SELECTED SHELL CHARACTERS AS CRITERIA OF DISTINGUISHING BETWEEN *VENTROSIA VENTROSA* (MONTAGU, 1803) AND *PERINGIA ULVAE* (PENNANT, 1777) (GASTROPODA: PROSOBRANCHIA: HYDROBIIDAE)

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ABSTRACT: Some shell characters of *Ventrosia ventrosa* (Montagu) and *Peringia ulvae* (Pennant) can be used to distinguish between the two taxa. Out of 12 initially analysed characters, 3 (shell width, spire height, aperture height) were selected as sufficient to describe the shells and distinguish between the species. Discriminant analysis made it possible to construct two classifying functions. Though the results confirm the difficulties implied in conchological identification of *V. ventrosa* and *P. ulvae*, the high proportion of correct species distinction (over 90%) based on the three characters invites further research.

KEY WORDS: snails, *Ventrosia ventrosa, Peringia ulvae*, shell characters, morphometrics

INTRODUCTION

Ventrosia ventrosa (Montagu, 1803) and *Peringia ulvae* (Pennant, 1777) are small snails of the family Hydrobiidae. Since externally they are very similar, distinction between them is usually based on their soft parts (SEIFERT 1935, BISHOP 1976, FALNIOWSKI 1987), but these are not always available, e.g. when dealing with fossil material. This study is an attempt at finding shell characters that would make it possible to distinguish between the two species.

MATERIAL AND METHODS

The material was collected in 1974 in the Puck Bay, and stored in 80% ethanol. Specimens with relatively undamaged shells were selected at random. The selection was often made difficult by corrosion of periostracum, especially in its apical part. A camera lucida drawing of each shell in front view was made. Then the species identity and sex of the specimen were determined, based on its soft parts (FALNIOWSKI 1987). Twelve shell parameters were measured in the resulting 30 drawings for each species: shell height, shell width, spire height, aperture height, aperture width, angle formed by the upper margin of aperture and the shell axis, body whorl height, body whorl width, penultimate whorl height, penultimate whorl width, angle formed by the body whorl suture and the shell axis, angle formed by the penultimate suture and the shell axis (Fig. 1).

The measurements were subject to multivariate analysis (FALNIOWSKI 2003) with the NTSYSpc2 programme (ROHLF 1998). The first step was approximation of the character distribution to normal distribution, by means of their logarithmic transformation. Standardisation of the characters, constructing a matrix of Euclidean distances between specimens, and calculating correlations between the characters were followed by cluster analysis and principal component
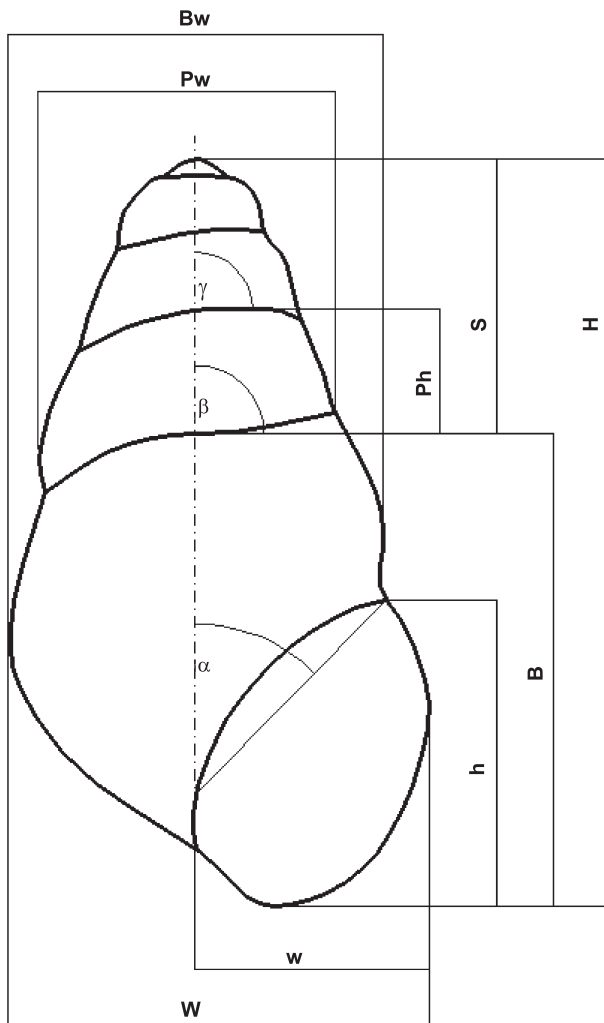
Fig. 1. Shell measurements

