Mr. Munson (right) maps the site, while students excavate and screen.

As previously mentioned, perhaps the most interesting aspect of the excavations was the discovery of several items of European manufacture deep within three pits in direct association with aboriginal artifacts. These items include a fragment of a brass or copper tinkler, two fragments of sheet brass (kettle fragments?), a fragment of a brass ring or other ornament made by folding in the edges of a strip of brass so that a B-shaped cross-section results, and a larger, thicker brass object of the same construction. The latter two items are similar to the "double wire" spring coil ear or hair ornaments which were found at the early historic Zimmerman Site near Starved Rock. Also found at the bottom of an aboriginal pit was a heavily corroded iron object containing wood in the rust. This might possibly be a clasp knife.

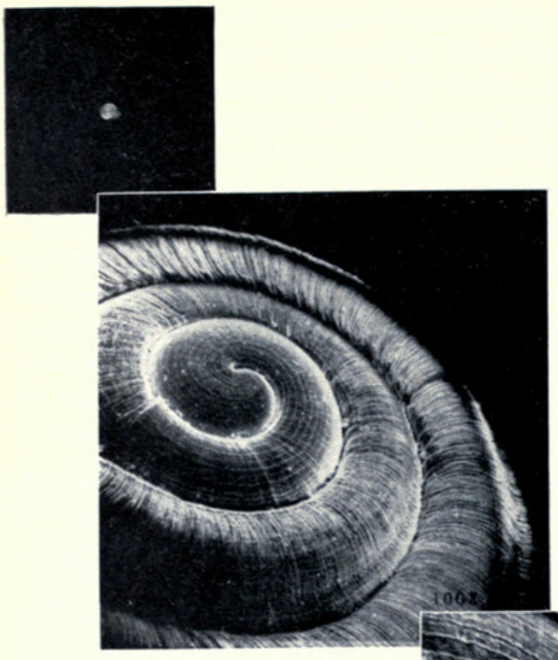
The presence of these European trade goods in association with artifacts of aboriginal manufacture indicates that the Blue Island Culture lasted into the early historic period and that the inhabitants of the Palos Site were trading either directly with Europeans or with other Indians who had acquired these materials from Europeans. The site seems therefore to have been occupied at, just after, or slightly before the first European contact, which in this area occurred in 1673 when Father Jacques Marquette and Louis Jolliet traveled up the Illinois and Des Plaines rivers and portaged to the Chicago River and Lake Michigan. But the absence of glass beads at the site, which were being traded into northern Illinois by 1693, suggests that the site was occupied for no more than 20 years after the first period of contact.

Students excavating storage pit and screening its contents.

The tribal identity of groups which are known only archaeologically is often a difficult problem. When the Blue Island Culture was known only from prehistoric sites, some archaeologists, on the basis of the similarity of its pottery to pottery in Wisconsin which had been identified as prehistoric Winnebago, had very reasonably concluded that the Blue Island Culture sites in the Chicago region represented encampments of Winnebago groups several hundred miles to the south of the area they were occupying at the period of first European contact. However, one of our colleagues, Mr. Charles H. Faulkner, who has recently been working with similar remains in northeastern Indiana, has suggested to us that the Blue Island Culture might represent the Miami tribe. Since the excavations of the Palos Site have demonstrated that the Blue Island peoples were living in the area at the beginning of the historic period, and since the early historical records do not mention Winnebago villages in the area but do note many Miami villages, we find Mr. Faulkner's suggestion most reasonable.

To summarize, we have interpreted the Palos Site as representing a Miami camp occupied during the late summer months between 1673 and 1693. During this part of the year the people subsided by hunting deer and smaller animals, by fishing, and by collecting some mussels and crayfish. They may have grown corn and beans near the site or possibly they brought to the site part of their harvest from fields elsewhere. Other plant foods, apparently in limited quantities, were obtained by collecting nuts and other wild seeds. Food was cooked and stored in pits dug into the ground. The people had a varied tool kit including stone and antler points for bow-and-arrow hunting, stone knives and scrapers for butchering game and preparing hides, milling and hammerstones for cracking and grinding nuts and seeds, and bone awls for sewing and weaving. Well-made pottery vessels were used for cooking and storage. Unfortunately no knowledge of their house types or burial practices was gained from this season's investigations, but it is anticipated that this deficiency will be rectified by additional research at this site.

