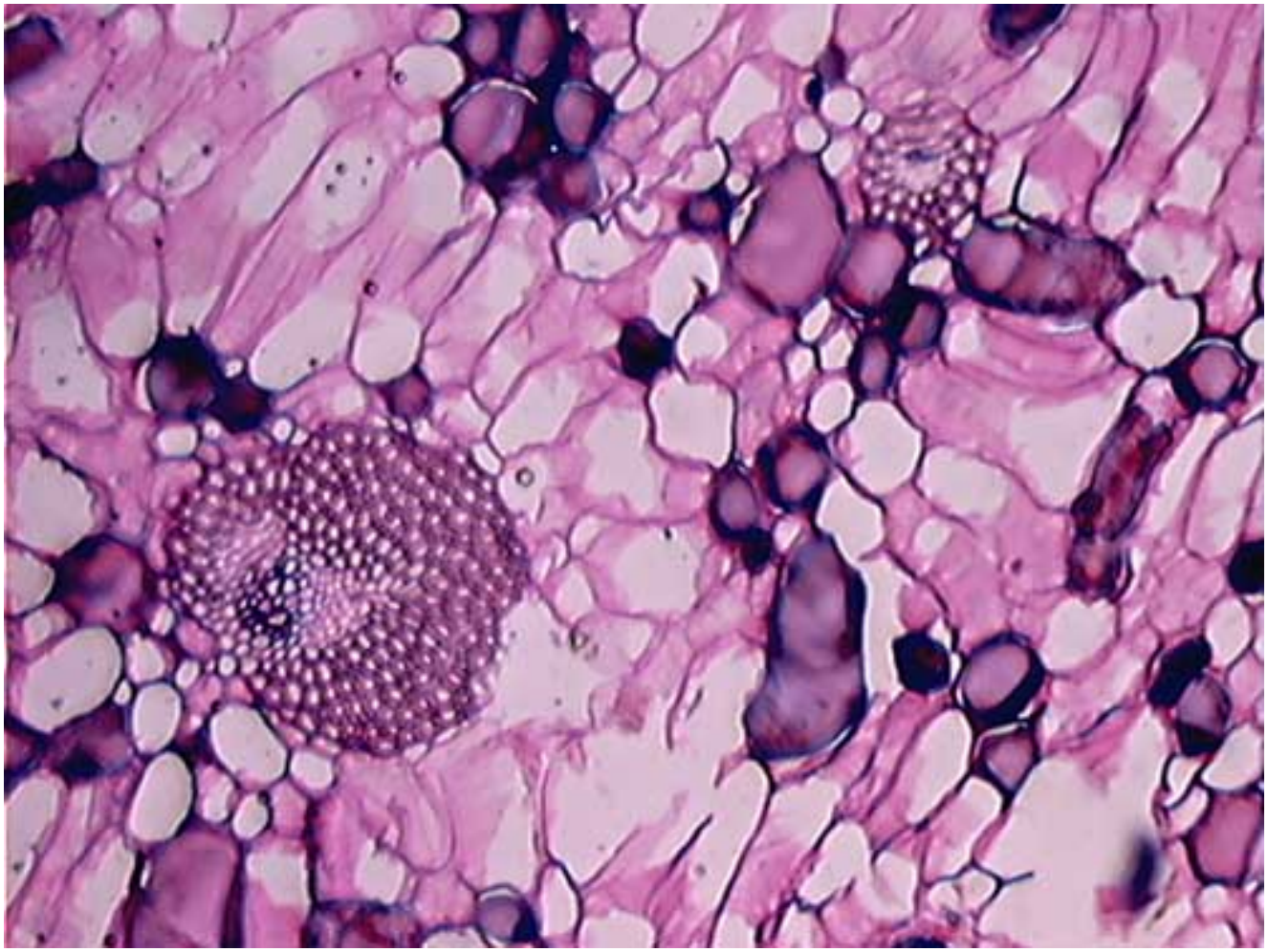
The Wonderful World of Amateur Digital Microscopy

or

"How To Get Your Astrophotography Fix During Times of Poor Weather"

Ever wonder what is inside your average coconut?
by Mark Estes Click to email author



Editors Note: Mark and Wendy Estes own and run Digitec Optical. A reseller of telescopes and astrophotography equipment.

