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RESEARCH PAPER

Morphometric Parameters Comparison of *Viviparus contectus* (Millet, 1813) in Demirköprü Dam Lake, Turkey using multivariate statistical methods

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Citation

Abstract

In this study, some biometric characteristics were assessed in freshwater snail *Viviparus contectus* (Millet, 1813) from Demirköprü Dam Lake, Manisa province, Turkey. Shell length (SL) (mm), shell width (SW) (mm), aperture length (AL) and width (AW) (mm), spiral height (SPH) (mm), body whorl height (BWH) and weight (W) (g) were measured in individuals (n=63). A multivariate statistical evaluation was performed to determine morphological relationships. Mean of SL, SW, AL, AH, SPH, BWH and W of *V. contectus* were determined as 28.37±9.48, 17.27±5.19, 14.84±4.22, 10.87±4.00, 3.26±1.09, 25.12±8.87 and 6.52±3.87 mm, respectively. According to principal components analysis (PCA), there was a strong relationship between shell height, body whorl height and weight.

Introduction

Turkey has a rich flora and fauna as a result of topographical, hydrographic and climatological developments. One of the fauna elements of this rich structure is the freshwater snails in the Gastropoda class, which constitutes an important part of the Mollusca. In aquatic ecosystems, freshwater molluscs have a key component role and they are consumed by many fish species and vertebrates (Yıldırım, 1999; Yıldırım et al.,

2006a,b; Yıldırım and Kebapçı, 2009; Gürlek et al., 2019). Additionally, they have an importance economically and medicinally. Humans use mussels in different ways (e.g. food, jewellery, tools, pets). Moreover, they play significant role in veterinary and public health. The Bivalvia and the Gastropoda are two main groups of freshwater molluscs (Gürlek et al., 2019).

Two of the three subclasses of the Gastropoda class in Turkey; 124 species were identified from the Prosobranch subclass and 40 from the Pulmonate subclass. 63% of

Prosobranch consists of endemic species. Species of the genus *Viviparus* generally inhabit a variety of habitats, including rivers, streams, ponds, lakes, and marshes, and are distributed in parts of the North, America, Australia, Asia, Africa, and Europe (Gürlek et al., 2011, 2019). Members of the genus *Viviparus* usually feed on detritus, but also filter water. Thus, they clean the water and sediment. They breathe through gills and are distributed between 0 and 20 m depths. Reproduction takes place in the spring with individuals distributed in the coastal region (Uvayeva et al., 2021). They move to deeper waters in the autumn and to shallower coastal areas in the spring at breeding time. *Viviparus contectus* is dark green, translucent with brown spiral bands. Females are larger than males (Bugler et al., 2009; Kutluyer and Kocabas, 2022). In this study, morphometric parameters of *Viviparus contectus* in Demirköprü Dam Lake were compared using multivariate statistical methods.
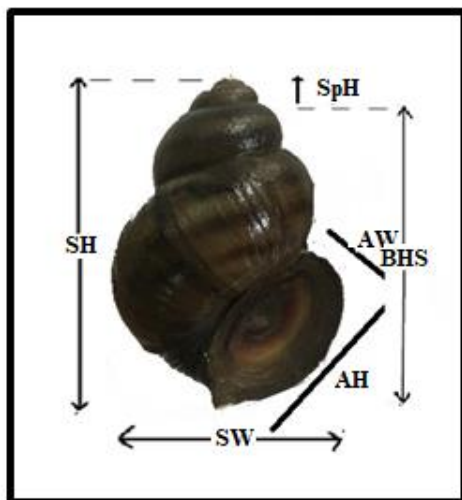
Material and Methods

A total of 63 freshwater snails (*V. contectus*) were collected from the wild population (38° 38' 12" N-28° 20' 01" E, 38° 37' 36" N-28° 21' 04" E, 38° 39' 11" N-28° 23' 00" E) during summer season (June-August, 2022) and washed for elimination of encrusted organisms. The shell width (SW) (mm), shell length (SL) (mm), shell height (SH), aperture length (AL) and width (AW) (mm), spiral height (SPH) (mm), body whorl height (BWH) (Figure 1) and weight (W) (g) were measured using calipers (Figure 2) and precision balances in *V. contectus* (n: 37).

