TRICK MAGNIFICATIONS

Having been a photographer for more than 45 years, I have accumulated several cameras, from full frame to micro 4/3. Many photographers have a tendency to view full frames as the best (if not the *only*) choice for serious photography. But if full frames may have some advantages in some situations it does not mean that they are the ideal tool for everything or everyone, something I have been teaching in photography workshops for many years. For instance, in wildlife photography a smaller sensor means that a given focal length can give more *apparent* magnification. My micro 4/3 300mm gives the equivalent magnification a 600mm would give on a full frame but at a fraction of the cost and size. The same kind of principle can also be applied in microscopy.

We use microscopes to increase our ability to see the very small, just like we use telescopes to magnify our vision of the very far. Like most amateurs microscopists, I can't afford modern top of the line microscopes that can cost tens of thousands of dollars. My microscopes are good, but many date back to the late 1960's. Their lenses are still serviceable, especially if I stick to the lower magnifications; 400x is pretty much my limit. So what to do if the organism I want to photograph is too small to fill the frame properly at such magnification?

I do own a few 100x lenses which would give me 1000x with the standard 10x ocular. All are oil immersion lenses, far from ideal when you need to chase after ciliates that are constantly moving about; they also slow things down when you need to quickly switch between magnifications. That's where different sensor sizes can become handy.

The full frame will be chosen when I want to cover a wider area, either when the subject is too big or I need to show the context of the closer pictures that follow. But it comes with its own problems. Diaphragm and condenser must be adjusted with precision to minimize the nearly unavoidable vignetting which appears as darker edges of the picture.

If I can get away with a slight crop of the image, I may switch to an APS-C camera. Most have a factor of 1.5, meaning that the apparent magnification is multiplied by 1.5x. In everyday photography, the magnification of a lens is calculated by dividing its focal length by 50 (the standard lens) to obtain its magnification. Thus a 300mm divided by 50 gives a magnification of 6x; in other words a subject will appear 6 times closer than with a standard lens. That's for a full frame. With an APS-C, the 300mm is multiplied by 1.5 and becomes the equivalent of a 450mm; divided by 50, it gives 9x of magnification. Move on to a micro 4/3 and the conversion factor is 2x. That's why my 300mm is equivalent to a 600.

A smaller sensor also has another advantage over full frame. With optical equipment design to be used with full frames, be it telephoto lens or microscope, a smaller sensor uses only the central portion of the image generated. That part of the image is usually the sharpest, with fewer distortions. In microscopy, unless you use a plan apochromatic lens the corner of the image can show a certain amount of chromatic aberrations and field curvature; using a smaller sensor will automatically improve the image.

Many mirrorless cameras, like my Olympus, also offer the possibility of using a digital converter, something that is common with compact cameras. When activated, the digital converter multiply the magnification by another factor of 2, but what is really interesting with my cameras is that the image is not simply cropped, which would lose pixels; the built-in software interpolate the image and add pixels to compensate. The final picture has as much resolution as a shot made without the digital converter. In some situations it can be a good way to add more reach to a long lens.

The same principles applies to microscopy; 40x multiplied by 1.5 = 60x equivalent for the APS-C and 40x multiplied by 2 = 80x equivalent for the micro 4/3. It quickly becomes evident that when we wish to fill the frame with the smallest subject the smaller sensor has a distinct advantage. However, smaller sensors tend to have lower resolution than their bigger sensors counterpart. The more recent full frame cameras have resolution that can be as much as 50 megapixels, while the best micro 4/3 is currently limited to 20 megapixels, but as with magnification there can be a way to cheat the system…

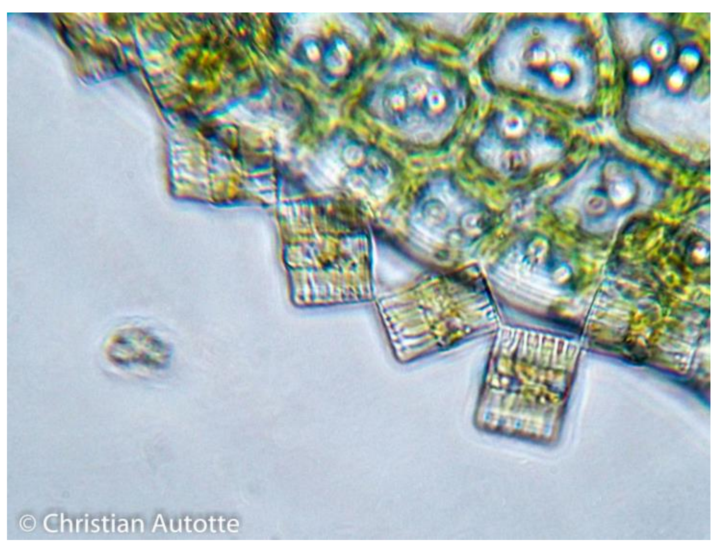
A few manufacturers have cameras that can combine a number of pictures to increase resolution. For instance, my OMD E-M1 Mark II has a base resolution of 20 megapixels, but in High Res mode it combines several pictures to create a single 50 megapixel image. The only drawback: because the camera takes a few seconds to take the shots this technique is restricted to inanimate subjects.

