11.6-18.5	9.2-12.7	10.6-18.6	9.7-13.7	9.9-19.4	9.6– 14.74
S.D	1.20	0.60	1.55	0.98	1.22	0.85	1.8	0.81	1.9	0.95
CV (%)	7.85	4.91	9.6	8.20	8.33	7.8	12.0	7.08	12.7	7.75
$\bar{X}$ ± SE	9.54 ± 0.06	6.98± 0.05	9.72±0.07	6.71± 0.04	9.19±0.06	6.5±0.08	8.86±0.07	6.25±0.03	8.9±0.08	6.81 ± 0.04
Range	6.76-11.86	5.62-7.98	6.9-11.8	5.13-7.96	6.3-11.5	5.3-7.4	5.57-11.3	5.1-7.5	5.6-11.8	5.20– 8.05
S.D	0.87	0.49	1.03	0.53	0.86	0.5	1.11	0.51	1.2	0.58
CV (%)	9.12	7.09	10.6	7.98	9.3	7.7	12.5	8.18	14.17	8.51
$\bar{X}$ ± SE	11.3 ± 0.06	8.72± 0.06	11.9±0.08	8.42± 0.05	10.7±0.06	8.18±0.09	10.8±0.08	7.9±0.05	11.0±0.10	8.43 ± 0.05
Range	7.97-13.58	6.55-9.92	9.09-14.4	6.35-10.35	8.3-13.5	6.6-9.2	7.2-13.2	6.5-10.7	7.0-14.1	6.60– 10.70
S.D	0.96	0.62	1.12	0.69	0.9	0.6	1.3	0.73	1.4	0.77
CV (%)	8.52	7.10	9.4	8.22	8.66	7.4	11.9	9.2	13.3	9.16
$\bar{X}$ ± SE	15.76 ± 0.10	12.02± 0.09	16.7±0.13	11.18± 0.08	15.0±0.10	10.6±0.13	15.4±0.16	10.8±0.08	15.6±0.16	11.16 ± 0.07
Range	10.75-20.69	9.79-15.33	11.5-20.8	8.82-14.31	10.3-18.9	9.16-12.5	8.6-20.7	8.5-19.7	9.3-20.3	8.27– 14.09
S.D	1.52	0.89	1.87	1.03	1.4	0.84	2.4	1.2	2.4	1.12
CV (%)	9.67	7.42	11.2	9.26	9.9	7.9	15.7	11.15	15.5	10.11
$\bar{X}$ ± SE	7.15 ± 0.05	5.51± 0.04	7.21±0.05	5.27± 0.04	6.7±0.04	4.9±0.08	6.6±0.06	4.6±0.03	6.6±0.06	5.05 ± 0.03
Range	4.89-9.29	4.42-6.44	5.5-9.2	3.82-7.35	4.2-8.9	3.8-5.8	3.8-9.0	3.7-6.0	4.04-8.8	3.65– 6.21
S.D	0.70	0.41	0.756	0.50	0.66	0.50	0.9	0.42	1.0	0.49
CV (%)	9.87	7.55	10.4	9.67	9.87	10.10	13.6	9.0	15.17	9.76
$\bar{X}$ ± SE	14.10 ± 0.07	11.76± 0.08	14.8±0.08	11.31± 0.06	13.4±0.07	10.76±0.12	13.9±0.11	10.7±0.06	14.4±0.11	11.29 ± 0.06
Range	10.49-16.53	9.03-13.51	11.6-17.8	9.25-14.18	10.4-17.2	8.9-12.5	9.25-17.6	8.4-13.2	9.7-17.8	8.16– 13.79
S.D	1.08	0.78	1.2	0.87	1.02	0.8	1.6	0.95	1.6	0.97
CV (%)	7.68	6.67	8.08	7.75	7.6	7.4	12.0	8.8	11.5	8.60
$\bar{X}$ ± SE	16.9 ± 0.12	13.33± 0.11	17.9±0.14	12.34± 0.10	15.8±0.11	11.7±0.15	16.8±0.18	11.8±0.10	17.0±0.17	11.87 ± 0.08
Range	12.33-21.16	10.4-17.25	12.4-22.8	9.18-16.31	11.4-20.3	9.3-13.9	9.12-22.7	8.8-20.3	10.4-22.4	9.13– 15.47
S.D	1.68	1.09	1.9	1.28	1.58	0.93	2.7	1.3	2.6	1.20
CV (%)	9.93	8.20	10.7	10.39	9.9	8.0	16.3	11.7	15.3	10.17
$\bar{X}$ ± SE	11.35 ± 0.07	9.59± 0.07	12.1±0.080	9.39± 0.06	10.7±0.06	8.8±0.11	11.5±0.10	9.3±0.05	11.8±0.09	9.65 ± 0.06
Range	8.21-14.61	7.97– 11.29	8.7-14.8	7.32-11.16	8.7-13.5	7.2-10.6	7.8-19.7	7.13-11.5	8.13-15.0	7.06– 12.56
S.D	0.98	0.71	1.10	0.77	0.96	0.72	1.57	0.79	1.3	0.95
CV (%)	8.68	7.47	9.10	8.24	8.97	8.24	13.6	8.5	11.8	9.86
$\bar{X}$ ± SE	7.71 ± 0.05	5.88± 0.07	8.17±0.07	6.21± 0.05	7.22±0.05	5.7±0.10	7.53±0.07	5.9±0.04	7.6±0.07	6.30 ± 0.05
Range	5.40-10.30	4.42– 7.43	5.7-10.3	4.37-8.57	5.45-9.5	4.3-7.3	5.14-10.2	4.5-8.2	4.3-10.14	4.55– 8.61
S.D	0.77	0.68	1.00	0.64	0.81	0.6	1.0	0.67	1.1	0.77
CV (%)	10.06	11.62	12.3	10.30	11.3	11.3	14.2	11.2	14.7	12.28
$\bar{X}$ ± SE	7.86 ± 0.05	6.11± 0.07	7.9±0.07	6.02± 0.06	7.2±0.06	5.4±0.11	7.1±0.08	5.89±0.05	7.54±0.08	6.30 ± 0.05
Range	6.04-9.75	4.62– 8.44	5.2-9.8	4.26-8.24	4.27-9.87	4.2-7.0	4.07-9.7	4.12-7.9	4.7-9.9	4.42– 8.34

