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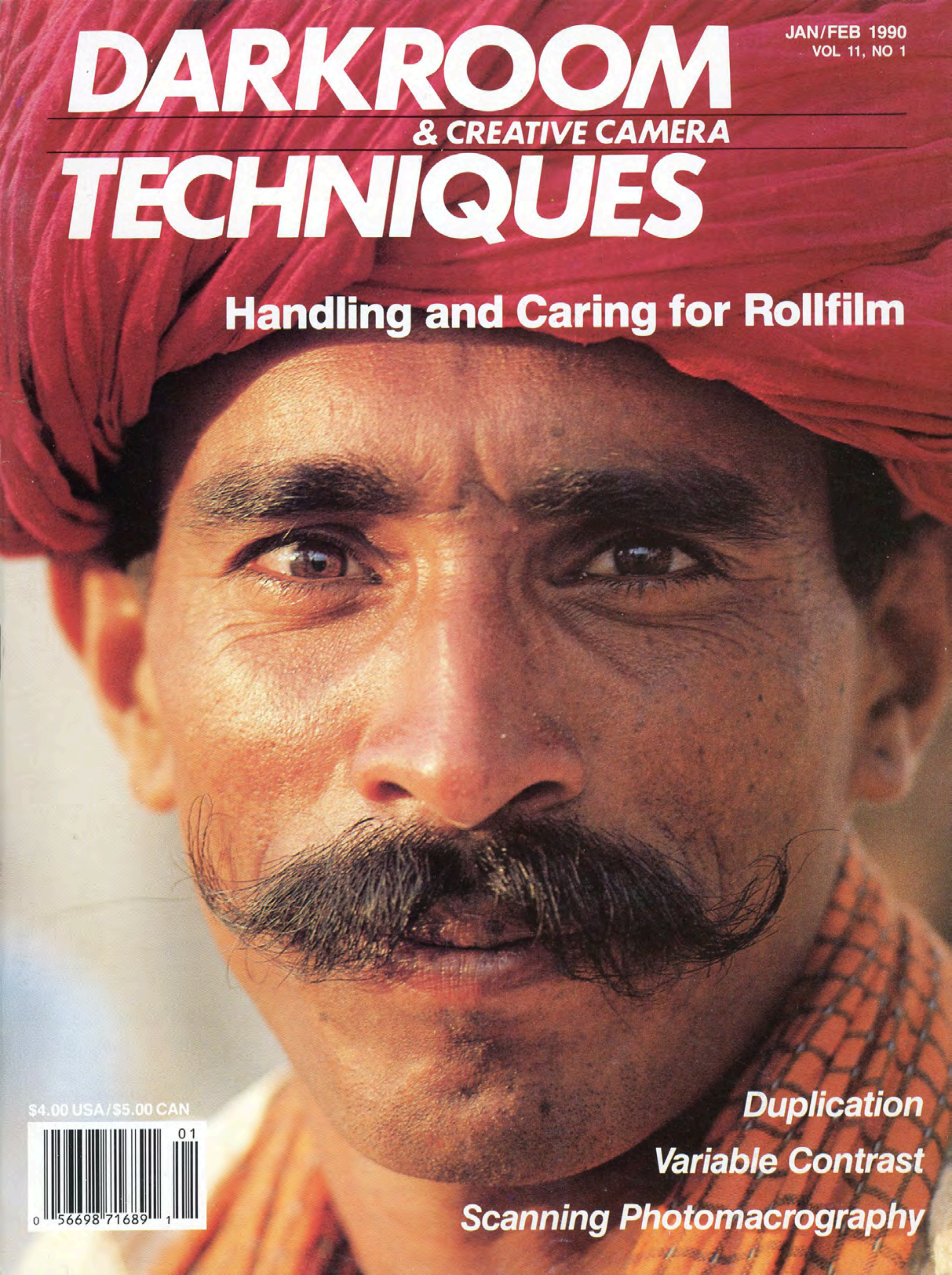
DARKROOM & CREATIVE CAMERA TECHNIQUES