But do you need so many pixels? Contrary to popular belief, more pixels don't necessarily mean sharper pictures. Any camera from the past few years can produce pictures that will be reasonably sharp when enlarged to A4 or A3 photographic size (8x10 or 11 x 14 inches). More pixels will only be useful if you wish to make bigger prints or if the original is to be cropped before making a big enlargement.

And that brings us to the last of our tricks of magnification. When the subject is really small and the closer you can get still leaves too much empty space, cropping is always a possibility. The main problem is when the exact magnification must be included. Using 400x magnification on the microscope can become misleading: what size of sensor made the shot and was there any cropping? That is why scientific photographers wishing to show the size of a subject often include a scale in the form of a size line (ex. a one micron, 1 μm).

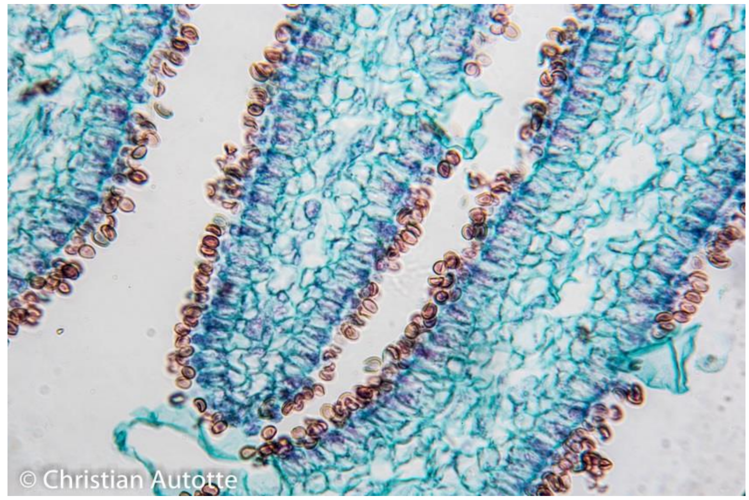
As I have been teaching for many years, when choosing a camera it is important to know what kind of pictures you take and what will be done with the pictures. Full frames are good in low light and to make *big* enlargements. They are also an advantage to portrait photographers who need shallow depth of field. For the rest, smaller sensors offer interesting alternatives.

