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CHARACTER VARIATION IN MOLLUSC POPULATIONS OF *LAMPSILIS* RAFINESQUE, 1820

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ABSTRACT

Character variation was examined in two mollusc populations of *Lampsilis radiata siliquoidea* collected from different habitats, a lake and a small stream. Sexual dimorphism occurred in both populations. The two populations were also found to have significantly different meristic characteristics. This was attributed to effects of the different habitats on the shell morphology. A sympatric species, *L. ovata ventricosa*, of the lake population had shell meristic characteristics which were more similar to the lake population than were the characteristics between the two *L. r. siliquoidea* populations.

INTRODUCTION

The occurrence of variation in mussels, primarily over relatively large latitudinal differences, has been attributed to possible clinal relationships (Cvancara 1963, Clench 1954, Van der Schalei 1948). The degree of this variability depends on the latitudinal distance and degree of contact between species populations. Clinal variability may be important when mollusc distribution is used to assess past and present stream confluence and lake shore lines (Van der Schalei 1963, 1945, Goodrich et al. 1939, Ortmann 1924), and four systematic considerations. A great deal of variability in mollusc shell meristic and morphometric characters may be due to habitat differences such as substrate type, wave action or

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current speed and the realtive distance from a rivers head waters (Ball 1922, Huxley 1938). Thus, when investigating populations of freshwater mussels, particularly when specific or subspecific identification is necessary, it is important to consider habitat types as well as clinal variation.

To investigate the effects of habitat on morphological variation two populations of *Lampsilis radiata siliquoidea* from widely differing habitat types with little latitudinal displacement were studied. One population was then compared to a sympatric species from the same habitat to assess similarity of morphological characteristics in coinhabiting species.

STUDY SITES AND METHODS

Two species of *Lampsilis* (Unionidae, Lampsilinae) were collected from Silver Lake, Wisconsin. Silver Lake, located just across the Illinois-Wisconsin border, is a spring-fed lake with an artificial outlet to the Fox River, Illinois. Ninety-four specimens of *L. radiata siliquoidea* (Barnes) and 21 specimens of *L. ovata ventricosa* were obtained from this site. Live specimens were collected from a sand-gravel substrate near the shore in 1 to 3 m of water. These mussels were usually found with the anterior half of the shell imbedded in the substrate and the exposed, posterior half covered with a heavy green algal growth.

Little Indian Creek, located in northeastern Illinois, is part of the Fox River drainage basin and was the second sampling site. Only *L. r. siliquoidea* was present here, where 27 specimens were collected. The clear water creek is small with an average depth at the collection site of 90 cm and a current velocity of approximately 0.7 m/sec. Specimens were collected from a sand-gravel substrate. Trails were often visible in the substrate due to movement of individuals which were generally found lying on the substrate with their foot extended. However, the posterior portion of these clams was also covered by an algal growth indicating that they often remained partially buried, possibly during adverse environmental conditions.

In all cases, specimens were keyed to genus using soft body characters (Burch 1973) and further keyed to species and subspecies using shell characters. Specimens were separated into male and female on the basis of brood pouch gill modifcations in the latter.

Thirteen measurements were taken on each specimen using vernier calibers. These measurements included total length, posterior length, shell height, total width, shell thickness, lateral tooth height, lateral tooth length, anterior pseudocardinal tooth height, pseudocardinal tooth length, posterior adductor scar height, anterior adductor scar length, and anterior adductor scar height. Because the meristic characters considered varied depending on the relative age and health of an individual, it was necessary to use character relationships for comparisons. Only those characters which demonstrated a significant linear correlation (Fig. 1), were used. The ratio of these characteristics

