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RIB NUMBER AND SHELL COLOR IN HYBRIDIZED SUBSPECIES OF THE ATLANTIC BAY SCALLOP, *ARGOPECTEN IRRADIANS*[1]

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ABSTRACT

Bay scallops, Argopecten irradians *(Lamarck), from populations with low rib number (Texas) and high rib number (Virginia) were bred separately and also hybridized. The results suggest that rib number is under genetic control and that the two populations are genetically differentiated. Scallops taken from a population polymorphic for shell color (Massachusetts) were bred in groups, each group containing a single color. The results suggest that color is also under genetic control and is not strongly influenced by the environment.*

The Bay Scallop, *Argopecten irradians* (Lamarck), occurs in disjunct populations from Massachusetts to the Texas gulf coast. Three subspecies are recognized: *Argopecten irradians irradians* (Lamarck) from Massachusetts to New Jersey, *Argopecten irradians concentricus* (Say) from New Jersey to Louisiana, and *Argopecten irradians amplicostatus* (Dall) from Galveston to Laguna Madre along the Texas coast (Waller, 1969). Clarke (1965) has suggested that the Texas populations should be considered a separate species distinguished by fewer ribs per shell and more inflated valves than other populations. However, the genetic basis, if any, of these shell characteristics is not known. Struhsaker (1968) has found a genetic basis for shell sculpture in the gastropod *Littorina picta* and Staiger (1957) has demonstrated that shell thickness is genetically controlled in the gastropod *Nucella lapillus* (formerly *Purpura lapillus*).

The subspecies *A. i. irradians* is known to be polymorphic for shell color and pattern. One or both valves can be orange, brown, yellow or white and the color can be distributed as solid, banded or mottled. Shell color has been shown to be controlled by a single gene in the mussel *Mytilus edulis* (Innes and Haley, 1977) as has the color pattern *notata* in the clam *Mercenaria mercenaria* (Chanley, 1961). However, diet is also known to influence shell color and banding in some mollusks (Moore, 1936; Underwood and Creese, 1976). Genetic and environmental influences on shell color have not been investigated in *A. irradians.*

When shell characteristics are used to distinguish populations of mollusks, information on the genetic control of the trait is very desirable. We report the results of several experimental crosses made to investigate the inheritance of rib number and shell color in *A. irradians.*

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Materials and Methods

All the adult scallops were mated and their offspring reared at the Virginia Institute of Marine Science (VIMS) Eastern Shore Laboratory using methods described by Castagna (1975). For the investigation of rib number, scallops were imported from Laguna Madre, Texas. These were mated among themselves (Texas cross) as were animals from a native Virginia stock (Virginia cross). Individuals from the two stocks were mated to produce an F_1 (hybrid cross). All three matings were made at the same time and all offspring were the same age when scored for rib number. During the growth period, conditions were kept as uniform as possible.

Scallops for the shell-color matings were obtained from Sengekontacket Pond on Martha's Vineyard, Massachusetts. The animals were sorted into three groups based on the colors of their top and bottom valves: orange top-orange bottom (o/o, 18 scallops), brown-white (b/w, 21 scallops), and white-white (w/w, 32 scallops). Each group was mass spawned. When the offspring were 1.5 to 2.0 cm long, they were scored for top and bottom valve color.

Results and Discussion

Table 1 shows the distribution of shell colors among the offspring of each color group. As expected in mass crosses of wild-caught individuals, no Mendelian ratios occur. However, the distribution of colors was completely different in each of the matings and no single parental phenotype produced the entire range of colors among its offspring. All of the white offspring and none of the orange ones came from the mating of white-shelled parents. One phenotype (both valves brown), that was not present in any of the parents, appeared among the progeny of all three crosses and the phenotype "striped yellow", also not present in the parents, appeared in the b/w cross.

These results are not compatible with any hypothesis that the environment, particularly the diet, has a strong influence on shell color. All three crosses were reared in natural sea water from a common source. Furthermore, the offspring were reared in Virginia where the native population is not polymorphic for these shell colors. The results are compatible with the hypothesis that shell color is genetically controlled, possibly by only a few genes. Because none of the parental phenotypes produced uniform progeny none of the three phenotypes tested can represent a single, homozygous genotype.