Diatom



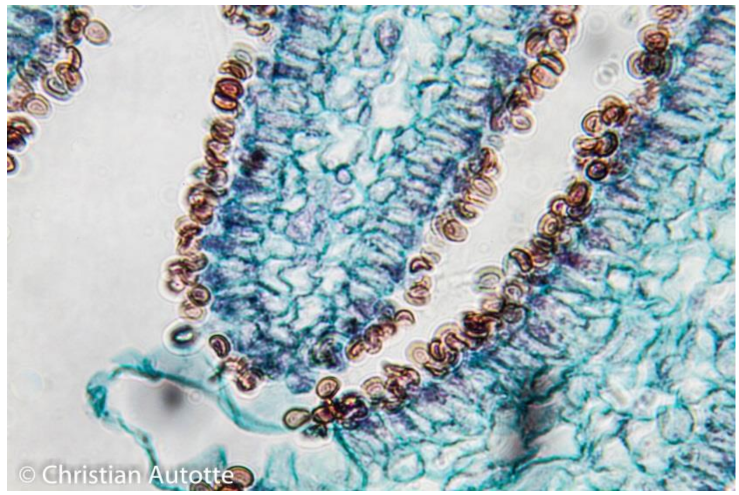
Fragellaria

Full Frame, 40x

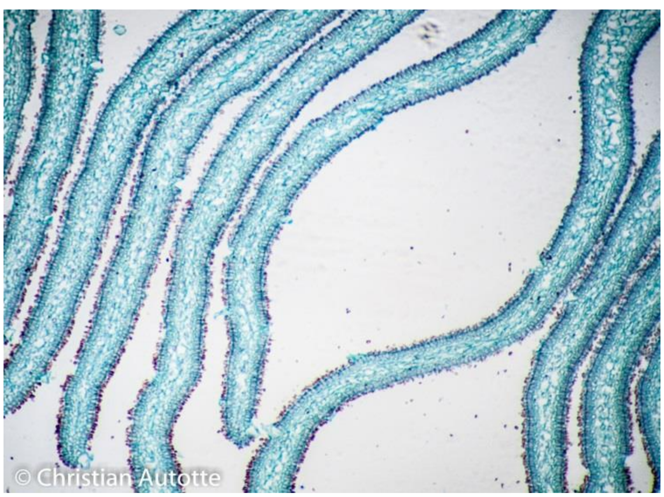


Full Frame 400x

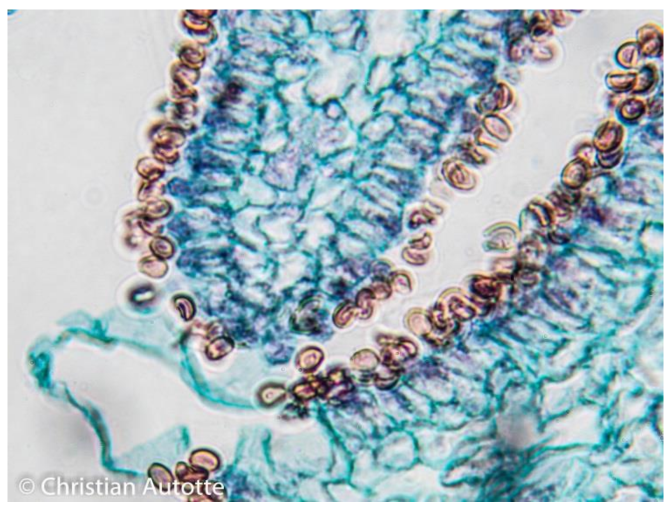
APS-C 40x (60x equivalent)



APS-C 400x (600x equivalent)

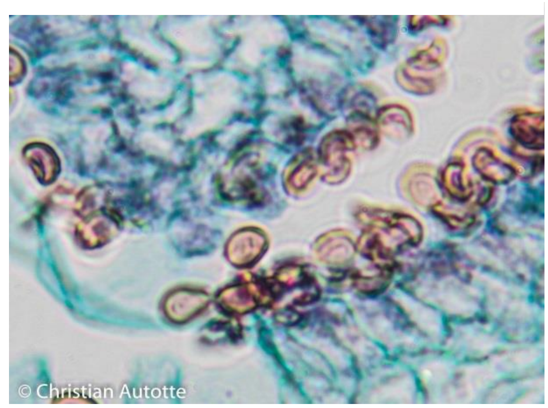


Micro 4/3, 40x (80x equivalent)



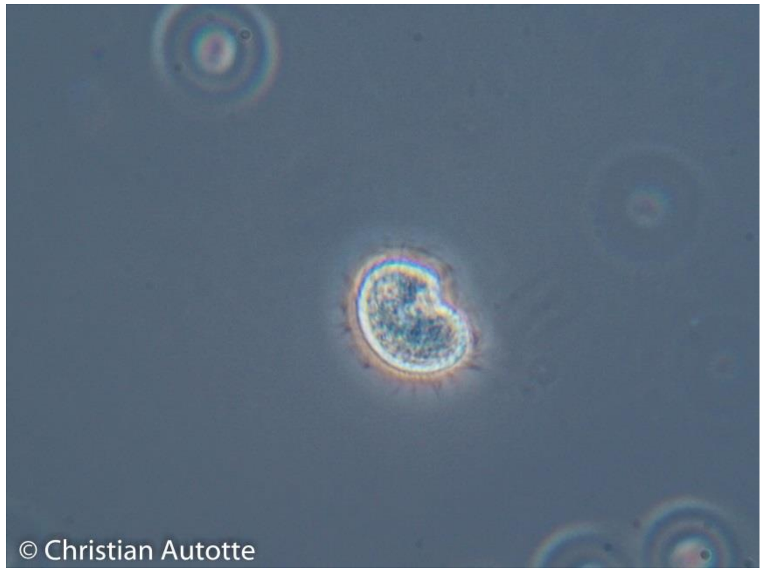
Micro 4/3, 400x (800x equivalent)

Examples of pictures shot at 40x and 400x on the microscope. The last picture (at right) was done with a Micro 4/3 and the built-in digital converter. It doesn't simply crop in the image; it also does some interpolation. So even if the final picture may not be quite as sharp, it has the same number of pixels and it's still quite acceptable for a number of use.



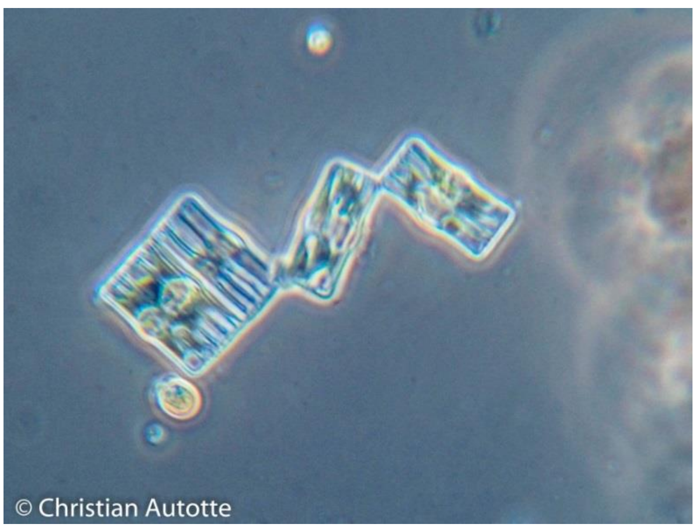
The pictures on this page were all done at 400x with the digital converter of my micro 4/3 camera.

Nematode worm



Ciliate

Colpidium



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