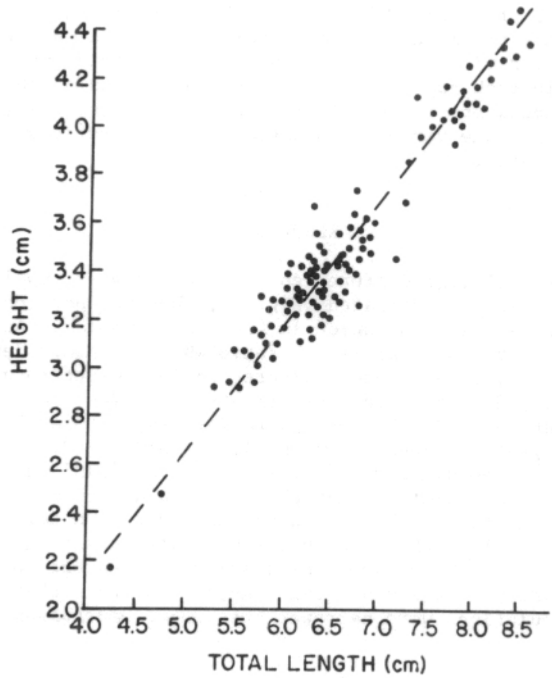

Figure 1. Simple linear correlation of height versus length, r = 0.96. Example of the type of correlation computed for the determination of independent characters.

would be independent of the relative age and health of individuals and thus could be used for comparisons. Consequently the following measurements and resulting character ratios were used: total length, greatest length measured parallel to the hinge line; height, measured at the highest part of the umbone at a right angle to the hinge line; width, distance across both valves taken at the same position on the umbone as the height measurement; posterior length, distance from the point of the height measurement on the umbone to the posterior end of the shell; shell thickness, measured at the midpoint of the height determination line. All measurements which did not require both valves were made on the left valve. Ratios used included height versus total length, width versus height, width versus total length, posterior length versus total length, and shell thickness versus total length.

Data were submitted to a 2X3 factorial analysis of variance to determine relationships between sexes in each population and the relationship between populations for each of the ratios used. Because factorial analysis indicated statistically significant differences between factors, Hubb's diagrams (Hubbs and Perlmutter 1942) were drawn to observe possible species or subspecies distinctions between each population. In Figures 2 and 3 the horizontal line is the mean, the vertical line the range, the open bar 1½ standard deviations, and the shaded portion of the bar 1 standard error. Variation in characters between sexes in each population was also examined using these figures. For further comparisons the coefficient of difference (CD) (Mayr 1971), was calculated for the various populations and sex relationships over each character ratio.

RESULTS

Although significant differences occurred between populations for all character ratios investigated (Fig. 2), they are not generally sufficient for subspecific separation in *L. r. siliquoidea*. An exception was the shell thickness/total length ratio where standard deviations did not overlap (Fig. 2). Only one character ratio, height/total length, was significantly different for the sympatric species from Silver Lake. Three of the ratios, width/height, posterior length/total length, and shell thickness/total length showed similar trends (Fig. 2). For all of these characters, the sympatric species, *L. r. siliquoidea* and *L. o. ventricosa*, were more similar than the two populations of *L. r. siliquoidea* from different habitats. This trend was apparent when comparing total populations (Fig. 2) or the sexes between populations (Fig. 3). The only character ratio which showed similarity between the two populations of *L. r. siliquoidea* was width/total length. For this characteristic both of the populations were narrower than *L. o. ventricosa*.

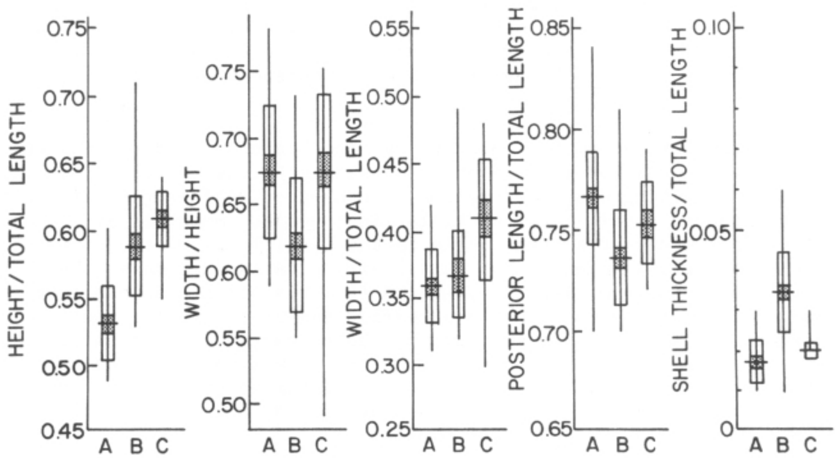

Figure 2. Hubbs diagrams (Hubbs and Perlmutter 1942) of each population for each examined character relationship, A = *L. r. siliquoidea* (Silver Lake), B = *L. r. siliquoidea* (Little Indian Creek), C = *L. o. ventricosa* (Silver Lake).