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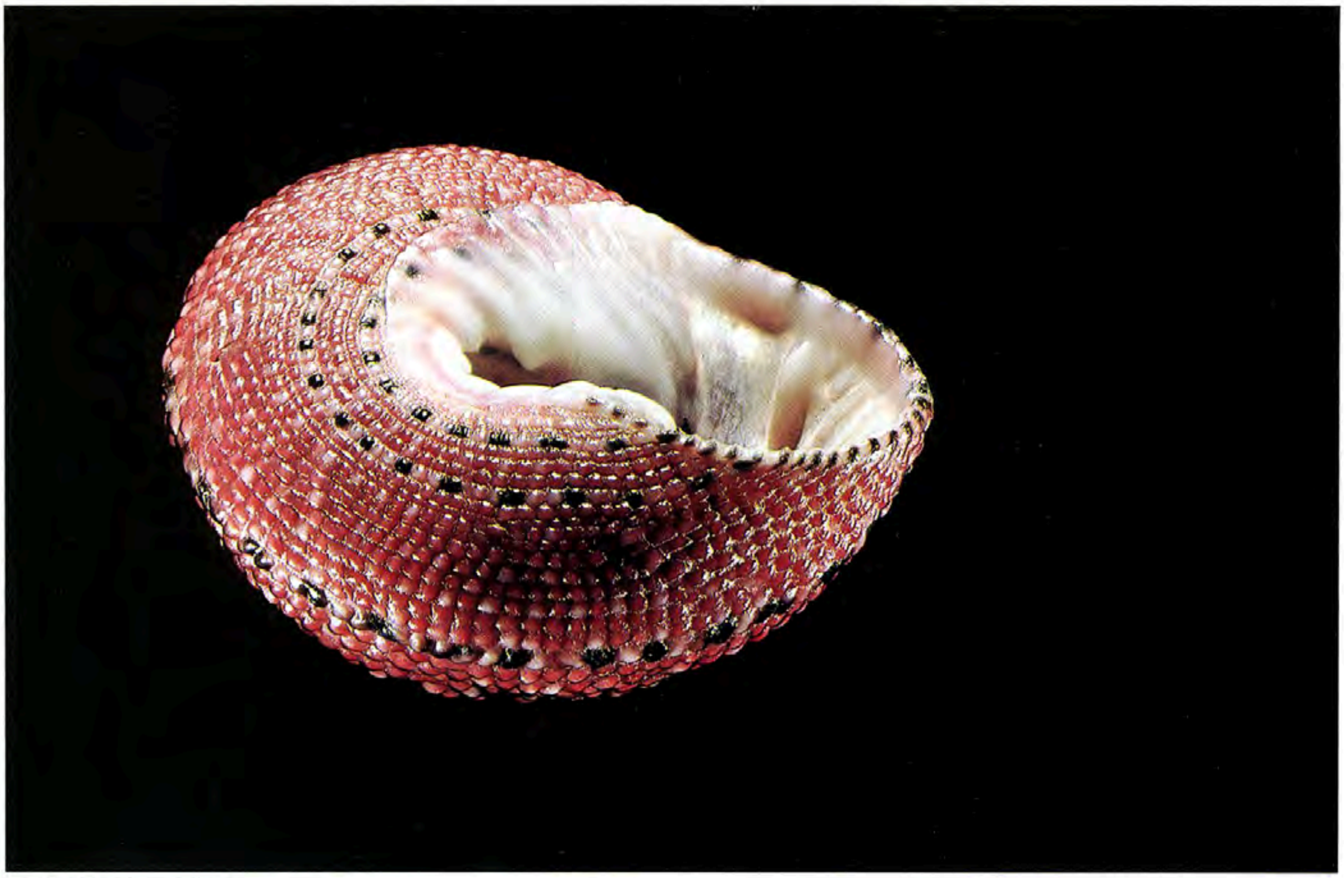


CLANCULUS PHARONIUM

Scanning Light Photomacrography

Maximize Sharpness and Contrast

By William P. Sharp and Charles J. Kazilek

Scanning light photomacrography (SLP) provides a solution to several of the most limiting problems associated with more conventional close-up techniques. As implied by its alternate name, deep-field photomacrography, subjects recorded using this method will be rendered in focus from the details nearest to the lens to those at the farthest limit. Using conventional techniques, only a part of the subject can be in acceptable focus when recorded at magnifications high enough to resolve fine detail.