Table 2 presents the data on number of ribs per top valve in the Texas and Virginia crosses and their F_1 hybrid. The Texas and Virginia offspring were distinctly different with no overlap in number of ribs. The maximum number of ribs for a Texas shell was 18 and the minimum for a Virginia shell was 19. The mean rib number for the Texas scallops was 15.96 and for the Virginia scallops it was 20.39. Clearly the hybrid cross was intermediate both in range of rib numbers, 17 to 21, and in mean rib number, 18.90. However, the hybrid mean of 18.90 differed

TABLE 1. Distribution of shell colors in offspring of mass matings of single colors. Colors are o = orange, b = brown, w = white, y = yellow. Top valve is listed first, bottom valve second.

Parental Phenotype	Offspring Phenotypes					TOTAL
	o/o	b/b	b/w	w/w	y/y	
o/o	1671	413	197	0	0	2281
b/w	30	143	760	0	25	958
w/w	0	124	137	949	0	1210

TABLE 2. Distribution of rib number on the top valves of *A. irradians* from experimental crosses.

Number of Ribs	CROSS		
	Texas	Hybrid	Virginia
14	8		
15	25		
16	34		
17	29	7	
18	4	28	
19		37	25
20		24	36
21		4	23
22			9
23			5
24			2
TOTAL ANIMALS	100	100	100
MEAN	15.96	18.90	20.39
VARIANCE	1.029	0.960	1.473
STD. ERROR OF MEAN	0.101	0.098	0.121

significantly from the mid-parent value of 18.18 and was closer to the Virginia mean than to the Texas mean. A one-way analysis of variance showed a highly significant difference in rib number among the three crosses (F ratio = 440 with d.f. 2 and 297, error mean square = 1.15, $p<0.0001$). These results are exactly what one expects for a polygenic trait when two genetically distinct strains, or in this case subspecies, are crossed (Falconer, 1981).

An examination of size differences among the three crosses also supports the hypothesis that differences in rib number are genetically determined. Figure 1 shows the mean and range of shell length (lip to hinge) for each of the rib numbers in each of the crosses. The three crosses were significantly different in shell length with the Texas scallops smallest and the hybrids exactly intermediate (mid-parent = 32.3). A one-way analysis of variance of shell length among crosses gave an F ratio of 40 with 2 and 169 degrees of freedom, $p < 0.001$. However, when each cross was examined separately, there was no tendency for size to increase with increasing rib number. The regression coefficient of size on rib number was not significantly different from zero in any of the three crosses. One cannot conclude that the Texas progeny have low rib numbers merely because they are small.

Interpretation of the size differences themselves is less clear. The intermediate performance of the hybrid cross does suggest that the differences among the crosses is genetic and additive. However, the stocks may have differed in genes for temperature adaptation rather than in genes for growth rate. The Texas parents were native to an area of higher water temperature than that in which their offspring were raised. Rearing offspring at a temperature other than that to which their parents were adapted has been shown to affect growth rate in clams (Menzel, 1962).

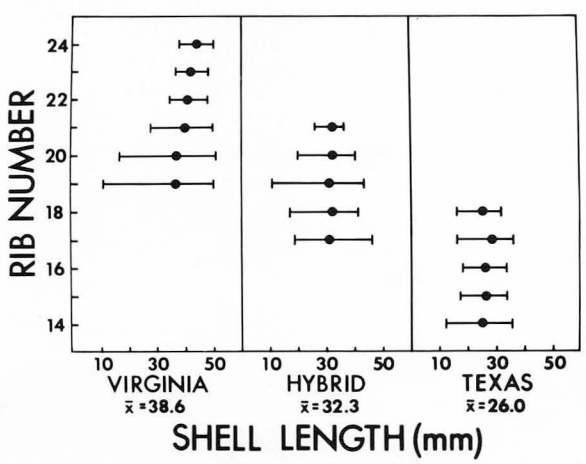

FIG. 1. The range of shell lengths and the mean for each rib number class in *Argopecten irradians*. The Virginia, Hybrid and Texas scallops are the same as those described in Table 2.

Conclusions

From this study, shell color appears to be under genetic control, to be insensitive to the environment and, therefore, to be a valid character for distinguishing between individuals and between populations. Rib number also appears to be genetically controlled and a good character for distinguishing individuals and populations. The data on rib number and shell length show that rib number is a valid characteristic for distinguishing two shells regardless of their absolute sizes. The data also suggest that populations of different geographical origin are genetically differentiated for rib number. The Texas scallops maintained their characteristically lower number of ribs despite being bred and reared in Virginia.

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