BIOMETRICAL STUDY OF GONIOBASIS COMALENSIS PILSBRY FROM TWO DIVERSE HABITATS[1]

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Much has been written on the part played by the environment in changing secondary characters of the more plastic invertebrates. Baker[2] points out a resultant change in shell-contour of mollusks when a small stream was converted into a ponded area. Goodrich[3] concludes, from his study of pleurocerids inhabiting the Tennessee and Cumberland river-systems, that a "relatively broad shell is the environmental reaction to harsh conditions, and a high shell to conditions less disadvantageous." Other papers could be cited which show that careful as well as biometrical studies are necessary in order to interpret intelligently variations and their extent in mollusk shells.

When collections of animals are made from contrasting habitats it is only natural for the collector to single out apparent differences, such as size, and attribute these to environmental agencies. Often if a complete biometrical study of the populations from each locality were made and the data compared mathematically, many of these "differences" would be found not significant.

During February, 1934, a collecting trip was made to San Marcos, Texas, where two contrasting aquatic habitats were found, both of which were inhabited by the branchiate snail *Goniobasis comalensis*. Several hundred individuals were collected from each habitat, the shells measured, and a statistical study made of size differences. One

[1]The writers are indebted to M. M. Kuser for the construction of charts and to Sol Haberman for the measurements of shells.

[2]Baker, F. C., Influence of a Changed Environment in the Formation of New Species and Varieties. **Ecol. 9**:271-283, 1928.

[3]Goodrich, Calvin, Studies of the Gastropod Family Pleuroceridae. **Occ. Pap. Mus. Zool., Univ. of Mich., 286**:1-17, 1934.

lot of snails were taken from a large ponded area fed by several artesian springs, and serving as the source of the San Marcos river. Since there is a constant influx of clear, warm water, the pond level remains constant, providing favorable conditions for high development of *Potamogeton, Ceratophyllum, Myriophyllum, Cabomba,* and other water plants. The gastropod *Goniobasis* occurs abundantly both on the vegetation and floor of the pond. The effluent of the pond is a swiftly flowing stream, its bed in partially protected places covered with luxuriant vegetation. Here, as well as in the more exposed areas of the river, *Goniobasis* may be found in large numbers. Collections were made for a distance of approximately one-fourth mile downstream.

Data

The following data are based on measurements of maximum diameter and length of 692 river and 507 pond shells:

Table 1. River Shells

Diam. in mm.	Frequency
4.6 - 4.99	11
5.0 - 5.39	41
5.4 - 5.79	106
5.8 - 6.19	257
6.2 - 6.59	158
6.6 - 6.99	76
7.0 - 7.39	34
7.4 - 7.79	6
7.8 - 8.19	2
8.2 - 8.59	1
Total	692

Table 2. Pond Shells

Diam. in mm.	Frequency
4.8 - 5.19	4
5.2 - 5.59	15
5.6 - 5.99	42
6.0 - 6.39	171
6.4 - 6.79	89
6.8 - 7.19	93
7.2 - 7.59	62
7.6 - 7.99	12
8.0 - 8.39	14
8.4 - 8.79	4
8.8 - 9.19	1
Total	507

Table 3. River Shells

Length in mm.	Frequency
9.0 - 9.99	1
10.0 - 10.99	0
11.0 - 11.99	13
12.0 - 12.99	31
13.0 - 13.99	143
14.0 - 14.99	204
15.0 - 15.99	177
16.0 - 16.99	93
17.0 - 17.99	22
18.0 - 18.99	8
Total	692

Table 4. Pond Shells

Length in mm.	Frequency
11.5 - 12.49	1
12.5 - 13.49	5
13.5 - 14.49	22
14.5 - 15.49	106
15.5 - 16.49	137
16.5 - 17.49	142
17.5 - 18.49	66
18.5 - 19.49	18
19.5 - 20.49	8
20.5 - 21.49	2
Total	507

The arithmetical mean with its probable error and the standard deviation, was calculated for each of the four sets of data given in Tables 1, 2, 3, and 4. Results of the analysis are given in Table 5.