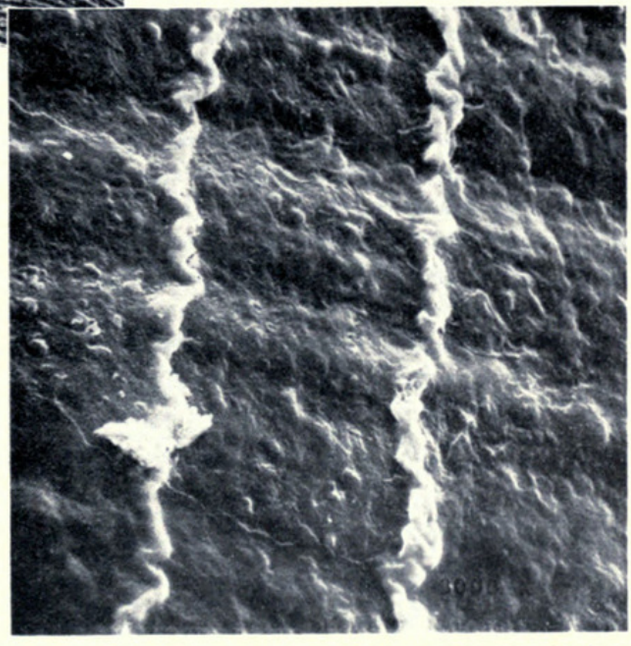
The early explorers rarely recorded detailed information on the life ways of the Indians they encountered, but through archaeology we can recover much of this missing information. By reconstructing the cultural patterns manifested at the Palos and other Blue Island Culture sites we have gained a general knowledge of the life ways of the Indians who inhabited the Chicago region from A.D. 1300 to early historic times. In addition, the students who participated in the program have learned how archaeological excavations are conducted and they have participated in determining who the occupants of the Palos Site were, what kind of culture they had, and when they lived at the site. But perhaps most important, by answering these questions the students have discovered what can be learned through archaeology. During the summer of 1969, students in the next Summer Science Training Program in Anthropology will return to the Palos Site and continue this exciting endeavor.



The scanning electron microscope fills the gap between the optical and the electron microscopes, revealing an exciting and beautiful world to the author.

. . . *in his dim, uncertain sight*

By Alan Solem
Curator, Lower Invertebrates



Top photo shows the actual size of the tiny Palau shell, the white dot in the center of the black background area. Working down the page: The Palau shell magnified about 75X, then 200X, and finally, slightly over 2000X. The original photographs show slightly higher magnifications, but space limitations in the Bulletin made it necessary to reduce them here.

Over the years I have become reconciled to the relevant absurdities that enter my mind unbidden during moments of intense scientific thought. Hence the sudden eruption of Nicholas Butler's definition of an expert as "one who knows more and more about less and less," was hardly surprising. I was seated on the edge of a typist's chair in a darkened room, peering intensely at a small television screen on which there were appearing in sharply outlined detail, structures that I had been seeking, without success, to view for more than six years. This was during my first visit to Alpha Research and Development Company of Blue Island, Illinois, and my first opportunity to make use of its scanning electron microscope.

Earlier that afternoon, Mr. John Brown of Alpha Research had placed several minute snail shells in a vacuum chamber, coated them with about a 400-Angstrom Unit layer of pure gold, then transferred the gilded group into the scanning electron microscope specimen chamber. A sequence of flashing lights and moving dials traced the

reduction of air pressure within the chamber. After a few minutes a buzzer signalled that operations could begin. By bombarding the gold film on the snail's surface with a 20-KV stream of electrons, it was possible to produce a highly magnified image on a viewing screen. Sure twists of positioning knobs by John Brown, slight changes in specimen angle, adjustments of the focusing and contrast knobs, and there, for the first time, I could see without question the true sculptural structures of endodontid land snails. Simple clicks of a magnification control, and suddenly magnification of the same spot could be changed from 50X to 10,000X.