S.D	0.79	0.71	0.96	0.76	0.87	0.71	1.20	0.71	1.1	0.71
CV (%)	9.75	11.67	12.03	12.65	12.18	13.0	16.7	12.0	15.6	11.41
$\bar{X}$ ± SE	6.93 ± 0.05	5.56± 0.06	7.27±0.06	5.53± 0.05	6.5±0.05	4.8±0.08	6.6±0.07	5.14±0.04	6.75±0.07	5.74 ± 0.05
Range	4.44-9.34	4.14– 7.29	4.9-9.0	3.93-7.32	3.8-8.3	3.7-5.9	3.9-9.5	3.6-6.7	3.6-8.7	3.66– 7.63
S.D	0.74	0.65	0.86	0.70	0.76	0.5	1.14	0.64	1.0	0.80
CV (%)	10.68	11.7	11.8	12.77	11.6	10.5	17.2	12.5	15.7	13.98
$\bar{X}$ ± SE	6.93 ± 0.05	5.34± 0.06	7.56±0.07	5.55± 0.06	6.86±0.05	4.9±0.08	6.7±0.07	5.29±0.04	7.02±0.08	5.99 ± 0.05
Range	4.62-8.94	3.77– 6.70	4.9-9.9	3.57-7.79	4.5-8.9	3.7-5.9	4.46-9.19	3.8-7.02	3.6-9.7	3.88– 8.08
S.D	0.80	0.66	1.02	0.76	0.80	0.5	1.08	0.65	1.2	0.74
CV (%)	11.32	12.49	13.5	13.76	11.6	10.9	16.16	12.3	17.15	12.48
$\bar{X}$ ± SE	12.36 ± 0.10	8.73± 0.14	12.6±0.13	8.99± 0.10	11.6±0.09	8.4±0.2	12.0±0.14	8.6±0.08	12.3±0.13	9.30 ± 0.08
Range	7.79-17.04	5.80– 11.49	7.71-16.6	6.20-12.62	8.3-15.4	6.5-11.4	6.64-16.6	6.1-11.5	6.12-17.3	5.96– 12.38
S.D	1.48	1.39	1.8	1.34	1.3	1.2	2.18	1.1	2.0	1.17
CV (%)	11.98	15.93	14.4	14.96	11.49	15.3	18.2	13.03	16.2	12.63
$\bar{X}$ ± SE	39.01 ± 0.25	25.16 ±0.17	39.7±0.37	24.98± 0.19	34.5±0.28	22.3±0.40	37.2±0.44	23.7±0.14	35.3±0.48	24.49 ± 0.17
Range	26.47-48.16	20.8– 20.71	25.1-48.7	18.45-32.17	25.9-49.1	18.0-28.1	20.2-47.7	19.2-29.0	19.3-47.7	17.96– 31.03
S.D	3.57	1.64	5.14	2.46	4.07	2.4	6.5	1.9	7.09	2.50
CV (%)	9.17	6.52	12.9	9.85	11.7	11.1	17.4	8.4	20.04	10.21
		6.52		9.85		11.1		8.4		10.21