Table 5. Comparative Averages

	Arith. mean	Prob. error	Stand. dev.
Diam. of river shells	6.134	*0.362	0.536
Diam. of pond shells	6.615	*0.440	0.652
Length of river shells	14.806	*0.895	1.327
Length of pond shells	16.396	*0.909	1.348

(*Plus or minus)

Table 5 shows a difference of 0.481 and 1.59 mm. respectively in the arithmetic means of the diameters and lengths of pond and river shells. These differences *apparently* indicate that the pond shells have a greater mean diameter and length than the river shells. Figures 1 and 2 which present these data in the form of histograms based on percentages of total frequencies in each class interval illustrate the differences graphically. A change to a percentage basis was necessary due to difference in total number of shells from each habitat.

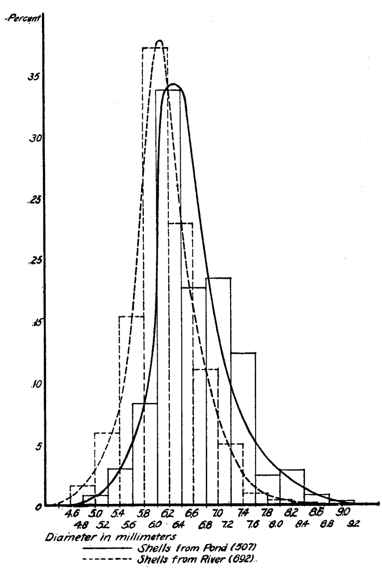

Fig. 1. Shell diameters of Goniobasis comalensis.

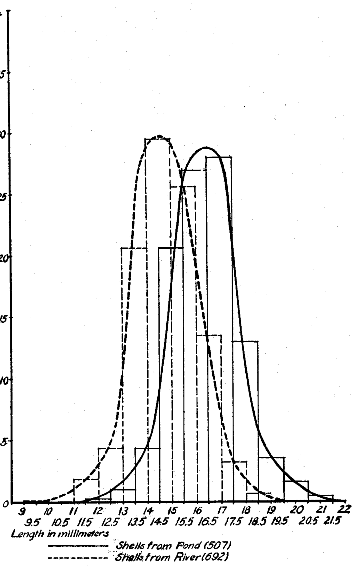

Fig. 2. Shell lengths of Goniobasis comalensis.

Figure 1 shows that the solid curve representing the diameter of pond forms ranges over larger values than the broken curve for river forms. The mode for pond forms falls within the interval 6.0 - 6.4 mm. whereas, for the river forms it is within the interval 5.8 - 6.2 mm. These modes were calculated to be 6.27 and 6.04 mm. respectively; thus indicating again that the pond forms are larger in diameter than the river forms. Figure 2 shows similar data for length, the mode of pond and river shells being 16.83 mm. and 14.55 mm. respectively.

Tables 6 and 7 show the ratio of the diameter of each shell to its length for the snails from both habitats.

Table 6. River Shells
(Ratio of Diam. to length)

D/L	Frequency
0.29 - 0.309	1
0.31 - 0.329	2
0.33 - 0.349	17
0.35 - 0.369	32
0.37 - 0.389	101
0.39 - 0.409	151
0.41 - 0.429	188
0.43 - 0.449	107
0.45 - 0.469	51
0.47 - 0.489	23
0.49 - 0.509	10
0.51 - 0.529	7
0.53 - 0.549	1
0.55 - 0.569	1
Total	692

Table 7. Pond Shells
(Ratio of Diam. to length)

D/L	Frequency
0.31 - 0.329	4
0.33 - 0.349	18
0.35 - 0.369	59
0.37 - 0.389	105
0.39 - 0.409	132
0.41 - 0.429	82
0.43 - 0.449	58
0.45 - 0.469	29
0.47 - 0.489	17
0.49 - 0.509	3
Total	507

The arithmetic mean of the ratios for river forms is 0.415, plus/minus 0.023; the corresponding mean for the pond snails is 0.403 plus/minus 0.023. Apparently the mean ratio for river snails is greater than that for pond snails. This would appear to indicate that the mean ratio of maximum diameter to maximum length of the river shells is greater than the corresponding ratio for pond shells. The percentage of the ratio of each frequency to the total frequency in Tables 6 and 7 is represented graphically in Figure 3.

