

Photomicrography a Marriage of Science and Art

Dr. Robert Berdan, Calgary, Alberta, Canada

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Fig 1. White Pine Wood viewed by Polarization microscopy

Science & Art

Can photomicrography produce art? I believe it can. Science and art are complementary ways of looking at the world. Science is a systematic process that employs an objective approach in its search for knowledge. Repeatability is essential for science in order to offer predictive value. Art on the other hand tries to communicate how one person feels about a subject and this maybe expressed using a variety of media. There are many different kinds of art: writing, music, sculpture, painting, poetry, and photography are some common types. Art is not supposed to be reproducible as it attempts to provide something unique. Visual art must engage or communicate with the viewer and make them feel and think about the subject portrayed. Obviously not every image can be considered art. Together, science and art are often considered the highest cultural achievements of human kind even though they represent different ways of examining our universe. Scientists and artists are often compelled to examine the beauty of our surroundings and the unsolved problems of our time and both employ experimentation to reveal new things. Creativity is an inherent element in both science and art.

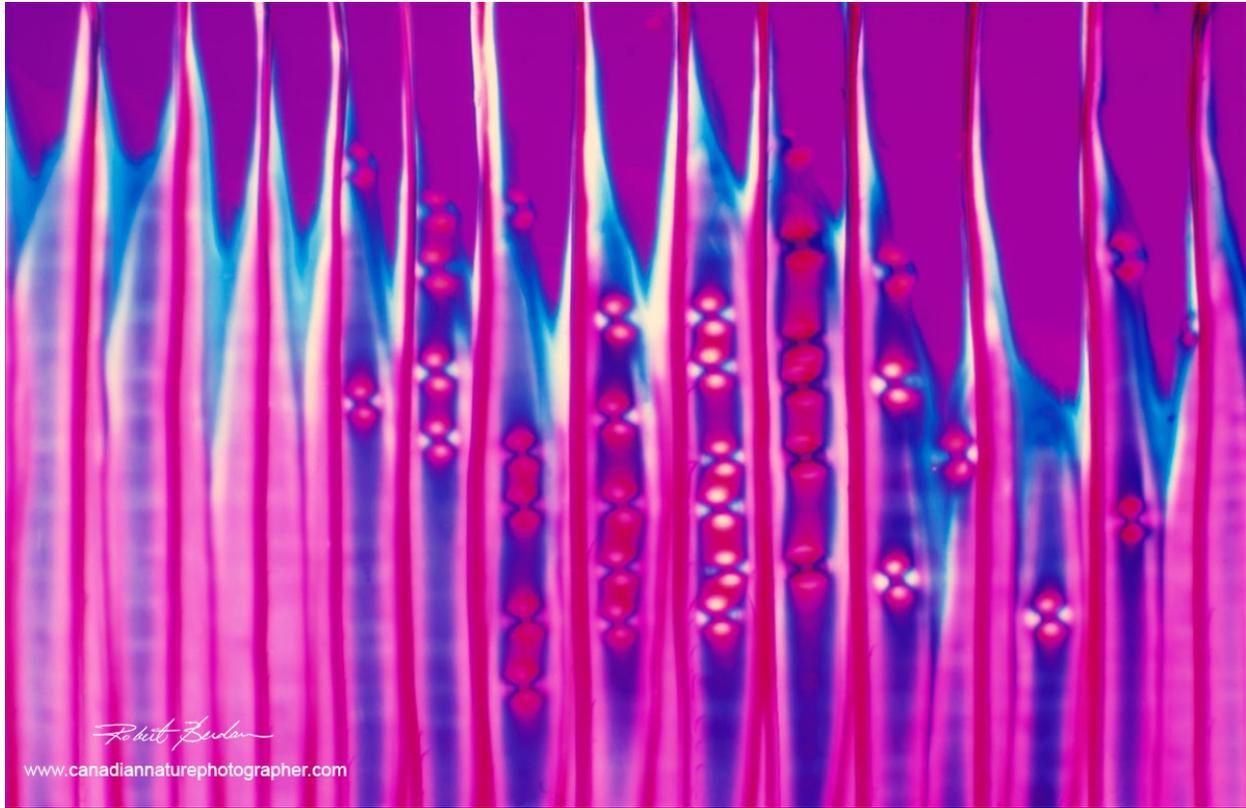


Fig 2. Section through White Pine as seen in Polarized light microscopy and a full wave filter 200X

Photomicrography can have two purposes 1) in science to show or reveal something new and 2) it can fascinate, or inspire us through shape, colour and pattern and thus produce art. To some folks photomicrographs appear abstract as the viewers may not know what they are looking at. I don't believe you have to know what the subject is to appreciate its beauty. One doesn't need to know the name of a flower to appreciate it. Not knowing what you are looking at can sometimes stimulate the imagination. The fact that art can engage or stimulate us is enough. Rachel Carson said "It is more important to feel than to know". Tools like cameras, telescopes, and microscopes can reveal things that most of us are unaware of and or have never seen. The information shown with a microscope can be beneficial to humanity as in the identification of pathogenic bacteria, or it may reveal how cells and microorganisms work.