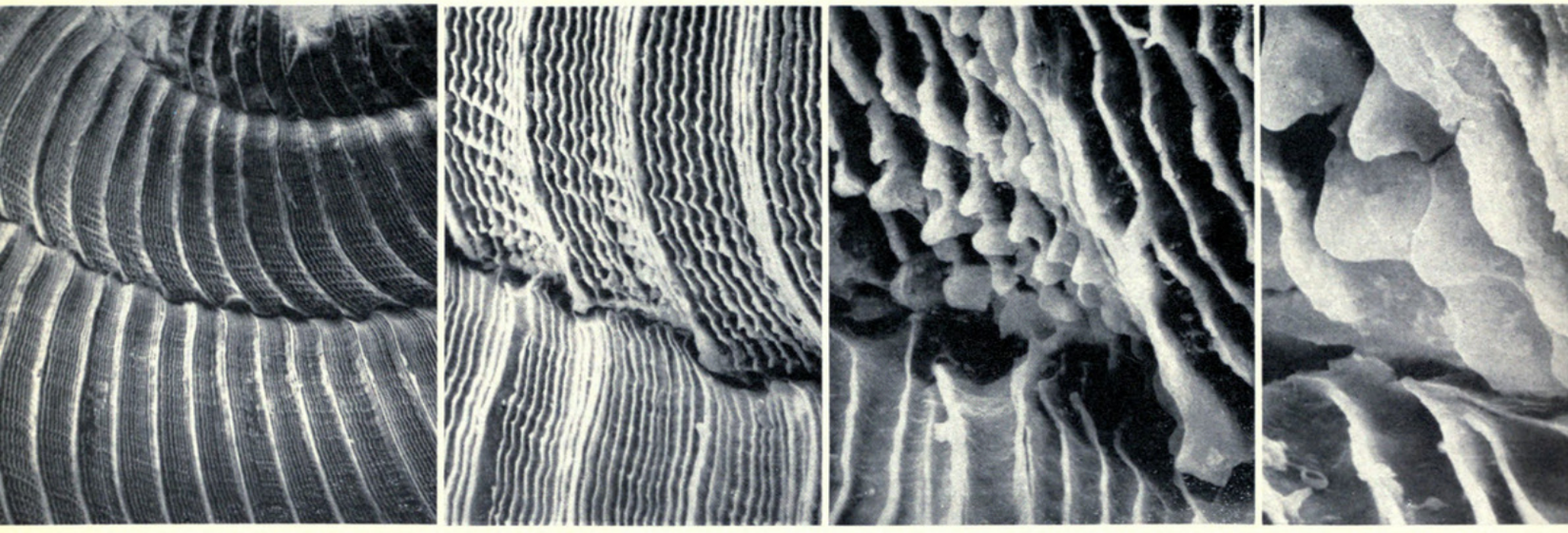
Few things please a scientist more than being able to confirm a pet prejudice. That afternoon was filled with pleasures. In three hours I answered questions that it had taken six years of work with the light microscope to ask, and, in asking, to know that I could not answer them. The answers to those questions lay at or beyond the resolution limit of the light microscope. Combining the microscope's shallow depth of field, a globular shell with marked surface relief, and never enough light on the shell, hid the answers that I sought behind a blurred fog.

Scientific progress is intimately connected with the continual development of new tools that extend man's feeble senses. Decades of careful and patient labors by many individuals will come up against a wall beyond which our tools will not reach.

Since the mid-1660's, generations of scientists have utilized the optical microscope in studying the form and fine structure of living organisms. Between the range of the standard light microscope and the extremely high magnifications of the standard electron microscope, there was a visual gap. This has been bridged only by the recent production of an effective scanning electron microscope.

