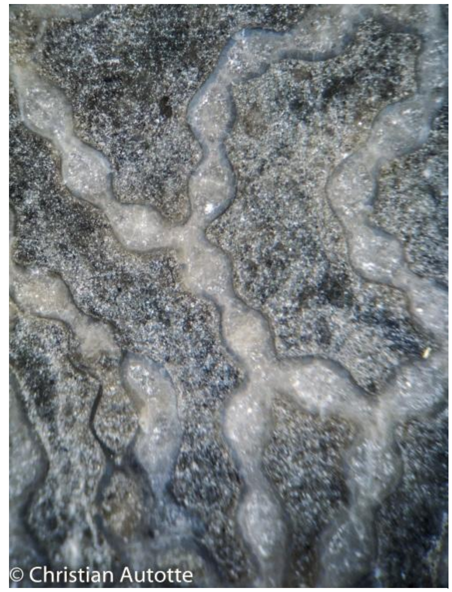
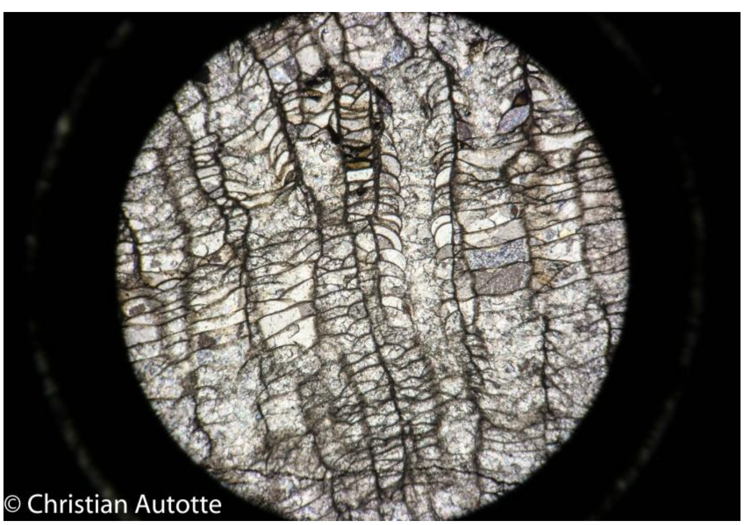
FOSSIL MICROSCOPY, by Christian Autotte, Canada

Amateur paleontologists are used to do a lot of work with binoculars. We use binoculars to examine our finds or to clean them out of their matrix. But when it's time to take pictures, binoculars are not the ideal microscopes on which to mount a camera. Photographers prefer working with trinocular microscopes. A potential problem is the needed magnification. Quite often, fossils will be very interesting when observed with magnification around 10x, but the standard range of an optical microscope is more like 40x and up. Add to that an adapter for the camera which can give an extra bit of magnification and you may find yourself with too narrow a field of view. Worst case scenario may call for a series of pictures which are then assembled panoramic style. At times, I also select a different camera. An APS-C or Micro 4/3 camera introduce a magnification of its own due to the size of its sensor, so it make sense that a full frame camera will give an image with more coverage. But even that can have its own drawback: depending on the adapter and the ocular being used, the resulting image can end up being round, which is not to everyone's liking. A simple solution is to edit the picture to make a square image.



Halycites coral. Shot at 10x on the binocular. The camera and its adapter were held by hand on one of the eyepiece. We see a lot of defects at the edges and, curiously, the magnification is not that good (see on the next page).



Thin section of fossil coral. Shot with a full frame camera, at 40x lens. The same picture was then cropped to a square format.

Halycites coral. About 4x with a 4x microscope lens on a bellows.

An actual microscope may not always be needed. All we really need is a *microscope lens* to get the proper magnification, which is more than a standard macro lens could provide. It's very easy to mount a microscope lens on a threaded adapter; there are a lot of these to be found on eBay or Amazon. A 4 or 10x microscope lens can then be mounted on a bellows or a set of extension tubes to provide less magnification than the same lens on a microscope. A 4x lens on a set of 68mm extension tubes gives about 2.75x of magnification; add a second set of tubes and magnification increases to about 3.75x. A 10x lens with one set of tubes gives about 8x but the working distance can be very close; care should be taken when moving the assembly up and down so as not to damage the lens on a fossil's rough surface.