Table 3. MANCOVA (sex*Location) of carapace size measured at five study locations in *A. alcocki.*

	Wilk lambda *(λ)*	**d.f.**	***F* values**	***P* values**
Sex	0.310	1	94.26	<0.001
Location	0.385	4	11.43	<0.001
Sex*Location	0.527	4	7.372	<0.001

Table 4. Discriminate morphometric characters of *A. alcocki* retained by stepwise discriminant analysis.

Variables	**Female**			**Male**		
	Wilk Lambda *(λ)*	*F* value	*P* value	Wilk Lambda *(λ)*	*F* value	*P* value
T12	0.99	2.19	0.021	0.95	7.19	0.000
T118	0.98	4.27	0.006	0.95	7.46	0.000
T34	0.89	29.69	0.000	0.95	8.19	0.000
T417	0.96	10.83	0.000	0.98	1.38	0.015
T1415	0.96	8.36	0.000	0.94	9.45	0.000
T1516	0.93	19.31	0.000	0.87	23.28	0.000

Table 5. The number of individuals classified and the percent in each group from the confusion matrix by discriminant analysis; SEC-Chennai; SEN-Nagapatinam; SET-Tuticorin, SWK-Kalamuku; SWS-Sakthikulangara.

		Populations		**SEC**	**SEN**	**SET**	**SWK**	**SWS**	**Total**
Female	Original	SEC	Count	143	16	17	17	5	198
			%	72.22	8.08	8.59	8.59	2.53	100.00
		SEN	Count	24	118	13	18	21	194
			%	12.37	60.82	6.70	9.28	10.82	100.00
		SET	Count	15	7	174	3	8	207
			%	7.25	3.38	84.06	1.45	3.86	100.00
		SWK	Count	17	32	20	127	30	226
			%	7.52	14.16	8.85	56.19	13.27	100.00
		SWS	Count	6	24	10	24	151	215
			%	2.79	11.16	4.65	11.16	70.23	100.00
	Cross-validated	SEC	Count	134	18	19	20	7	198
			%	67.68	9.09	9.60	10.1	3.54	100.00
		SEN	Count	24	110	15	22	23	194
			%	12.37	56.7	7.73	11.34	11.86	100.00
		SET	Count	16	7	173	3	8	207
			%	7.73	3.38	83.57	1.45	3.86	100.00
		SWK	Count	21	36	22	109	38	226
			%	9.29	15.93	9.73	48.23	16.81	100.00
		SWS	Count	6	27	12	26	144	215
			%	2.79	12.56	5.58	12.09	66.98	100.00
Male	Original	SEC	Count	45	24	29	28	10	136
			%	33.08	17.64	21.32	20.58	7.35	100.00
		SEN	Count	24	51	27	25	31	158
			%	15.2	32.8	17.1	15.8	19.6	100.00
		SET	Count	12	12	54	24	12	114
			%	10.5	10.5	47.4	21.1	10.5	100.00
		SWS	Count	41	17	44	54	36	192
			%	21.4	8.9	22.9	28.1	18.8	100.00
		SWK	Count	11	24	36	19	115	205
			%	5.4	11.7	17.6	9.3	56.1	100.00
	Cross-validated	SEC	Count	39	11	36	25	25	136
			%	28.6	7.7	26.4	18.5	18.5	100.00
		SEN	Count	25	49	30	24	30	158
			%	15.8	30.8	19.1	15.2	19.1	100.00
		SET	Count	18	18	40	27	12	114
			%	15.8	15.8	34.2	23.7	10.5	100.00
		SWS	Count	41	17	44	54	36	192
			%	21.4	8.9	22.9	28.1	18.8	100.00
		SWK	Count	12	25	38	19	113	205
			%	5.9	12.2	18.5	9.3	54.1	100.00