Fig. 3. Citric acid crystals viewed by Polarized light microscopy and a full wave filter. About 100X.

I have been lucky to work as both a scientist and artist (photographer) and I would like to share some photomicrographs using a variety of techniques that I hope you might appreciate first for their aesthetics and then for the information contained. I started taking pictures with a microscope when I was 13 and it steered me toward a career in Cell Biology and Neurobiology research. After years of research I left to focus on teaching, learning Web Design and Nature Photography. I started my own business which I aptly called "Science & Art" because of my dual interests. Recently I have been drawn back to my passion for photomicrography which I now hope to help promote and popularize. One way I hope to achieve this is by writing articles and presenting pictures on the Internet.



Fig. 4. An arrangement of Freshwater Diatoms viewed by Dark-field microscopy. About 400X



Fig 5. Ciliates viewed by differential interference contrast (DIC). *Spirostomum minus* (top) and *Urocentrum turbo* (bottom) - are common in freshwater. The shape they produced in this image is suggestive of a cursive hieroglyph or Chinese character.



Fig. 6. Unidentified ciliate found in water sampled from moss – Family Euplotidae? DIC microscopy.

Taking pictures through a microscope has never been easier and can be done using a cell phone or a single lens reflex camera with adapters costing as low as \$20-\$100. I describe the equipment and techniques I use for photomicrography on my web site "[Tips on how to take better pictures through a microscope](http://www.canadiannaturephotographer.com/photomicrography_tips.html)" (URL: http://www.canadiannaturephotographer.com/photomicrography_tips.html). By using a digital camera there is no cost associated with taking the photos once you acquire the equipment. Modern digital cameras are more sensitive to low light than film and most offer an instant preview. Many digital cameras can also perform time lapse and record high definition video (2K and 4K). Software can be used to record and view the images on a computer live (e.g. [Digicam control](#) which is free). When viewing and photographing using Camera Live View there is no camera mirror induced vibration. Software like Photoshop, [GIMP](#) and [Helicon Focus](#) permits post processing of the image on a personal computer. With digital photography one can improve quickly and can experiment without incurring additional cost. There has never been a better time to take up photomicrography.

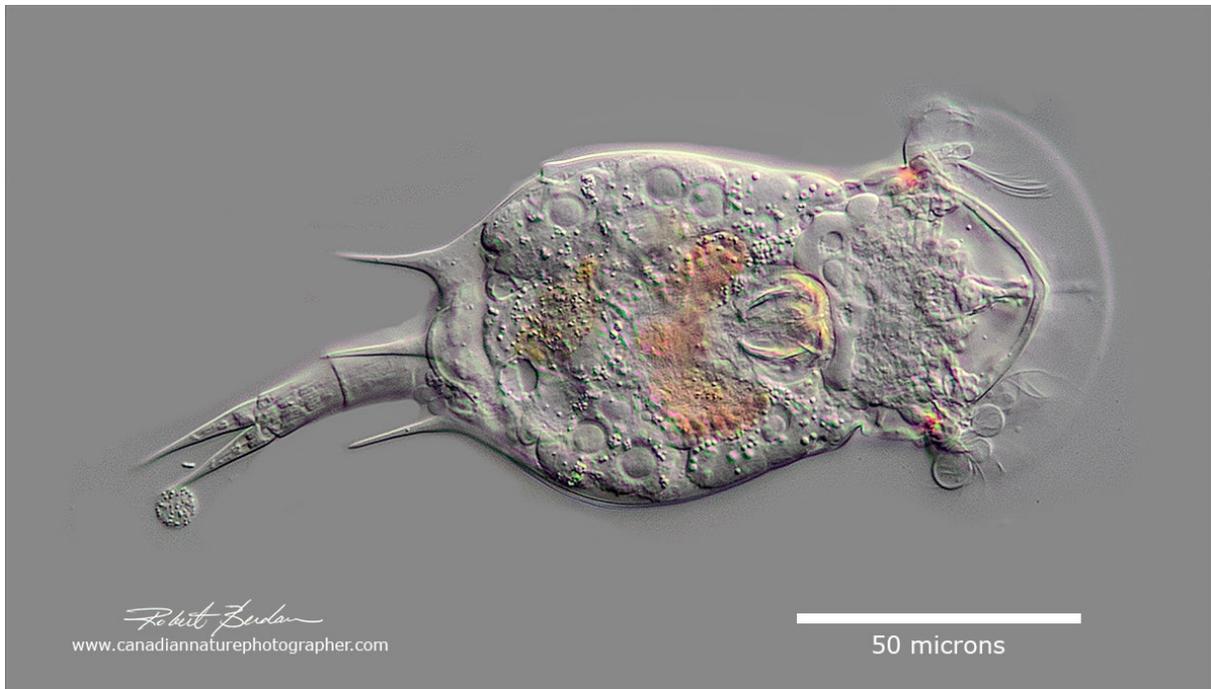


Fig. 7. *Squatinella rostrum* an alien-like looking rotifer - note 2 red eyes on the side of the head. DIC microscopy.