The superiority of this instrument lies not primarily in the greater magnification of which it is capable, but in the infinitely greater depth of field that it produces at any given magnification. I have seen estimates indicating that the scanning electron microscope has 300-500 times the depth of field obtainable with the best optical equipment. The illustrations produced here amply demonstrate the high magnification and resolving power of this instrument.

With this tool I could examine structures on the surface of snail shells with magnification as high as 10,000X. By taking a photograph at a particular magnification, rotating the specimen only two or three degrees and taking a second picture, I can obtain a stereo pair for viewing, and thus achieve a three-dimensional portrait of these structures.



This relative "giant" among entodontid land snails measures about 1/6 of an inch in life. This series shows the shell (from left) *at about 60 × magnification, 180 × magnification, 600 × magnification, and 1800× magnification.*

Why? What is the importance of the results?

Why did I ask the previously unanswered questions?

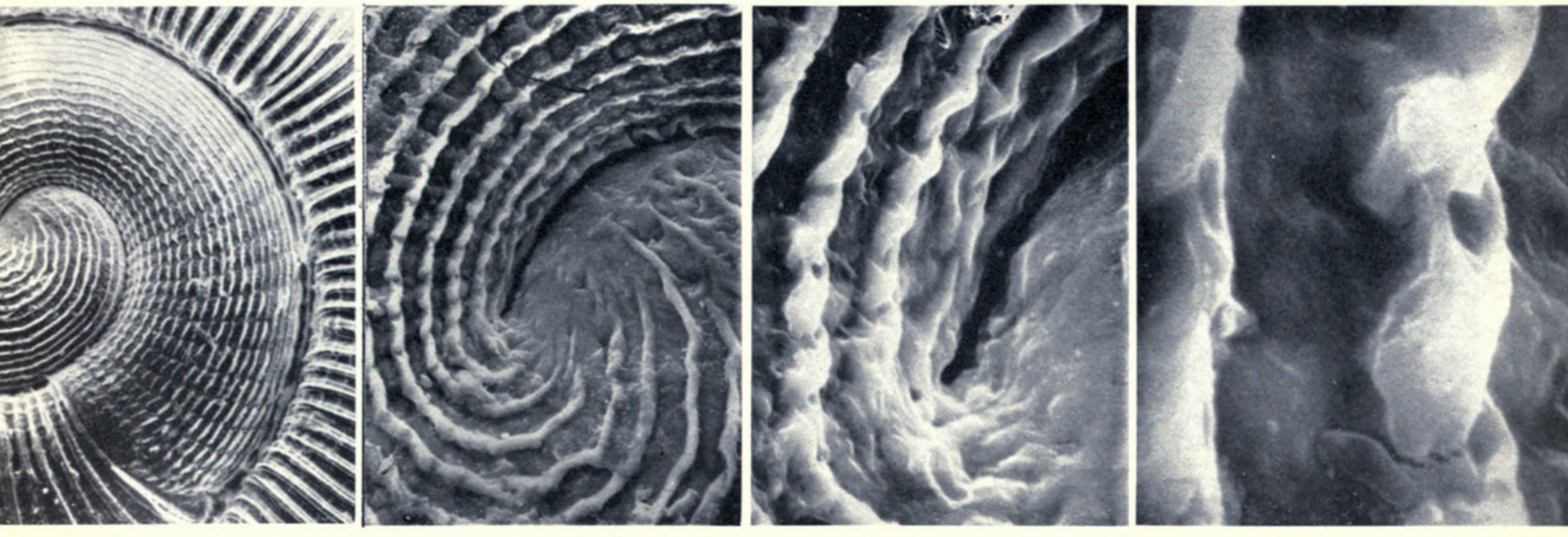
For the past several years I have been studying the endodontid land snails of Polynesia and Micronesia. These are quite small, one to five millimeters in adult size, land snails that are generally restricted to the leaf litter in undisturbed forests on the high volcanic islands of the Pacific Basin. After studying almost 30,000 specimens I have recognized about 280 different species, the majority of which had not been previously described. My primary concern is not the comparatively simple matter of telling species apart, but in trying to learn what are the relationships between species and what has been the pattern and pathways of evolutionary change within the group. My studies have not consisted solely of observing the shells, but have included dissection of the soft parts wherever possible.