Symbols: B – body whorl height, Bw – body whorl width, H – shell height, h – aperture height, Ph – penultimate whorl height, Pw – penultimate whorl width, S – spire height, W – shell width, w – aperture width, α – angle between the upper margin of aperture and shell axis, β – angle between shell axis and penultimate/body whorl suture, γ – angle between shell axis and penultimate whorl suture
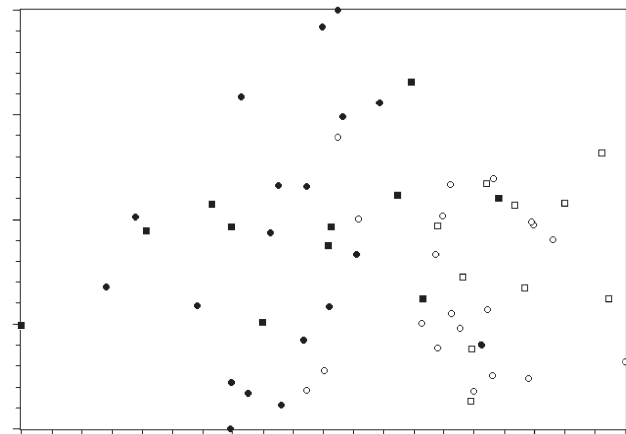
analysis. Both these techniques illustrate dependencies between specimens and indicate a possible classification without the previously defined groups. These

techniques allow for a reduction of data and make it possible to present the multidimensional observation on the surface of the first two components (Fig. 2).

The discriminant analysis was aimed at constructing a function which would allow to distinguish between *V. ventrosa* and *P. ulvae* based on significantly different shell characters. The characters were selected from among the initial 12 characters by trial and error. The two functions which were constructed allowed to classify the specimens into groups 1 – *V. ventrosa* or 2 – *P. ulvae*. To allocate the snail shell to one of these two species (groups), proper characters were provided for both functions. The shell was allocated to the group for which the function achieved the higher value. The last step was to verify the goodness of the constructed function. First, 30 random shells of *V. ventrosa* and *P. ulvae* were measured; then (after standarization and logarithmic transformation) the selected characters were provided for the earlier calculated functions and the correctness of classification was verified.

Symbols:
○ – female of *P. ulvae*
□ – male of *P. ulvae*
● – female of *V. ventrosa*
■ – male of *V. ventrosa*

Fig. 2. Projection of specimens on the surface of the first two components

RESULTS

The principal component analysis made it possible to distinguish two basic groups; variation within them was small. This is reflected in the graphic representation of the cluster analysis and in the projection of specimens on the principal component surface (Fig. 2). The figures show the two groups (1 – mostly *V. ventrosa* and 2 – mostly *P. ulvae*) as well as their slight overlap: group 1 includes 22 specimens of *V. ventrosa* and 4 of *P. ulvae* while group 2 includes 26 shells of *P.*

ulvae and 3 of *V. ventrosa*. The third group, including 5 specimens of *V. ventrosa*, and clearly distinct from the rest, was disregarded in further analysis.

Out of the 12 analysed features, the shell width, spire height and aperture height were selected as the most significant characters, sufficient to describe the shells of both species and make a distinction between them.

Table 1. Mean and extreme values for the shell characters selected for discriminant analysis (based on 30 specimens of *V. ventrosa* and 30 *P. ulvae*, considering sex)

		W [mm]	S [mm]	h [mm]
VM	average	1.8	0.9	1.2
	minimum	1.3	0.6	0.9
	maximum	2.2	1.4	1.6
VF	average	1.7	0.7	1.2
	minimum	1.4	0.4	1.0
	maximum	1.9	1.0	1.4
UM	average	2.2	1.3	1.6
	minimum	1.9	1.0	1.5
	maximum	2.4	1.7	1.8
UF	average	2.0	1.2	1.5
	minimum	1.7	0.8	1.3
	Maximum	2.4	1.5	1.9

Symbols: VM – male of *V. ventrosa*, VF – female *V. ventrosa*, UM –male *P. ulvae*, UF – female *P. ulvae*, W – width of the shell, S – height of the spire, h – height of the mouth

Fig. 2 shows that the sex-dependent differences are not significant enough to distinguish such sub-groups within groups 1 and 2. However, males of both species tend to attain a bigger size compared to females (except the same mean aperture height in *V. ventrosa*), while at the same time the extreme values are the highest in male *V. ventrosa* and female *P. ulvae* (Table 1). *P. ulvae* reaches higher mean values of the analysed parameters than *V. ventrosa* (Table 1). Irrespective of sex, the mean shell width in *P. ulvae* was higher by 23%, spire height by 50% and aperture height by 25% (Table 2). Thus the shells of *P. ulvae* were slimmer and seemed to have a thinner periostracum (the last feature has not been examined yet).