Fig. 8. Rotifer - *Platyias quadricornis* Ventral view of the Lorica - Stack of 15 images DIC microscopy.

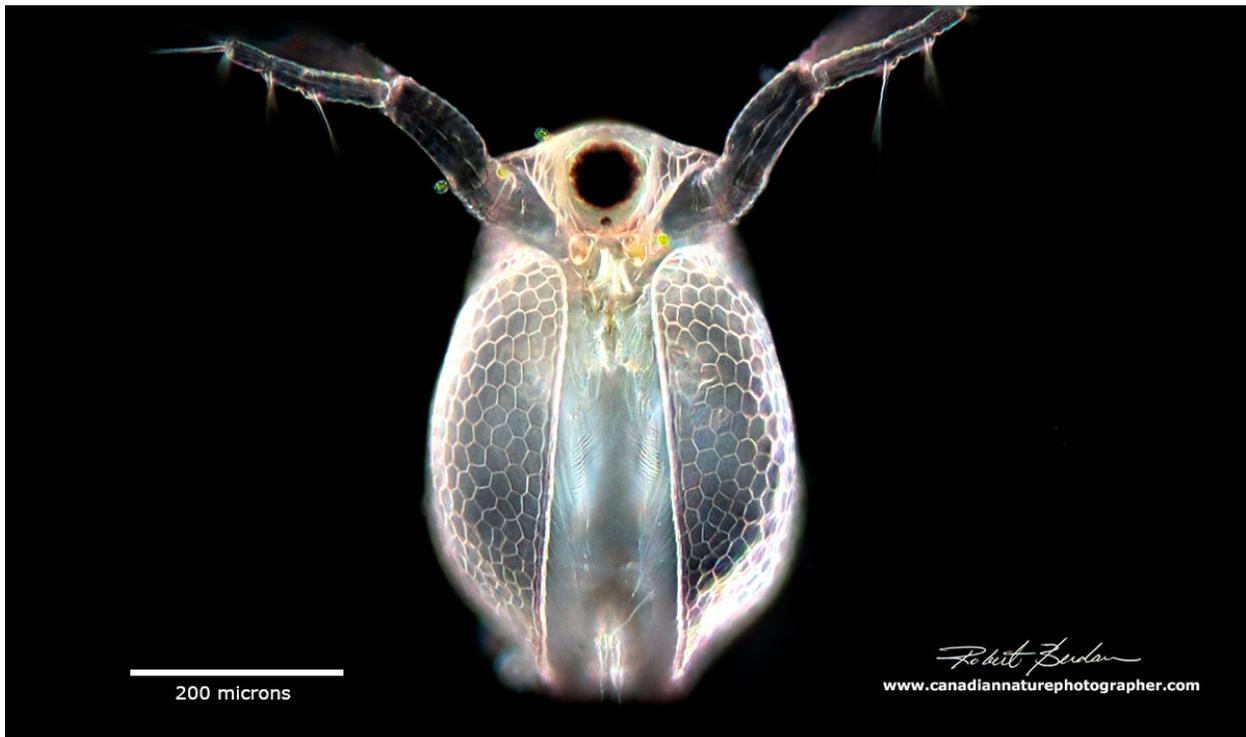
Photomicrography of some subjects poses challenges that require knowledge of the specimen and some preparation techniques. Depth of field is often shallow in microscopy, the higher the magnification, the shallower the depth of field. A shallow depth of field can be overcome by focus stacking which requires taking multiple photos of the same subject at different focus levels and then combining (stacking) the images into a single image. Sometimes 1-3 images is sufficient, other times it may take 30 or more images to achieve sufficient depth of field. The images can be stacked using software like Adobe Photoshop, Helicon Focus, and Zerene ([I recently reviewed these three stacking programs for photomicrography](#)). Stacking images is becoming a common technique used for both macro and photomicrography.



Fig. 9. *Stentor sp.* viewed by Dark-field microscopy - this photomicrograph resembles an abstract painting. 200X.



Fig. 10. Hydra ingesting a water-flea (*Daphnia sp.*) Dark-field Microscopy. About 100X



Water flea (*Daphnia sp.*) Focus stack Dark-field microscopy.