The principles of SLP have been known since the early 1960's (McLachlan, 1964), and have been documented frequently as having excellent results with subjects requiring up to 30× print magnification. In our case, we have worked with subjects of varying size but have concentrated on the magnification range that is in the crossover between non-macro and macro-photography, from about one-fifth life size on the film to about 2.6×. SLP seems to work very nicely in this range.

Since SLP uses traditional optics, it is governed by physical laws for depth-of-field. The closer the lens is to the subject and the higher the required magnification, the smaller the depth-of-field will be. Since only one plane can ever be in true focus, the size of the circle of confusion, variously quoted at $\frac{1}{500}$ to $\frac{1}{1000}$ of an inch for 35mm formats, determines how much of the specimen appears to be in acceptable focus. The smaller the aperture, the farther away from the plane of true focus you can go before reaching the circle of confusion limits. When working at image to specimen ratios of about 1:10 or greater, the following formula for depth-of-field applies (Engel, 1968):

$$\frac{n(M+1)\ (2C)}{M^2}$$

Where:
C is the permissible circle of confusion.
n is f/stop.
M is the image magnification.

SLP overcomes the problems of depth-of-field by recording only information between the maximum circle of confusion limits on either side of the plane of true focus. To accomplish this, the subject is mounted on a stage that moves perpendicular to the film plane. A thin slice of light parallel to the film plane illuminates the subject as it passes through the light source. The direction of movement can be either towards or away from the lens as long as the travel is perpendicular to the film plane. As the subject passes (scans) through the narrow plane of light, the image is painted onto the photographic emulsion (Figure 1). As long as the band of illumination is thinner than the depth-of-field at the given aperture and specimen magnification, all parts of the subject will be in acceptable focus.

Equipment required to make SLP im-

***CHAMA CONGREGATA CONRAD.* The one on the left was done using SLP: the one on the right was not.**

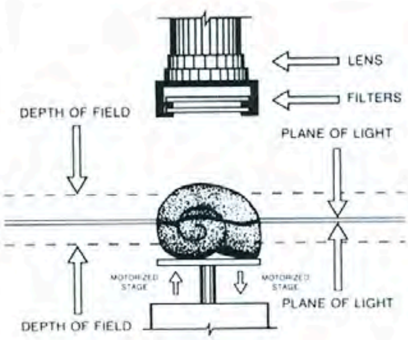


Figure 1. SLP principles and depth-of-field limits.

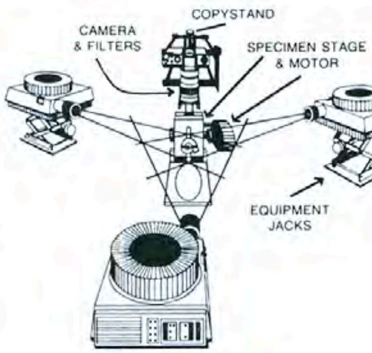


Figure 2. SLP set-up and projector mounting.

Illustration by Michael Junius

ages is commercially available from Irvine Optical Corporation. The system is called Dynaphot™ and is built based on a photomacroscope with 4×5 capabilities and a choice of either two or three illuminators. For those on a budget, a working system can be built for under $200, depending on how much equipment can be borrowed, rented, or scavenged.

The setup used to make the accompanying images consists of three standard Kodak Ektagraphic AF-2 projectors using ELH lamps and fitted with 102-152mm zoom lenses. The projectors were positioned at a distance sufficient to project as thin a focused plane of light on the sample as possible, about 24 inches from lens to subject. To create the thin plane of light, plastic slide mounts were used to hold pieces of double-edged razor blades, edge to edge, across the center of the slide mount aperture. The area above and below the metal blades was masked with at least two layers of metallized tape to limit the spill of light (Root, 1986).