Figure 1. Biometric measurements; Shell length (SH), Shell width (SW), Aperture height (AH), Aperture width (AW), Body helezone height (BHL) and Spir hight (SpH) (Kutluyer Kocabaş and Kocabaş, 2022).

A multivariate statistical evaluation and Principal Component Analyses (PCA) were performed to determine morphological relationships with Statgraphics Centurion XV1. Kaiser-Meyer-Olkin's measure of sampling adequacy (KMO) was used to validate the usefulness of PCA. The KMO ranges from 0 to 1 and should be above 0.5 if the variables are highly dependent on each other and PCA is beneficial. Also,

Bartlett's test measurement was applied to validate the usefulness of PCA. If the data are significant ($p < 0.001$), PCA is useful and the variables are highly interdependent.

Results

Mean of Shell length (SL), Shell width (SW), aperture length (AL), aperture height (AH), spiral height (SPH), body whorl height (BWH) and weight (W) of *V.*

contectus were determined as 28.37±9.48, 17.27±5.19, 14.84±4.22, 10.87±4.00, 3.26±1.09, 25.12±8.87 and 6.52±3.87 mm, respectively.

It was determined that there is a strong correlation between shell height-shell width, shell height-weight, shell height-aperture width, shell height-body helix height, shell width-aperture height and aperture height-aperture width, body helix height-weight (Table 1 and Figure 2).

According to principal components analysis (PCA), there was a strong relationship between shell height (SH), body whorl height (BWH) and weight (Figure 3).

Table 1. Correlation matrix among the parameters measured for *V. contectus*

	SH	SW	AH	AW	SPH	BSH	W
SH		0.8454	0.8732	0.5771	0.5988	0.9951	0.8933
		-63	-63	-63	-63	-63	-63
		0	0	0	0	0	0
SW	0.8454		0.9265	0.7895	0.6983	0.8176	0.7678
	-63		-63	-63	-63	-63	-63
	0		0	0	0	0	0
AH	0.8732	0.9265		0.8311	0.6737	0.8504	0.7903
	-63	-63		-63	-63	-63	-63
	0	0		0	0	0	0
AW	0.5771	0.7895	0.8311		0.6435	0.5375	0.5098
	-63	-63	-63		-63	-63	-63
	0	0	0		0	0	0
SPH	0.5988	0.6983	0.6737	0.6435		0.5167	0.6194
	-63	-63	-63	-63		-63	-63
	0	0	0	0		0	0
BSH	0.9951	0.8176	0.8504	0.5375	0.5167		0.8785
	-63	-63	-63	-63	-63		-63
	0	0	0	0	0		0
W	0.8933	0.7678	0.7903	0.5098	0.6194	0.8785	
	-63	-63	-63	-63	-63	-63	
	0	0	0	0	0	0	