Early in the study it became evident that there are two major taxonomic groups present on the Pacific Islands. Anatomical differences are numerous, discrete and easily observable from even fragmentary preserved specimens.

Many species have become extinct within the last 100 years and several specimens have been recovered from the deep core drilling on Bikini, Eniwetok and Funafuti

atolls. The specimens from the cores range in age from comparatively recent to perhaps 20 million years old. It would be most helpful in determining patterns of colonization to relate these shells to modern species. Obviously they could not be dissected. Hence, a major concern of mine has been to learn if there are any shell features which serve to distinguish sub-family groupings that are based on anatomical differences. For a long time, this search appeared unsuccessful. Almost any shell feature that was found in members of one sub-family, was duplicated one or more times in specimens of the other sub-family. While certain average groups of characters seemed, in most cases, to distinguish between the different groups, I was unable to pick any shell features that could be used, without question, to differentiate the subfamilies.

The actual size of this entire shell is only 1/25 of an inch at its widest dimension. With the scanning electron microscope, the exquisite details of its shell surface have been revealed. From left, *180× magnification, 600× magnification, 1800× magnification, and 6600× magnification.*



The nearest I had come to a solution was an indication that there might be some differences in the very fine sculpture on the shell surface. With a few exceptions, the sculpture on the apex seemed to correlate with the anatomical structure. These features were at the limit of resolution for the light microscope. I never could be certain whether I was seeing or merely wishing to see.

Two sessions with the scanning electron microscope produced results beyond my wildest expectations. Clear shell differences exist in the shell microsculpture. The technical report and conclusions will appear elsewhere, but here we can appreciate these shells for their beauty.

We have chosen to show you a full series of pictures for a Palau Island species whose largest dimension is $\frac{1}{12}$th of an inch (see actual size picture), details from the center sculpture of a Fijian species whose maximum size is less than $\frac{1}{25}$th of an inch, and details of a "giant" that reaches almost $\frac{1}{6}$th of an inch. Depth of field limitations made 100X magnification an effective limit for examining these with the light microscope. Obviously, at 100X magnification sculptural details of the Palau shell are scarcely visible. One can see that the sculpture of the first few whorls is different from that on the remaining whorls, but it isn't possible to make out details. Only at the much higher magnification and particularly at the 1,000 and 3,000 magnification level is it possible to see clearly what are the structural elements of the sculpture. Greater differences are demonstrated in the very small Fijian shell, with the apex having strands arranged in spiral rows and resembling some very peculiar cake decoration or strings of pasta. What seems at first to be a rather simple and crowded sculpture of the Austral Island species at higher magnification turns out to be an incredibly complex series of jagged-edged swirls and dips.

My first question, concerning whether there were any shell features to separate the sub-family groupings, was answered in the affirmative. A more fundamental question was raised. What possibly could be the function of such complex ornamentation on the surface of very small snails? While we have no certain answer, ideas produced by these pictures will lead me back to the scanning electron microscope and its operator, John Brown. More specimens, more pictures, more ideas, a new area of research opened, since what was "in his dim, uncertain sight" is clearly seen by electrons. They are far superior to both bifocals and binocular microscopes.

The largest known specimen of *Cypraea pulchra* (Beautiful Cowry), three inches in length, will be the featured exhibit during the Fifth Annual Shell Show of the Chicago Shell Club at Field Museum in March. "Shapes and Patterns of Shells" is the focal point of the show which will display larger specimens of beautiful and unusual shells from all parts of the world. About 90 per cent of the known mollusks, however, are very small, measuring ½ inch or less in size. These, too, come in a marvelous array of shapes and patterns as demonstrated in Dr. Solem's article about some of the tiniest shells known.