To adjust the height and level of the projectors we initially used books and cardboard shims. This is not a practical approach if you plan on doing SLP on a regular basis, but worked well for preliminary tests. Later, we purchased equipment jacks (from VWR or other scientific supply house) which provided a quick and easy way to adjust height, pitch, and roll (Figure 2).

To focus and align the light sources we used a piece of clay formed into the shape of a three-sided pyramid as a target. By placing the pyramid on the specimen stage (corners pointing towards the projectors) and positioning it in the path of the three projected planes of light, it is simple to focus a thin plane of light using the zoom and focus controls. Before focusing the light, it is important that the projectors be positioned at equal distances from the specimen stage to obtain a consistently thin band of illumination on the target. After focus is set, each projector is checked for pitch and roll using a carpenter's level laid across the slide trays in two directions. Assuming the copystand baseboard and camera film plane are also level, this will bring the plane of light into rough alignment, leaving fine adjustments to small movements of the equipment jack controls and locks. These fine adjustments are accomplished using the target to assess the results. When the illuminating sources are set correctly the pyramid will have a thin continuous band of focused light around it.

In addition to focus and alignment of the light sources, we also hold a white piece of cardboard behind the clay pyramid and across from each projector to see that the beam is set so the specimen is in the center of the plane of light (left to right). This is critical for all subjects but even more so with larger ones. Failure to check that the subject is evenly illuminated throughout the scan will result in images that are unevenly lit or have areas which the light completely misses.

The camera we used was a Nikon FE-2 equipped with either a 55mm Micro-Nikkor (with or without a PK-13 extension ring) or a Nikkor 28mm f/2.8 lens reversed using a Nikon BR-2 ring. The shutter was set at B and held open with a locking cable release. The camera was mounted on a tabletop copystand. The lens was fitted with a Cokin filter adapter and Cokin blue filters were used to balance the light.

The subject stage design and operation are critical factors. Luckily, there are a few alternatives. We used a modified dissection microscope stage that was moved up and down by a focusing motor attachment controlled by a foot switch. The revolution rate is fixed at about 2 rpm which gives a linear stage speed of about 38mm/minute in our case. Another good source for a stage is described by Nile Root (Root, 1985) who used a telescope eyepiece focusing assembly connected to a 12 volt DC motor. Any smooth rack-and-pinion movement that can be motorized will work. We found the microscope stage had the advantage of greater vertical travel, 6 inches rather than 3 inches, which is essential for larger subjects.

Our film selection was based on several factors. Since the main purpose of photographing these images was to document a large shell collection, we decided that 35mm slides would be best based on our cost and cataloging needs. To ensure maximum detail, color saturation, and archival qualities we selected Kodachrome 25. Initially, we tested our SLP system and determined approximate exposure using Technical Pan 2415 film rated at EI 25. We made a series of test exposures in ½-stop increments ranging from f/5.6 to f/22. After the film was developed and evaluated, we determined the best range of apertures. Taking the filters into consideration, the range from f/8 to f/11 gave the best results.

Our final consideration was the color balance of the Kodachrome. Ektagraphic slide projectors provide a strong source of illumination rated at approximately 3350K, a bit warm for natural results with daylight-balanced film. By running several series of bracketed exposures with different combinations of Cokin filters (023, 024, 025) we selected the combination that produced correct color balance. We run through this procedure every time we buy a new film lot. As a result, we buy a "brick" of film (twenty rolls of film packaged from the same emulsion lot) if color rendition is critical.