It almost goes without saying that astrophotography is one of the most rewarding and enjoyable parts of astronomy. When the weather is good, many of us are out there grabbing as much raw data as possible, and spend sometimes weeks processing the pictures into something useable. As is often the case, you invariably find yourself lacking new material to work with. This can be due to inclement weather, finicky equipment, getting poor results and so on. There never seems to be enough raw data to have fun with.

About a year ago, while needing a fix badly, it dawned on me that I should try using my normal CCD camera on my microscope to see what kind of results were possible. I don't know why I hadn't thought of this earlier, digital Microscopy has been around for a long time. I think its just one of those things that would seem more appropriate in a biological laboratory, and not at your computer desk. Well, it is easy, and cheap! The results are nearly always good and you can even use the same techniques and software that you presently use to shoot and process astronomical pictures. Given the variety of cool things to look at, you can create endless directories of stunning pictures while never having to leave the comfort of your desk. It is also a great method of familiarizing yourself with the operation of a new camera and software before getting under the stars with it.

Easier and Cheaper than Astrophotography?

Cheaper? Well, yes, for the most part. A nice microscope capable of this can be had for less than $300 these days, and you probably already own a CCD camera. Common telescope coupling devices will work on most microscopes, or can me made to work. Your attachment solution may already exist in your spare coupler box. Even though I own more expensive CCD cameras, I usually use a low cost SAC7 for microscopy as I enjoy using the live video. Most of the image noise is removed during processing.

Easier? You bet. You are working comfortably at your desk, no freezing weather or difficulty seeing the keyboard in the dark. Alignment of the images during processing generally isn't necessary as the subject never moves, making processing a snap.

Drawbacks and Difficulties

Lighting: There is a lot of available light coming through your microscope, sometimes saturating your CCD even when it is cranked all the way down and the CCD set for its fastest exposure. If your microscope comes equipped with a built-in light source with an adjustable iris diaphragm, that is usually all that is needed to get the light down to an acceptable level. You can make your own diaphragm if necessary using dark colored paper with a hole cut in the middle.

If you use a tilt mirror then you can simply tilt the mirror to adjust the light. As mentioned earlier, you can use filters either on the microscope itself, or screwed into the nosepiece of your CCD camera. Moon filters and polarizers work well for this.

Sometimes it is desirable to over-light a subject if it is translucent in nature, as most are. There are several pictures of a Honey Bee leg in the photo gallery where I cranked the light up to reveal some inner

structures. With a little practice you can get some really interesting results.

Focus: The depth of field on most microscopes is fairly short. If the subject is thick, you will be unable to bring the entire subject into focus vertically. If you make your own slides, try to keep the specimen as thin as possible. I like to use prepared slides a lot as most of them are manufactured from thin slices of specimens.

Dirt: Every single tiny speck of dirt and dust looks like a brick under the microscope. Specimen slides need to be cleaned before photographing them or you will spend hours in processing playing tricks to try to get rid of it.

Here's How I Do It

Start by attaching the CCD to the microscope and get your software up and running. If you have a CCD camera capable of live video, like any SAC camera or Meade electronic eyepiece, start with this because you can see your results in real-time.

Get the subject centered and focused. Just viewing this way is enjoyable enough without shooting pictures.

Use a combination of setting exposure times, camera gain, and adjusting the microscope's light for a pleasing image on the screen. You will probably see dust motes and other foreign material on the slide and the microscope optics. You should clean the slides before you start because there is almost nothing you can do to get that crud out of your completed picture. Dust motes however, are easily dealt with in most cases as I will show later.

Once you're all set, shoot 10 pictures in rapid succession, saving them to disk along the way. We normally shoot in color and if you do will get either a composite file for each frame, or more commonly 3 files for each frame (one for each color).