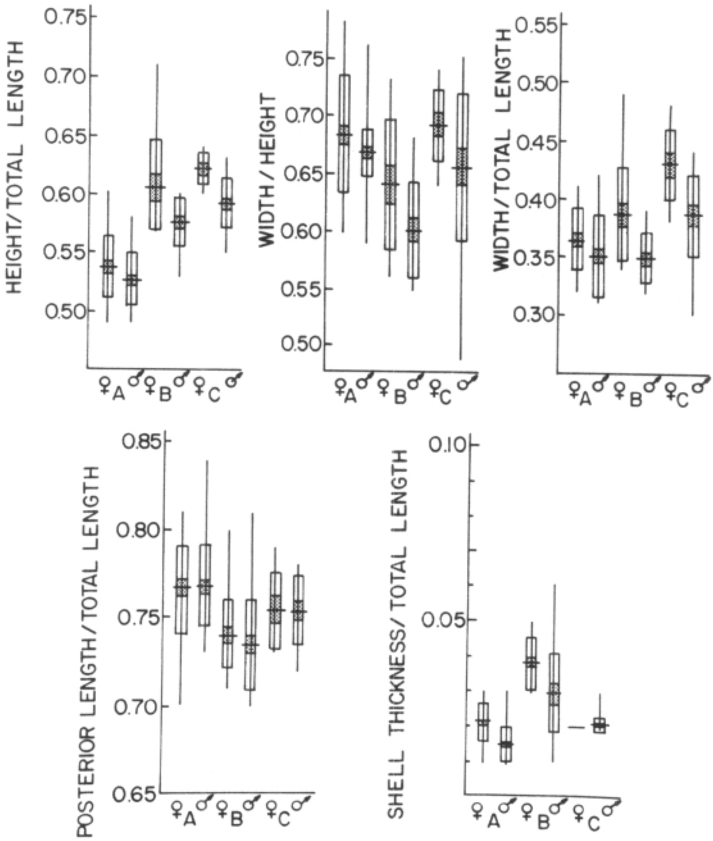

Figure 3. Hubbs diagrams (Hubbs and Perlmutter 1942) population for each character, A = *L. r. siliquoidea* (Silver Lake), B = *L. r. siliquoidea* (Little Indian Creek), C = *L. o. ventricosa* (Silver Lake).

Factorial AOV showed a statistically significant difference at the 0.05 level between the sexes in each population for all of the studied character ratios except the posterior length versus total length. These differences were clearly shown by the Hubb's diagrams (Fig. 3). In those ratios that were significantly different, the females had the larger values: thus, females were generally shorter, wider, higher, and had thicker shells than males (Fig. 3).

Interpretation of the hubb's diagrams both between populations and sexes was supported by the coefficient of differences (CD, difference between means divided by the sum of their standard deviations) (Table 1). Comparing the CD's for *L. r. siliquoidea* and *L. o. ventricosa* from Silver Lake to those of *L. r. siliquoidea* from Little Indian Creek, the comparative similarities of the sympatric species were much greater as they had lower CD's for the three ratios, width/height, shell thickness/total length, and posterior length/total length. The greatest similarity between sexes was found in the *L. r. siliquoidea*, Silver Lake, population while the greatest differences between sexes were found in the Little Indian Creek population. The CD values between the same sexes of the three populations accentuated the trends observed for comparisons between the total populations.

Table 1. Values of the coefficient of differences (CD) between sample groups were A = *L. r. siliquoidea* (Silver Lake), B = *L. r. siliquoidea* (Little Indian Creek), C = *L. o. ventricosa* (Silver Lake) for the characters H/L (height/total length), W/H (width/height), W/L (width/total length), P/L (posterior length/total length), and T/L (shell thickness/total length).