 * This table shows Spearman rank correlations between each pair of variables. These correlation coefficients range between -1 and +1 and measure the strength of the association between the variables. In contrast to the more common Pearson correlations, the Spearman coefficients are computed from the ranks of the data values rather than from the values themselves. Consequently, they are less sensitive to outliers than the Pearson coefficients. Also shown in parentheses is the number of pairs of data values used to compute each coefficient. The third number in each location of the table is a P-value which tests the statistical significance of the estimated correlations. P-values below 0.05 indicate statistically significant non-zero correlations at the 95.0% confidence level. The following pairs of variables have P-values below 0.05.
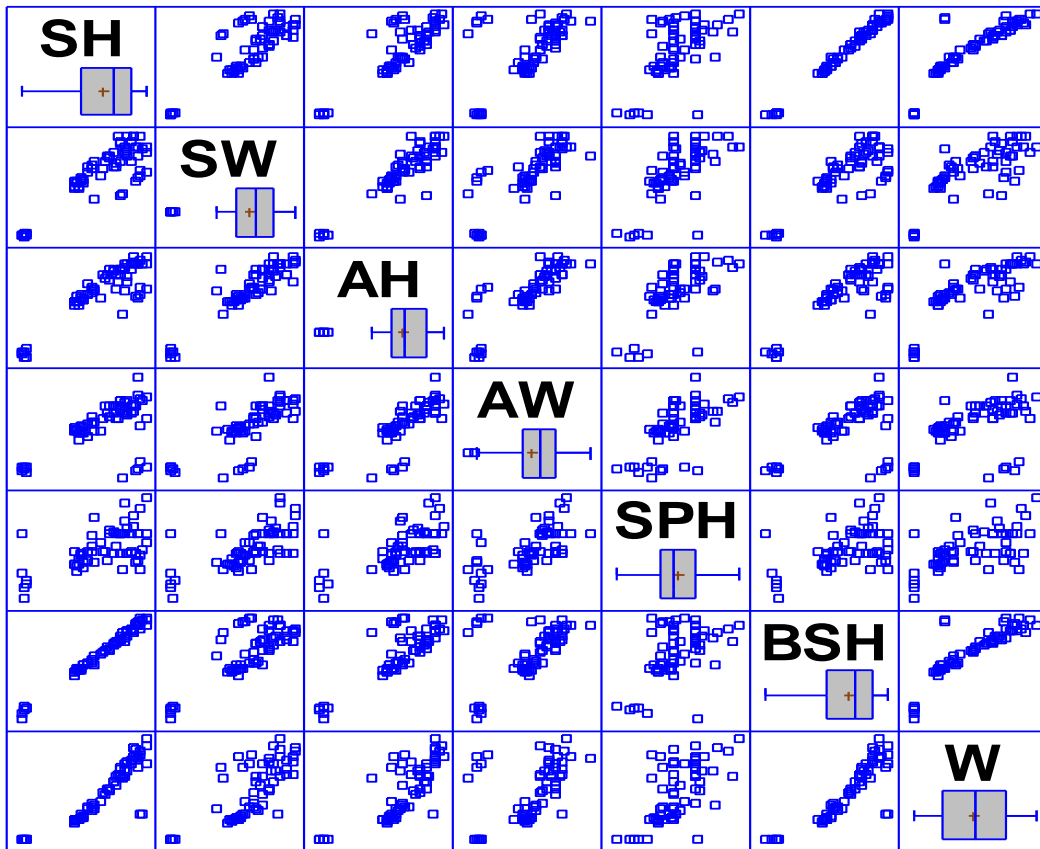
Figure 2. Correlation matrix among the parameters measured for *V. contectus*
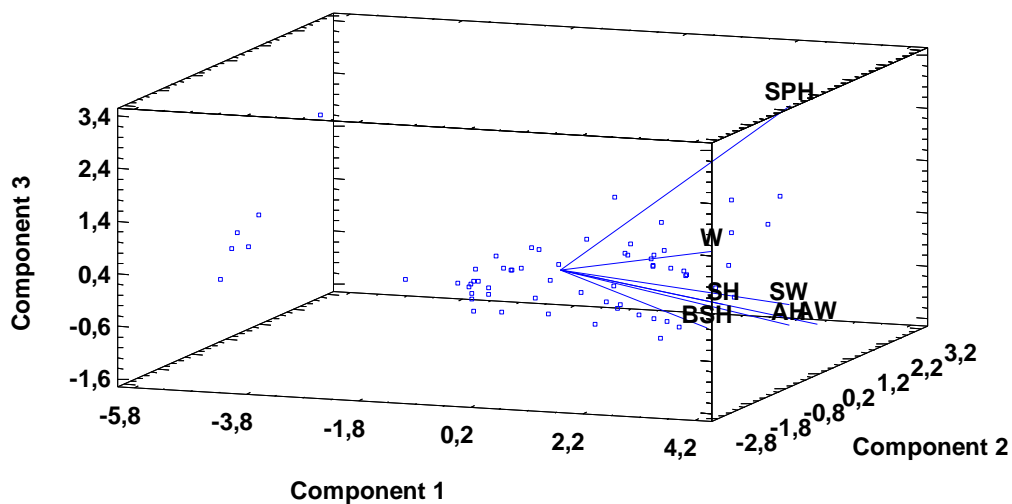

Figure 3. Principal components analysis of variables [Shell length (SL), Shell width (SW), Aperture length (AL), Aperture width (AW), Body helezone length (BHL) and Spir height (SpH)]