The other problem with most fossils is their density: they are not transparent, which means that episcopic lighting must be used. In other words, light must come from above the fossil and not go through the usual channel of a microscope condenser. Most fossils also tend to be bumpy; they are not your typical microscope slide thin and flat between two layers of glass. So another typical when I shoot fossil is to take a series of images that are stacked with software such as Zerene Stacker. Depending on the magnification, it may be useful to stack more than 20 or 30 images to get enough sharpness across the field of view. With some subjects you may still see some distortions at the edges of the image; this may also be caused by the microscope lens itself.

Crinoid segments, about 2.75x with a 4x lens on a set of extension tubes. A stack of 21 pictures.

Details of a cephalopod showing the siphon and the walls separating individual septa, or chamber. Microscope photograph at 30x; above, a group of 12 individual pictures were assembled to cover a wider area.

Fossil ostracods, about 2.8x, stacks of 15 and 30 pictures.

Episcopic illumination doesn't have to be very sophisticated. Here, a simple table lamp is used to light a series of fossil ostracods. The Olympus micro 4/3 camera is equipped with an adapter, then a set of extension tubes meant for Canon cameras; a threaded adapter and a 4x microscope lens complete the set up.

The camera is mounted on a "junk" microscope on which is fixed a programmable focusing rail (Cognisys.com) able to move the camera by as little as one micron; however, for most of the pictures seen here the camera was moved by 75 microns between shots.

As mentioned before, changing magnification with such a system can be done either by choosing a different lens or by adding more extension tubes.

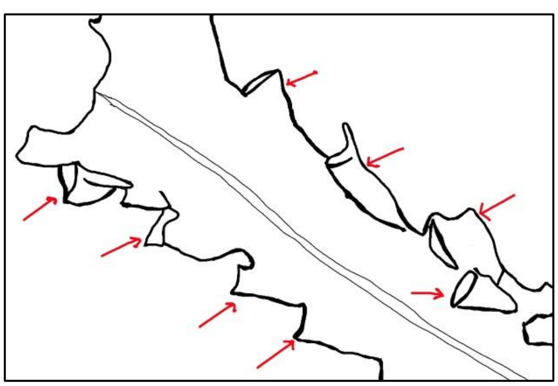
This stone was encrusted with worms and bryozoans some 10 000 years ago at the end of the last Ice Age. It was recovered from a clay cliff on the North-Shore of Québec.

A section of bryozoan shot with a macro lens set at 1x.

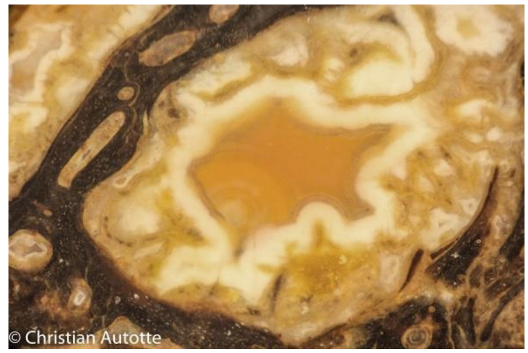
Fossilized worm case and bryozoan. Stack of 27 shots with a 4x lens on 68mm extension *tube* on a micro 4/3. 2.8x.

Detail of fossil bryozoan, with a 10x microscope lens on extension tubes. Stack of 10 pictures. About 9x.

I have a lot of graptolites in my collection, but few show as much details. With proper lighting I am able to resolve the median septum, the central line that separates two sets of individual theca, which housed the polyp-like organism (red arrows on the drawing).



Graptolites shot with a 4x lens on extension tubes.



Dinosaur bone fragment, cross section. The pictures on the right were shot with a microscope, 30x.

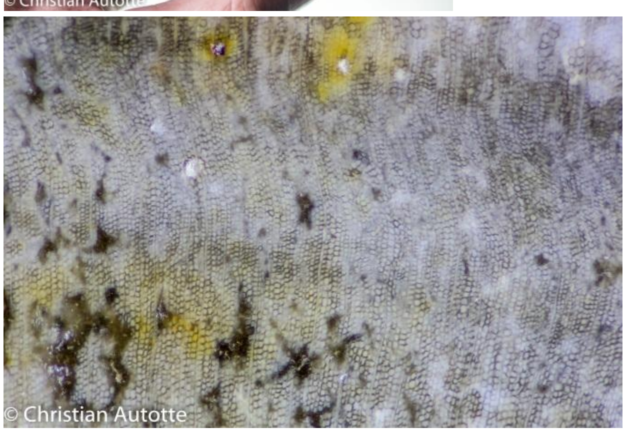
Whether photographed with the microscope or with a microscope lens on some extension the face of the fossil being photographed should be kept as parallel to the camera as possible. In many occasions I have used a wad of modeling clay to level an uneven stone.