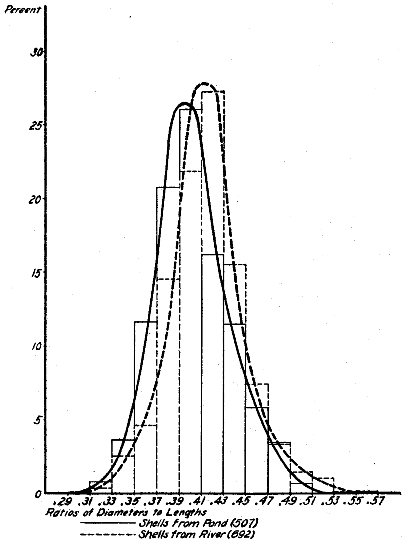

Fig. 3. Goniobasis Comalensis.

From such results (Fig. 3) one might assume that an ecological analogy exists between Goodrich's ('34) observations for anculosae and our river and pond goniobasids. These results might also be favorably compared to Wiebe's[4] findings; namely, obese individuals of *Goniobasis livescens* (Menke) in Lake Erie are correlated with exposed situations, whereas, small apertured and more slender mollusks are correlated with sheltered localities.

Discussion

The results presented appear to show: (1) that the pond shells are on the average greater in length and diameter than the river shells; (2) the mean ratio of diameter to length in river shells is greater than that for pond shells.

How significant are these results? Can it be said for instance, that, since the arithmetic mean of the diameter of the pond shells is 0.481 mm. greater than that of the

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[4]Wiebe, A. H., Variations in the Freshwater Snail, Goniobasis livescens. **Ohio Jour. Sci., 26:**49-68, 1926.

river shells, the pond shells have been affected by their environment? From the *statistical viewpoint* this question cannot be answered either in the affirmative or negative. It is possible, however, under the assumption that the deviation of means and their differences follow the normal law, to determine mathematically the odds against this pair of measurements being really identical (i. e., random samples from the same population). The ratio (0.5699) of the difference of the two means (0.481) to the standard deviation of the difference of the two means $\{0.844 = \text{sq. rt. of } [(.536)^2 + (.652)^2]\}$ was calculated. By referring to tables of the "Probability Integral"[5] it was found that the probability of reaching or exceeding the observed deviation is 0.5687456 and that of not reaching it is 0.4312544, or, odds approximately 4 to 3 of reaching this difference of 0.481 in the two means. In other words if two different sets of shells had been picked from the same habitat, in approximately 57 cases out of 100 the difference in the means of the two samples would have been as great or greater than the difference observed in the means of the diameters of the shells collected from the river and pond. In a similar manner the standard deviation of the difference of the arithmetic means of the lengths was determined (1.892). The probability of reaching or exceeding the observed deviation (1.59) was 0.4006294 and that of not reaching it 0.5993706 or odds of approximately 3 to 2 against reaching this deviation. In the case of the means of the ratios of diameter to length, the probability of reaching or exceeding the observed deviation was 0.8024716 and that of not reaching it was 0.1975284, or, odds in favor of reaching the observed difference about 4 to 1.

These differences, then, are apparently not so significant as they appear at first glance. In fact, from the point of view of the mathematical statistician, it is really quite fortunate that it was known that these two sets of data came from different localities, for otherwise the odds would probably have led us to conclude that they were random samples from the same population.

[5]Pearson, Karl, **Tables for Statisticians and Biometricians.** Part 1, 2nd ed., 1924, p. 2.