Comparisons	H/L	W/H	W/L	P/L	T/L
A to C	1.388	0.036	0.733	0.312	0.222
A to B	0.982	0.495	0.117	0.596	0.786
B to C	0.222	0.453	0.486	0.381	1.083
Female to Male - A	0.180	0.156	0.224	0.002	0.500
Female to Male - B	0.483	0.417	0.629	0.089	0.526
Female to Male - C	0.853	0.394	0.651	0.000	0.333
Females A to C	2.024	0.123	1.155	0.298	0.143
Females A to B	1.000	0.040	0.362	0.587	1.286
Females B to C	0.308	0.605	0.591	0.317	2.714
Males A to C	1.465	0.127	0.685	0.341	0.750
Males A to B	1.171	0.829	0.071	0.480	0.823
Males B to C	0.375	0.529	0.741	0.204	0.533

DISCUSSION

This study indicated sexual dimorphism in both species at both sampling sites. Females showed a wider, higher and thicker shell and were generally distinguishable from males both visually and statistically. As indicated by Grier (1920b), Parmalee (1967), Baker (1928), and Starrett (1971) and as found in this study, males had a bluntly pointed posterior margin while the females wer bluntly truncated with postero-ventral inflation. The postero-ventral inflation and blunting of the shell resulted in higher width/height and height/total length ratios in the females. The more globose condition of the female shell provided a larger cavity for the body and was particularly inflated in the gill area. This adaptation allows for the large number of eggs held in the first gill marsupium. The thicker shell found in females provided protection for the female. Increased abuse, as a result of the inflated shell, may occur through wave action or stream currents since the inflated conditions results in more resistance to these forces.

Differences between the populations of *L. r. siliquoidea* were attributed to the variation in the two types of habitats. It was found by Wilson and Clark (1914) that shell inflation and many other characters, were dependent on the rate of stream flow, size of the stream and kind of bottom. Meristic characteristics used for specific identification in one locality or habitat type might become valueless elsewhere. Grier (1920a) found that shells he collected from Lake Erie were more inflated, had a greater posterior development and were thinner than similar species collected from the Ohio River. In this investigation the Silver Lake population was more inflated, shorter, and had thinner shells than *L. r. siliquoidea* collected in Little Indian Creek.

Habitat parameters were similar at the two sites with the exception of the current in Little Indian Creek and the probable increased supply of plankton in the lake. The presence of a constant current may account for the variation in characteristics between habitats. The less inflated shells common in the creek, even in females, would present less resistence to the current whether the mussel was moving along the bottom or buried with its posterior extending above the substrate. Also the thicker shells in the creek populations may be a protective adaptation to current induced substrate shifting and dislodgement of individuals from the substrate with associated rolling of individuals across the stream bottom. The lake population was not subjected to this type of substrate shifting thus the shells were thinner and more inflated.

The sympatric species, *L. r. siliquoidea* and *L. o. ventricosa*, showed little character divergence. In fact the sympatric species showed greater similarities for at least three of the ratios examined than the two populations of the same species. This is contrary to the view of increased character divergence in areas of geographic overlap of similar species (Mayr 1971). However, this generality may not apply to molluscs when meristic characters are used to compare divergence between species due to the effects of habitat on these characteristics. In general an increase in the degree of inflation in most species of mussels collected in lakes or river pools compared to the less inflated shells taken in the swifter headwaters has been reported (Grier 1920a, Ortman 1920, Danglade 1914). Thus the factors that were the possible causes of character divergence in the two populations of *L. r. siliquoidea* were likely to be the causes of similarities in the sympatric species. Morphological adaptation to the habitat in the case of these sympatric species exerts a stronger influence on the studied characteristics than character divergence in coexisting species. However these two species do have life history characteristics which maintain the species distinction. *L. o. ventricosa* is reproductively active from late June to early August while *L. r. siliquoidea* breeds from mid-April to early July. Also glochidia are reported to be host specific; bluegill, yellow perch, and walleye are the known host for *L. r. siliquoidea* while white crappie and saugar are the host for *L. o. ventricosa* (Starrett 1971).

CONCLUSIONS

1. The two populations of *L. r. siliquoidea* had significant variation in meristic characteristics due to the presence of a current in one habitat.

2. Adaptations of *L. r. siliquoidea* and *L. o. ventricosa* to their environment result in similarity of the investigated characteristics in these sympatric species.

3. Sexual dimorphism occurs in both species and at both sampling sites and the comparative difference between sexes is independent of the habitat variables.

4. The use of meristic characteristics to compare mollusc populations or species must take into account the effects of habitat on these characteristics.

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