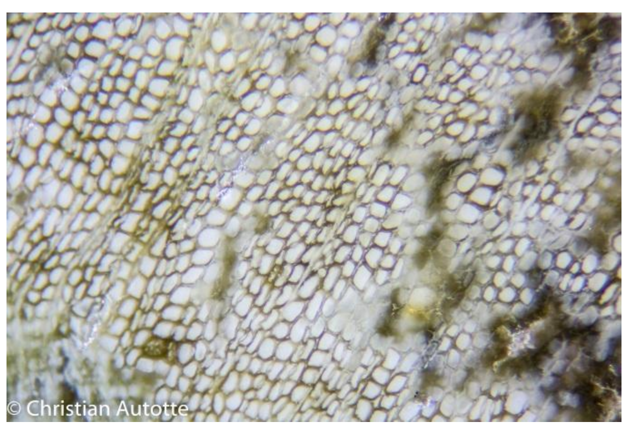
Of course subjects that are more flat (front and back) will be easier to photograph. Some fossils in my collection have been polished: fossil wood, corral, stromatolites, even dinosaur bones. While some were bought like that directly from suppliers, others I have polished myself. My polishing equipment is rather limited at the moment. It consists of very fine sandpaper on which I polish stones by hand with vigorous circular motions. It would be far better if I could use wet polishing plates of the type used in lapidary workshops, but I currently lack this type of equipment. Nevertheless, the result I get is still acceptable. A polished fossil will still be lit from above, and because it is polished care must be taken with the angle of light so as not to create reflections off the shiny surface.

Polished section of fossilized coral. With microscope at 30x.

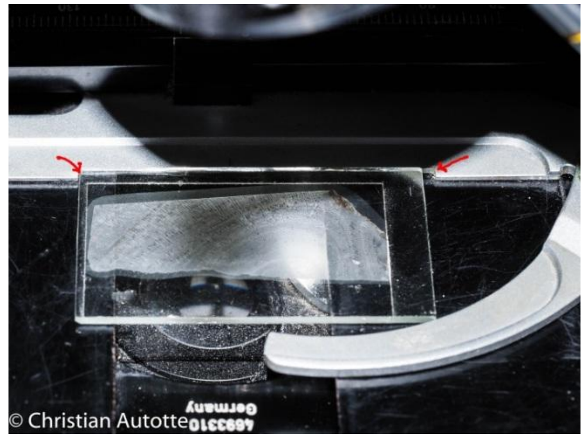
Two polished fossils that surprised me with the amount of details that could be seen. Above, I bought this piece of fossilized coral that was cut and polished to make a necklace. At left, the fossil was photographed with a 4x microscope lens on extension tubes (68 mm) and a full frame camera. Because the stone was given a rounded shape I had to stack a few pictures to keep everything as sharp as possible. The second shot was made on the microscope at 30x (stack of 10 pictures).

Below is a piece of fossilized wood (oak?) at 40x and 100x. Considering that it is photographed with episcopic lighting the amount of details is truly amazing; it almost look as if the light is shining through the fossil to reveal individual plant cells.