Now, its time to shoot a dark frame for later noise removal. Dark frames are easy on microscopes. Simply turn the objective turret until it is between objectives. No light gets in and this has the same effect as capping your telescope. If you like to average your dark frames like I do, shoot 5 or so of them in rapid succession, otherwise shoot one.

Now it is time to shoot a flat frame. How do you shoot a flat on a microscope? An acceptable flat can be produced simply by removing the slide. This gives a nice even field of light on most microscopes. Adjust the light so that it IS even, and saturates your camera about 50% or so. If you notice vignetting of any type, you can usually minimize or eliminate it by varying the focus. Shoot one or more flats as desired and save them. You now have all you need to generate the completed image.

Image Processing

I will describe the process for a monochrome image. If you are shooting color then modify the process accordingly.

Processing the pictures follows the same process as the astronomical stuff but is quite a bit easier. If you are shooting a fixed subject then there is no alignment to worry about! That is a big time saver because much of your processing time is usually taken by aligning pictures. Follow these simple steps to get the final picture.

- Average your dark frames together if you took more than one. This will make a master dark.
- Subtract your master dark from each of the flats you shot earlier.
- Average the dark corrected flats together into a master flat.
- Load your raw images and subtract the master dark from each.
- Divide your master flat into each of the raw images. This will remove all the dust motes and other brightness irregularities. All of your raw data frames are now calibrated. Save them.
- Stack (average) the frames together in the usual fashion to reduce noise and bring out more detail. This is my favorite part because there is NO ALIGNMENT NEEDED! That is, unless things shift a bit during the shoot. Heck, usually you don't even need to crop the pictures in most cases.

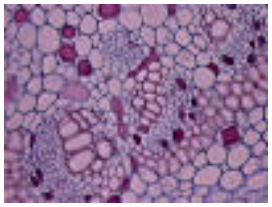
Usually, if I use a nice program like MaximDL, AstroArt or any of the others that have batch processing, I can take raw data to a fully calibrated 10 frame stack in just a few minutes if I stay focused on the task. The results are often stunning! Colors punch through strongly and give you a lot to work with in final processing.

You can create some interesting effects by varying the amount of light into the microscope. You can also use color filters on your CCD to great advantage, or on the microscope itself if your microscope has a filter tray built in. I have experimented for hours with this and have gotten some spectacular results, all very different, from the same subject.

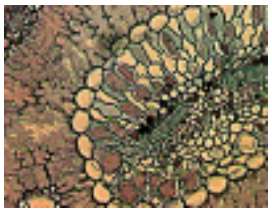
Amateur Digital Microscopy is FUN FUN FUN! The plethora of available subjects will keep you doing it for years. The micro-world can sometimes be beautiful, rivaling some of the best art hanging on museum walls. Plant matter can be especially beautiful at times. Make slides using the insides from various fruits and leaves. Play with the lighting and use filters. You can be really artistic with a little practice.

It can also be somewhat unsettling and even scary. Insects and many other subjects often look horrific when seen under a microscope.

Here are some examples of what I'm talking about. These were taken from our photo gallery.



Beautiful!
The specimen is a stained Indian Rubber Tree leaf. The intricacies of nature are sometimes beautiful and spellbinding. The insides of fruits and vegetables make great subjects for imaging.



This is a cross section slice of a pine needle. Thin sliced, prepared microscope slides eliminate a lot of work. Prepared slide sets can be had for about $15.00 each.

Horrific!

This is a view of a section of an Apis (Honey Bee) leg. In this shot I cranked the light way up to get some of the inner structures to show through. The microscopes short depth of field is evident here. If you look at the upper right side of the specimen you can see triangular shaped spikes that leave the field of focus as they travel down vertically. Try to keep your specimens as thin as possible.

Here is the same bee leg down at the tip. These shots are easy as they only require low magnification. Insects are really unsettling to view under a microscope.

The next time you get bored waiting for the sky to clear, give Microscopy a try. It’s easy, inexpensive, and will give you endless hours of enjoyment.