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10. We thank P. H. Winston for his important role in inspiring our experiments, and M. G. Ruddy for computer programming and data collection. We also thank K. Ainslie, V. Blaisdell, A. S. Coriell, B. Gates, G. Ozog, and R. Szoc for assistance with these experiments or related pilot studies, and M. Allyn and D. E. Meyer for extensive comments on the manuscript. This work was carried out while N.W. was on sabbatical leave from Loyola University of Chicago. It was supported in part by PHS grant R01EY00143 to N.W.
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Development of Mollusk Shells

We wish to contribute perspective to Clark's (*1*) report on the growth and shape development of bivalve shells. Our examination of representative species among the various pelecypod (bivalve) families indicates that, as a general case, the periostracum forms a topologically continuous sheath completely enclosing each growing shell. On the outer surface it becomes a tough cuticle (*2*). The Pectenidae (scallops) and Cardiidae (cockles) seem atypical in the apparent absence of this continuous periostracum.

It is not clear from the text or the electron micrographs in (*1*) whether the periostracum in *Pecten diegensis* forms a similar enclosing sheath, but it does appear that the periostracum is present, although extremely thin, and continuous over at least the margin of the advancing shell. Shell growth is probably not by extension of the advancing shell margin into the aqueous medium, but is more like the picture of a man in a sheet who extends his arms. All the sequential biochemical events are thus contained within this protective membrane, which is continuous and maintains a controlled environment. It would be valuable to follow the periostracum with the scanning electron microscope over the entire outer surface to the hinge to establish its continuity. If continuity were established, the shell development of *Pecten diegensis* would be consistent with that of many animals in other pelecypod families.

The layering observed by Clark in the deposition of new shell material suggests a biological rhythm, possibly the same rhythm which is responsible for the concentric lines normal to the direction of growth which are common to all of the pelecypods. If the periostracum were continuous over the tops of the growth ridges described by Clark, the interspaces might be due to loss of matrix during handling and treatment of the sections or perhaps partial delamination of the layers. The shells of the scallops and cockles are convoluted, and this may be related to the invisible (or missing) periostracum on the outer shell surface.

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References and Notes

1. G. R. Clark, *Science* **183**, 968 (1974).
2. In freshwater mussels of northern California this cuticle has a protective function, so that injury to this covering allows leaching and perforation of the shell matrix. Shell integrity seems essential, as all healthy individuals had intact shells, while all individuals found with perforations were dead and in many instances filled with mud.

26 March 1974

I appreciate the interest of Gainey and Morris in my recent report (*1*), and welcome the opportunity to broaden the perspective of the discussion.

Gainey and Morris devote most of their comment to a discussion of the function and limited distribution of the periostracum in bivalves. They correctly note two functions of the periostracum, the first being as a protective covering for the entire shell and the second being as a mechanism for isolating the calcification of the shell margin from the sea. They also note that in some groups of bivalves the periostracum is not obvious as a covering on the entire shell and suggest that scanning electron microscopy should be used to see whether it is, in fact, present in areas other than the shell margin. Here they seem to be arguing that the protective function is the original function of the periostracum, whereas current theory and the very evidence they cite suggest strongly that the periostracum evolved to satisfy the needs of calcification and the protective function evolved later in certain groups. These concepts are scattered throughout the literature of the past 25 years (*2*), and will be discussed at some length in a paper now in press (*3*).

Gainey and Morris also present some speculations on layering and delamination, but further discussion might best await at least one supportive fact.

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References and Notes

1. G. R. Clark II, *Science* **183**, 968 (1974).
2. For a beginning, see references in (*1*).
3. G. R. Clark II, *Am. Zool.*, in press.

9 September 1974

Niobium for Superconducting Alternating-Current Power Transmission

Suenaga and Garber (*1*) have reported low a-c losses for samples of Nb_3Sn conductor tested at 4.2 K and 60 hertz. Their results are significant because they demonstrate that the a-c losses of this material are not high enough to preclude its consideration for use as a commercial superconducting cable. However, their concluding sentence, "Such cables would have marked advantages with respect to higher operating temperature and fault current capability than cables employing a niobium conductor, and with the same or lower a-c loss," is not fully supported by the data in their report, nor is it supported by experimental work carried out and reported elsewhere (*2–7*).

Suenaga and Garber compare the a-c losses at 4.2 K of "composite" and "tin dipped" Nb_3Sn with the niobium a-c losses at 4.2 K reported by the Linde Division of Union Carbide Cor-