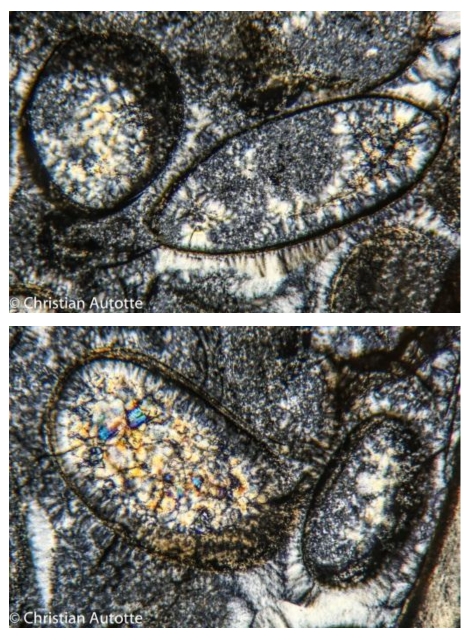
Once you start polishing, it may be possible to go one step further. As with minerals, it is possible to make thin sections with fossils. You start by cutting and polishing a specimen which is then glued on a microscope slide. The mineral or fossil is polished further until it is thin enough for light to shine through the specimen. There are some specialized slides that exist for mineralogy, they are called Petrographic Microscope Slides and measure 46x27x1.2mm. Some people may be surprised to learn that the slide holder on the mechanical stage of their microscope has a small notch to accommodate slides of that size. Two of mine are so equipped. While it may not be sized specifically for mineralogical specimens, a standard microscope slide could be used in a pinch. I will have to try making such slides of my own in the future.



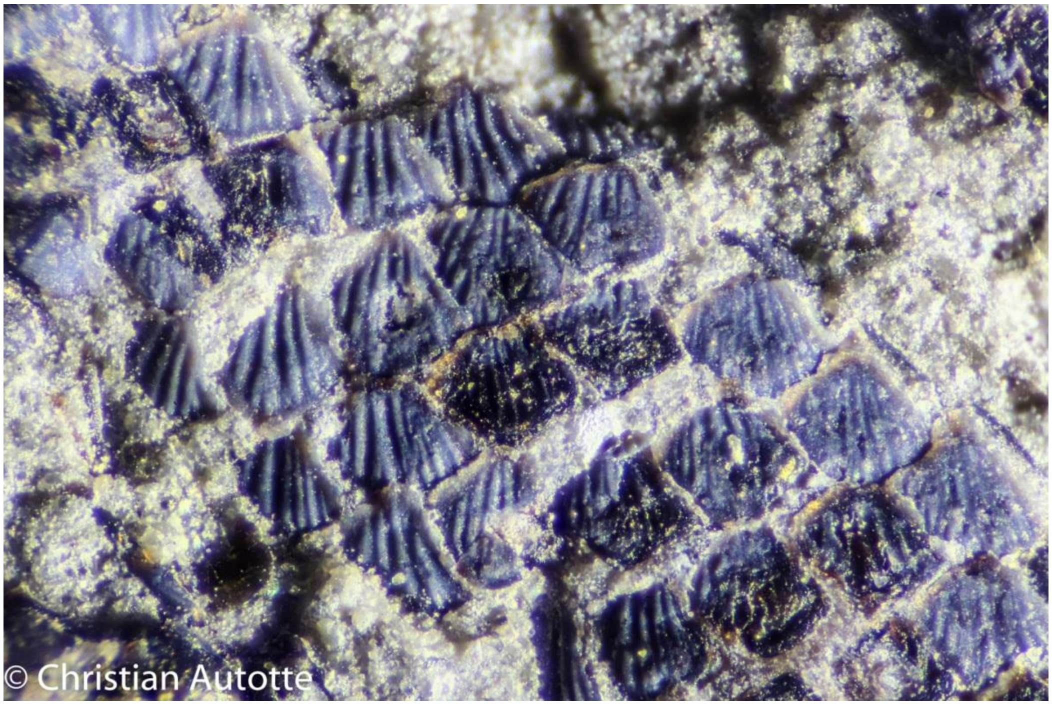
In the meantime, it's possible to find professionally made thin sections on eBay. I recently found a section of Elimia snail fossil filled with ostracods for $5.00 US. Until my expertise at making thin sections improves, I will keep looking for more such slides to add to my collection.

Fossil ostracods in bright field, 40x. Below is a panoramic assembly of 20 pictures shot at 40x. That picture shows the walls of the snail inside which the ostracods are tightly packed

As it is with many minerals, viewing these thin slides under polarized light can be very interesting.



Fossil ostracods at 100x, in polarized light.



Fossil fish scales, 40x, stack of 9 pictures.

Magnification is one thing, proper lighting is another. This is a small patch of fossilized fish skin I found on a local beach. At 40x we can clearly see the individual scales. But more important to resolve details was the light: if lighting had come from a higher angle the small grooves of each scale would not come out as clearly as seen here. As always, proper photography begins with proper light.

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