Brown Hydra hypostome Dark-field microscopy about 200X



Hydra viridissima - the Green hydra with a bud, bright-field microscopy. About 50X

Post processing of the image is an important component of digital photography for those that want the best results. In the past many professional photographers utilized a darkroom to process their film and made their own prints in order to achieve the best results. The same is true today, but processing is now done with software. Adobe Photoshop is the best image editing program that I know of but there are programs like [GIMP](#) available for free that will do many of the same things. RAW files provide more information and higher quality than a .jpg file. It is possible with Photoshop to modify the exposure, white balance, digital noise, and fix uneven illumination during post processing of either .jpg or RAW files. Processing can also remove sensor dirt or distracting elements in the picture. Digital editing is legitimate in science so long as it does not alter the biological integrity of the specimen. Digital processing is in fact widely used in research to improve image clarity. If one's intention is to produce art there are no rules. Photoshop can also be used to grab frames from a video which can be enlarged and printed. Most digital imaging techniques can be learned from online tutorials and step-by-step YouTube videos.



Eudorina elegans made up of 32 cells note the flagella - DIC microscopy about 400X



Volvox sp. DIC microscopy about 100X. The orange spheres are daughter colonies.



Volvox sp. viewed by a combination of Dark-field and DIC microscopy about 150X



Flatworm Class Turbellaria – 25X Dark-field.

In the future it seems likely that some microscopy techniques such as Phase contrast, Differential Interference contrast, Dark-field, Rheinberg lighting and others will be simulated using software ([Esslinger and Gross, 2015](#)). DIC can also be partly simulated using Oblique illumination ([Egmond, 2002](#)) and by using an Emboss or Bas Relief filter in Photoshop ([Dingley, 1998](#)) though so far in my testing these alternative techniques are not as good as the real thing – but they cost a lot less. With **confocal laser-scanning microscopes** software works in conjunction with the microscope to produce the images and hopefully these microscopes will become cheaper in the future.



Ciliate Subclass Hypotrichia – Phase contrast microscopy.



Tardograde (*Macrobotus sp.*) also called a Water-bear viewed by a combination of Rheinberg and DIC illumination. About 100X.



Stentor sp. with symbiotic algae *Chlorella* (yellow) via Polarized light microscopy. About 100X.

Photography, photomicrography and the processing of digital images use both science and technology. The art component is in choosing what to include in the frame and what to leave out and the image can be augmented by digital image processing. An understanding of visual elements of design and

composition can help make a more engaging photo. As a photographer I prefer clean backgrounds with even lighting and few distractions. Anyone who has looked through a microscope at living pond material especially with dark-field illumination knows that getting a clean background isn't easy to achieve. Also if your subject is too big to fit into one image at a particular magnification you can take overlapping photos and stitch them together to produce a panorama. I often take photos at higher magnification then stitch the images to produce a photo with more detail. In short, digital photography and image processing are more economical than using film, provides more flexibility, and better quality images. The resultant photomicrographs can be of value to science and also appreciated as art.



Autofluorescence of bottle brush spores from horsetail ferns about 200X

There have been a number of scientists and artists that have created art work inspired by the microscope and I can only mention a few. Robert Hooke drew amazing pictures of insects and fleas using his primitive microscope and published them in *Micrographia* 1665. Another scientist-artist was Ernst Haeckel who published "*Art Forms in Nature*" in 1862 and his book is still being reprinted today. Other notable photomicrographers include Roman Vishniac (1897-1990) and [Manfred Kage](#) (1935-). Some painters have also been inspired by photomicrography such as Gustav Klimt who painted "*The Kiss*" (1907) ([S. Santos 2015](#)). One only need look at the winners of the Nikon's Small World contest to see many beautiful photomicrographs. Photomicrographers frequently post some of their best images on www.photomicrography.net, Flickr and the photomicrographers own web sites from which we can all draw inspiration. Perhaps the most amazing tool available today is the Internet which allows us to learn and connect with others having similar interests including both artists and researchers. The number of science papers published on the web is increasing and this is putting scientific discoveries and

techniques within easy reach of common folk. We live in amazing times where anyone with a computer connected to the Internet can pursue an interest in both science and art even if it's just from an arm chair. Photomicrography lets us cross borders and produce a marriage between both science and art.



My home microscopy lab that occupies what used to be my photography darkroom.

About the Author

Robert Berdan is a professional nature photographer living in Calgary, AB specializing in nature, wildlife and science photography. Robert retired from Cell\Neurobiology research to pursue his interest in Science & Art.

Robert's web sites:

www.canadiannaturephotographer.com – articles on microscopy

www.scienceandart.org – art photography

E-mail: rberdan@scienceandart.org

Phone: 403 247-2457

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