As a result of the discriminant analysis, two classifying functions were constructed for groups 1 and 2. For group 1, the function was (for explanation of the symbols see caption to Fig. 1):

F1 = W × 0.26091 – S × 1.89331 – h × 1.80589 – 1.78937

and for group 2:

F2 = W × 0.05736 + S × 2.71535 + h × 2.02806 – 2.63694

Table 2. Relative values of shell characters selected for discriminant analysis (based on 30 specimens of *V. ventrosa* and 30 *P. ulvae*)

Species	W [%]	S [%]	h [%]
V. ventrosa	100	100	100
P. ulvae	123	150	125

All symbols like in Table 1.

It should be remembered that the chosen values of the shell characters should be standarized and transformed logarithmically.

Species identification based on the soft parts made it possible to assess the number of misdetermination cases which appeared when using the calculated classifying functions. For the basic collection (it was the intial collection of 30 specimens of *V. ventrosa* and 30 *P. ulvae*) in all cases the identification was correct, and for the test collection (30 specimens of each species), only 2 incorrect cases of determination occurred. The proportion of correct identifications (93.3%) was high.

DISCUSSION

V. ventrosa and *P. ulvae* represent a morphostatic radiation. According to Davis (1993, cited after Wilke et al. 2000) such radiations are "... considerable, rapid speciation(s) with low anatomical diversification... there is little or no habitat diversification, speciation is widely allopatric, and there are low levels of anatomical change". For this reason many authors consider shell characters to be rather insufficient for a correct species identification (Seifert 1935, Fal- niowski 1987, Wilke et al. 2000). However, another view is that a shell can provide identification criteria, albeit with numerous reservations. This view can be found in all of the cited references; the reservations pertain to the shell variability due to different environmental factors, the occurrence of atypical specimens and also frequent corrosion. Particularly frequent occurrence of the specimens with atypical structure in the Baltic Sea, from which the material

for this study originated, was discussed by SEIFERT (1935) and FALNIOWSKI (1987). SEIFERT (1935) distinguishes *H. ventrosa* form *ventrosa* and *H. ventrosa* form *baltica*. The shells of the latter form are slimmer than those of the co-occurring *H. ventrosa* form *ventrosa*.

Specialist literature contains few values of parameters of *Hydrobia* shells. MUUS (1963) believes that it is possible to distinguish *V. ventrosa* from *H. neglecta* based on shell characters, but not in all cases. For the collection of 13 specimens of *V. ventrosa* and 11 of *H. neglecta*, he reports the mean male shell height of 2.6 mm and female – of 3.2 mm for the first species, and 3.0 and 3.3 mm, respectively, for the second. The mean shell height of *V. ventrosa* calculated in this study was 2.9 mm for males and 2.7 mm for females. Thus, considering the smaller difference between the mean values, the male specimens were smaller and the female ones slightly larger than in the cited study. It must also be noted that in the present study, as opposed to the results obtained by the above mentioned author, the males were slightly larger than the females. SEIFERT (1935) describes the shells of *P. ulvae* as slimmer than those of *V. ventrosa* and gives the height/width ratio in *P. ulvae* as 2.3:1 whereas form *V. ventrosa* it is 1.8:1 and for *H. ventrosa* form *baltica* – 2:1. Such a tendency was shown also in this study, but

the corresponding ratio values were 1.8:1 for *P. ulvae* and 1.6:1 for *V. ventrosa*.

The results confirm the difficulties, mentioned in earlier papers, implied in distinguishing *V. ventrosa* from *P. ulvae* on the basis of their shells. The analysis showed a slight overlap of characters between the groups as well as occurrence of atypical specimens. On the other hand, given a high variability of the Baltic population of *Hydrobia*, the high proportion of corrrect distinction between *V. ventrosa* and *P. ulvae* (100% in the basic collection and 93.3% in the test collection) by means of the three selected shell characters seems to be significant and encourages further research.

However, it must be remembered that this kind of identification procedure assigns every specimen to a group and there is no possibility to verify its species appurtenance. On the other hand, the procedure reveals significant differences between groups of specimens which are basically very similar, and the identification is correct in most cases. This may be especially important in the case of the Polish part of the Baltic Sea, where there is a third species, *H. neglecta* Muus, 1963, which is found only sporadically (FALNIOWSKI 1987). Besides, methods applied in this study and the resulting classifying functions, can be used to define the species when no soft parts are available (fossil material, poorly preserved museum collections etc.).

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