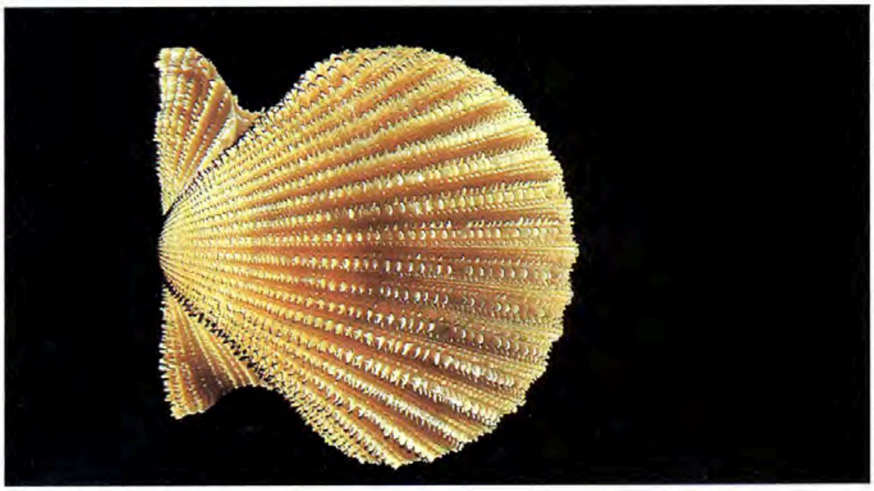
The benefits of SLP do not come without some sacrifice. The highly directional lighting used is both a blessing and a curse. Because of the lighting, the images give a heightened sense of detail. For the shells it is often the case that minute details become much more apparent in the photograph than when viewed with less directional lighting. Since this is also the case with tiny pieces of dust and lint, preparation of SLP samples requires careful inspection and cleaning using compressed air or a soft brush. A fine-tipped pair of forceps (No. 5 Dumont) and a good loupe or dissection microscope are also very handy for this purpose.

Contrast control is another problem with SLP. Again, due to the type of lighting used, photographs can be extremely harsh. This is most common with deeply textured subjects. The use of three light sources in our set-up (rather than the standard two) helps reduce contrast for many subjects. In some cases, you may have to adjust the sample alignment (to the plane of light) to reduce exaggerated shadows and harsh edge effects. Finally, you can use a negative rather than a reversal film to keep the shadows from blocking up.

In previous articles on SLP, light piping has been described as a problem when photographing translucent subjects. Such piping can cause ghost images on a photograph. We found this did not present much of a problem with the shells even though many of them are translucent. We attribute this to the Kodachrome 25 film, which has an extremely high exposure threshold. Due to this high threshold, the areas that pipe light are not nearly bright enough to create ghost images.

The very nature of SLP gives a dramatic appearance to subjects photographed using this technique. Only the subject is recorded on the film leaving all else a deep rich black. This is often beneficial, but at times can present problems. If the subject is very dark it tends to blend in with the background. Nile Root of RIT wrote in general terms about his double-exposure experiments to add background colors (Root, 1985). However, at this time, we have not found any articles

VERMICULARIA TENAGODUS



PECTEN MUSCOSUS WOOD

that describe in detail how this is done and what the results have been.

The original intent of using SLP was to document the Chester A. Melville shell collection which is housed in the Dept. of Zoology, Arizona State University. This collection is one of the larger privately amassed shell assemblies in the world and was placed at ASU on the condition that it be shared with the public. In addition to public displays of selected groups of the shells, it was felt that a method of showing even the rarest and most delicate shells should be investigated. Conventional macrophotography was rejected due to depth-of-field problems. Since the first shells were photographed using scanning light photomacrography, we have worked with specimens such as tiny insect leaf parasites and their habitat, specific types of ants and butterfly wings. Bits of acorns and other seeds and leaves all have been "pushed through the plane" in the name of clear, unambiguous scientific documentation and aesthetic gratification.

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William P. Sharp is lab manager of the Life Sciences Electron Microscope Laboratory in the Department of Botany at Arizona State University. Charles J. Kazilek is the communications facilitator for the Department of Zoology at Arizona State University. He is the department's graphics, art, and presentation expert, as well as a technical consultant on electron microscopy. Both have been involved in photography for a number of years.