Discussion

Morphometric relationships and shell morphology and description, species taxonomic identification have been studied in gastropod for determination of sexual dimorphism differentiation among populations. Mathematical models are important for transformation equations and establishing morphometric relationships and, applied in fisheries assessment and management, population dynamics,

fisheries biology and ecology (Vasconcelos et al., 2016). Particularly, weight-length relationships are used for stock assessment models and calculation of population production in different habitats and regions. Moreover, morphological comparisons and determination of life history are realized in species and populations (Ricker, 1973; Anderson and Gutreuter, 1983; Beyer., 1991; Pauly, 1993; Richter et al., 2000). Uvaeva and Shcherbina (2017) reported that individuals with a shell height of 2.7-3.0 cm weighed 6.0-6.9 g and individuals with a shell height of 4.0-4.4 cm weighed 14.5-17.4 g in the sampling they conducted in the Tyna River in Ukraine. In this study, the measured shell height and weight values of individuals detected in the study area are similar to those in Ukraine (Uvaeva and Shcherbina (2017). Uvayeva et al. (2021) investigated the effect of sexual dimorphism on the shell morphology of *V. contectus* and *V. viviparus* in their study in the Tyna River, Ukraine and, showed differences in shell morphology of male and female freshwater snails depending on age. They did not observe sexual dimorphism in Viviparus snails aged one to three years. In addition, they reported that shell width, aperture size and body body helezone length had significantly greater in mature females compared to males. Females of *V. viviparus*, two to five years old, could be distinguished from males by a statistically significantly higher mean shell width and shell height relationship than males. In their study, they made morphometric measurements of individuals aged between +1 and +5 years and reported aperture heights of 12.0±0.2 and 13.1±0.1 mm and aperture widths of 8.9±0.1 and 10.0±0.2 mm. In this study, the measured shell values of individuals detected in the study area are similar to those of +1 years old individuals. Kutluyer and Kocabaş (2022) reported that the mean shell height of individuals in the *V. contectus* population obtained from Demirköprü Dam Lake was 20.23±5.16 mm, shell width 16.11±3.33 mm, aperture height 11.93±2.39 mm, aperture width

9.71±2.11 mm, body spiral height 15.71±3.87 mm, Spir height was determined as 4.49±1.73 mm and weight as 4.50±0.93 g. In this study, mean of shell length (SL), shell width (SW), aperture length (AL), aperture height (AH), spiral height (SPH), body whorl height (BWH) and weight (W) of *V. contectus* were determined as 28.37±9.48, 17.27±5.19, 14.84±4.22, 10.87±4.00, 3.26±1.09, 25.12±8.87 and 6.52±3.87 mm, respectively.

In this study, Bartlett's test and KMO were used to validate the usefulness of principal component analysis (PCA). Principal component analysis was useful in summarizing the correlation matrix and Bartlett's test data were found to be significant (p = 0.000; p < .001). Therefore, principal component analysis has been found to be useful and the variables correlated with each other. It was determined that there is a strong correlation between the shell height (KY), shell width (KG), Apertur height (AY) and Body helix height (VHY). Vasconcelos et al. (2016) showed positive allometries among morphometric variables (SL and SW, AL, AW, SpL and SpW) of *Hexaplex trunculus* and growth in SW, AL, AW, SpL and SpW increased faster than SL. During ontogenesis, an increase in total length and the length of the siphonal canal and negative allometries in the relationships between SL, ShL and TAL have been reported in *H. trunculus*. Regarding weighted variants, positive allometries in the relationships between SL and TWg and between TWg and SpWg showed that both total weight and soft part weight (raw edible content) increased proportionally to shell length during growth, with *H. Trunculus* while positive allometries in the relationships between SL and SW, TAL, AL, AW, SpW, and ShL in *Bolinus brandaris*. Growth in tower length and shell length determined isometric relationship between SL and SpL during ontogeny. Uvayeva et al. (2021) determined the CG/HF ratio 0.76±0.01 and 0.78±0.02, VHS/HF ratio 0.49±0.02 and

0.49±0.01, LR/HF ratio 0.61±0.02 and 0.60± in male and female individuals aged +1 years of age of *V. contectus* species, respectively. They reported AG/HF ratio as 0.01, 0.50±0.01 and 0.50±0.01, respectively.

Consequently, a variety of abiotic and biotic factors highly affects growth, morphology, and relative proportions of Gastropod shells. In addition, the habitat and physiological conditions may affect the shell calcification process and the morphometric parameters during maturation, the growth, and reproduction processes and may cause variation in the shell. Hence, comparison of growth types and morphometric relationships in species and populations from different geographic regions should be analysed and interpreted with caution.

Ethical approval

The author declares that this study complies with research and publication ethics.

Data availability statement

The authors declare that data are available from authors upon reasonable request.

Funding organizations

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